Who Needs Dietary Supplements? Almost Everyone.

Even the most conscientious consumers find it difficult to get all the nutrients they need from food alone, and dietary supplements can help fill nutrient gaps. A sensible program of nutritional supplementation for most adults definitely would include a multivitamin, preferably with minerals. Other nutritional supplements could be added on the basis of a person's age, gender, and dietary pattern.

Much of the current research on nutrition and health focuses on the prevention of chronic disease. While this is obviously important, most people say the primary reason they use multivitamins and other nutritional supplements is to support overall wellness. For example, in one survey conducted for the Natural Marketing Institute, more than 60 percent of respondents said vitamin and mineral supplements were important to them for overall health and wellness, compared to about 20 percent who mentioned prevention of disease. (Dwyer, 2005)

OFFICIAL RECOMMENDATIONS

Scientists have put substantial effort into developing and revising nutritional recommendations over the years. The Food and Nutrition Board was established within the National Research Council of the National Academy of Sciences in 1940, and the first Recommended Dietary Allowances (RDAs) were presented in May 1941 in Washington, D.C., at a National Nutrition Conference called by President Franklin D. Roosevelt. The recognized purpose was "to recommend the amounts of the various nutrients that should be provided for the armed forces and also for the general population." (Roberts, 1958) The first published edition of the RDAs was in 1943, and it covered only calories, protein, two minerals (calcium and iron), and five vitamins (A, C, thiamin, riboflavin, and niacin). The RDAs were revised periodically through the Tenth Edition in 1989, by which time the coverage had expanded to include 13 vitamins, 12 minerals, and three electrolytes. Each edition was a small, single volume of text.

The RDAs have been the accepted reference value for desirable nutrient intake for almost 70 years. Beginning in 1994, the Food and Nutrition Board (now housed in the Institute of Medicine of the National Academies) undertook a broader approach to nutritional recommendations and for the first time proposed to consider reduction in the risk of chronic disease as a potential criterion for establishing recommendations for nutrient intake, in addition to consideration of nutrient requirements for maintenance of normal function. (Institute of Medicine, 1994) In the new recommendations, the RDA remains the key reference, but it is joined by three other values. Together, these four values are now called Dietary Reference Intakes (DRIs). The DRIs were published in a series of large volumes, beginning in 1997 and concluding in 2004, with each volume prepared by a different expert committee covering a limited set of nutrients: bone-related nutrients, B vitamins, antioxidant nutrients, trace nutrients (vitamins A and K plus 12 trace minerals), macronutrients, and electrolytes. The four volumes on vitamins and minerals are each 400 to 800 pages in length. (Institute of Medicine, 1997, 1998, 2000, 2001) A 500-page volume summarizing all of the DRI reports was published in 2006. (Institute of Medicine, 2006)

The DRIs will not be revised periodically in their entirety, as were the RDA books, but instead will be

revisited only when new scientific evidence requires a reappraisal of specific nutrients. The first major revision, relating to calcium and vitamin D, was published in 2010. (Institute of Medicine, 2010)

The RDA has historically included a "safety factor" over and above estimated nutrient requirements to account for variability in needs. In the new DRIs, the calculation of the safety factor is formalized. When there is sufficient information, an Estimated Average Requirement (EAR) is established, representing the amount of a nutrient that would meet the actual *requirement* for half of the people in a given population group. The RDA is derived by adding two standard deviations to the EAR. (In many cases, the standard deviations are not known with certainty and are based on estimates.) Thus, the RDA is always higher than the EAR, and the RDA remains the desirable target for individual nutrient intake. In some cases, there is not sufficient information to establish an EAR and an RDA. In those cases, an Adequate Intake (AI) is established instead. The AI is based on the amount of a given nutrient estimated to be consumed by groups of "apparently healthy people who are assumed to be maintaining an adequate nutritional state." (Institute of Medicine, 2006)

The RDA and the AI are intended as targets for individual intakes, and the EAR is a tool used by researchers to determine whether a population is at risk of inadequacy or deficiency. The UL, or Tolerable Upper Intake Level, is the "highest average daily nutrient intake level likely to pose no risk of adverse health effects for nearly all people in a particular group." (Institute of Medicine, 2006)

DIETARY REFERENCE INTAKES: EAR, RDA, AI, UL

EAR (Estimated Average Requirement)	Used to determine risk of deficiency for a population.
RDA (Recommended Dietary Allowance)	Target for intake of the individual. Defined as the EAR plus 2 standard deviations.
AI (Adequate Intake)	Target for intake of the individual when no RDA is established.
UL (Tolerable Upper Intake Level)	Upper level shown to be safe for use in a healthy population.

If people fall short of the RDA or the AI, they are falling short of the nutrient intake recommended for individual health. If a population falls short of the EAR, that population may be at actual risk of inadequacy or deficiency. To illustrate the difference in values, the table below shows the EAR, the RDA, and the UL for vitamin C and vitamin E for men and women. (Institute of Medicine, 2006)

EAR, RDA, AND UL FOR VITAMINS C AND E

NUTRIENT	EAR	RDA	UL
Vitamin C			
Women	60 mg	75 mg	2000 mg
Men	75 mg	90 mg	2000 mg
Vitamin E			
(all adults)	12 mg	15 mg	1000 mg

LOW INTAKE OF VITAMIN E

National survey data shows that 93 percent of Americans (of all ages and both sexes) get less than the EAR for vitamin E from their diets. (Moshfegh, Goldman, et al., 2005) Obviously, few people get the full RDA for vitamin E. If we are to take the RDAs seriously—and they are clearly meant to be taken seriously—we have a national problem with vitamin E consumption. A simple multivitamin could fill that gap, as could a separate supplement of vitamin E.

LOW INTAKE AND LOW SERUM LEVELS OF VITAMIN C

Vitamin C is a nutrient that is easy to get from normal diets, provided people eat some fruits and vegetables, yet national survey data shows that about one-third of Americans get less than the EAR for vitamin C from their diets. (Moshfegh, Goldman, et al., 2005) Almost half have vitamin C intakes that fall below the RDA and therefore could benefit from a multivitamin or a separate supplement of vitamin C to fill that gap.

Smokers need more vitamin C than other people, and higher recommendations are established for them—recommendations which more than two-thirds of adult smokers fail to meet. (Moshfegh, Goldman, et al., 2005) The greatest need is for smokers to quit, but in the meantime they should at least ensure that they are obtaining adequate amounts of the vitamins they need.

There is evidence that the current RDAs for vitamin C may actually be too low, which would make the shortfalls even greater. Dr. Mark Levine and coworkers at the National Institutes of Health have conducted depletion-repletion studies in men and women, measuring plasma levels, tissue levels, and urinary excretion of vitamin C over a wide range of intakes. In one study, seven young men were admitted to a hospital and put on a depletion diet until their serum levels fell very low without overt signs of scurvy. The men then were given repletion doses of vitamin C, allowing time for equilibration at each dose. The doses given were 30, 60, 100, 200, 400, 1000, and 2500 mg per day. The study lasted four to six months, depending on how long it took each person to reach a steady state on each dose. "Six of seven volunteers noted mild fatigue and/or irritability at depletion, without scurvy. Symptoms disappeared within several days of the 30- or 60-mg daily dose. Although fatigue and irritability have myriad causes, vitamin C deficiency without scurvy should be an additional consideration. Since fatigue and irritability are common symptoms and were so easily reversible, physicians should ask patients with these symptoms about vitamin C ingestion from foods or supplements." (Levine, Conry-Cantilena, et al., 1996) Urinary excretion did not occur until the dose reached 100 mg per day. The authors suggest that 200 mg would be a suitable RDA for vitamin C.

A similar depletion-repletion study was conducted in 15 young women who were hospitalized for five to seven months, depleted until serum vitamin C levels were very low, and then given increasing doses of vitamin C from 30 to 2500 mg per day, allowing the subjects to reach a steady state at each dose. The researchers concluded that the RDA for vitamin C for young women should be increased to about 90 mg, instead of the current level of 75 mg. However, they added: "Vitamin C, 200 mg daily, from fruits and vegetables might be needed in place of 100 mg of pure vitamin C, as it is possible that bioavailability from foods is less than that from pure vitamin C." (Levine, Wang, et al., 2001)

One of the first signs of poor vitamin C status is low energy. A study of serum levels of vitamin C in the 2003-2004 National Health and Nutrition Examination Survey (NHANES) found that seven percent of the population had serum levels so low that they could be considered deficient in vitamin C. Sixteen percent of

adults "had vitamin C concentrations that are associated with low energy and weakness as a result of inadequate intake of vitamin C. More than 20 percent of adults showed marginal vitamin C status, placing them at risk of vitamin C deficiency." (Schleicher, Carroll, et al., 2009)

LOW INTAKES OF SEVERAL VITAMINS

The NHANES data show shortfalls in several nutrients, not just in vitamins C and E. These data are summarized in the USDA report *What We Eat in America*. (Moshfegh, Goldman, et al., 2005) The report shows the percentage of each age and sex group that gets less than the EAR for many nutrients, but it does not directly show what percent gets less than the RDA. However, it is possible to calculate the approximate percentage of a population that falls below the RDA using the percentile levels of intake shown in the report. The following table shows both values—the percentage whose intakes fall below the EAR (from the report) and the approximate percentage whose intakes fall below the RDA (calculated from the percentile levels of intake shown in the report).

PERCENTAGE WITH VITAMIN INTAKES BELOW THE EAR OR RDA

VITAMIN AND POPULATION	PERCENT BELOW EAR	PERCENT BELOW RDA
VITAMIN A		
Men	57%	80%
Women	48%	75%
VITAMIN E		
Men	89%	Over 95%
Women	97%	Over 97%
VITAMIN C FOR NONSMOKERS		
Men	36%	45%
Women	32%	45%
VITAMIN C FOR SMOKERS		
Men	69%	75%
Women	84%	90%
NIACIN		
Men	3%	5%
Women	5%	20%
Women over 70	13%	35%
VITAMIN B-6		
Men 50-70	16%	30%
Men over 70	23%	35%
Women 19-50	22%	30%
Women 51-70	33%	50%
Women over 70	49%	60%

More than half of adults fail to obtain even the EAR for vitamin A from their diets, let alone the RDA. This shortfall could easily be remedied with a multivitamin containing a modest amount of vitamin A, preferably as a mixture of retinol and beta-carotene.

A large percentage of women fail to obtain enough B-6 from their diets to meet the RDAs or even the EAR. There is new evidence to suggest, however, that the recommended intakes for vitamin B-6 may be too low. Researchers examined blood levels of B-6 in relation to intake in a large national survey and concluded that intakes considerably higher than the current recommendations would be needed to avoid low blood levels in some population groups. Specifically, the authors concluded that vitamin B-6 intakes of three to 4.9 mg per day appeared to be more consistent with the defini-

tion of a Recommended Dietary Allowance than the current RDAs. RDAs are intended to meet the needs of 97 to 98 percent of the population for which they are established. The current RDAs of two mg or less for vitamin B-6 may not meet this objective. Thus, the gap in adequacy may be much greater than indicated by the table on page 8. (Morris, Picciano, et al., 2008)

These nutrient shortfalls are reason enough for using a multivitamin. Achieving recommended intakes is a desirable objective, and dietary supplements can help meet that goal.

LOW INTAKES OF IRON, ZINC, AND MAGNESIUM

A large fraction of the population also fails to consume recommended amounts of various minerals, and these shortfalls can have meaningful consequences. Low intakes of iron in women of childbearing age can have a negative impact on their ability to perform physical work as well as on cognitive function, and low intakes of zinc can have a detrimental effect on immune function, especially in the elderly.

PERCENTAGE WITH INTAKES OF SOME MINERALS BELOW THE EAR OR RDA

POPULATION GROUP	PERCENT BELOW EAR	PERCENT BELOW RDA
MAGNESIUM		
Men	64%	80%
Women	67%	80%
IRON		
Girls 14-18	16%	70%
Women 19-50	16%	85%
ZINC		
Men 51-70	20%	35%
Men over 70	30%	50%
Women 19-50	12%	25%
Women 51-70	18%	35%
Women over 70	36%	55%

Poor iron status affects cognitive function and behavior. Women of childbearing age are susceptible to iron deficiency and iron deficiency anemia. In a study of 149 women ages 18 to 35, those who were *not* iron deficient at baseline performed better on cognitive tasks and completed them faster. Women with iron deficiency anemia had the poorest performance, and women with iron deficiency but not anemia were intermediate between the two extremes. After 16 weeks of iron supplementation (100 mg ferrous sulfate), there was a five- to seven-fold improvement in cognitive performance and an improvement in speed of completing the tasks. "Iron status is a significant factor in cognitive performance in women of reproductive age. Severity of anemia primarily affects processing speed, and severity of iron deficiency affects accuracy of cognitive function over a broad range of tasks." (Murray-Kolb & Beard, 2007)

Iron deficiency, even without anemia, affects work capacity. In a study of 41 untrained women who were iron-depleted but not anemic, supplementation with 100 mg ferrous sulfate for six weeks improved the time to complete a 15-kilometer test on a stationary cycle and improved oxygen uptake. This suggests that iron deficiency "impairs adaptation in endurance capacity after aerobic training in previously untrained women. This impairment can be corrected with iron supplementation." (Brownlie, Utermohlen, et al., 2004)

Iron deficiency is believed to affect up to 16 percent of premenopausal women in the United States, because "suboptimal iron consumption and menstrual bleeding lead to negative iron balance." (McClung, Karl, et al., 2009) Women who engage in regular physical activity may be at greater risk, since such activity has a negative effect on iron stores. About 15 percent of the individuals serving in the U.S. military are female—amounting to over 340,000 women. "Maintaining optimal iron status in this population is critical because of the known contribution of iron nutrition to physical and cognitive performance." (McClung, Karl, et al., 2009) Iron deficiency reduces hemoglobin levels and

diminishes the ability to do physical work. Endurance and cognitive function may also be affected. During an eight-week study of 219 female soldiers, iron status declined during basic training. An iron supplement (100 mg ferrous sulfate) attenuated the decline, improved mood, and improved physical performance, compared to women who did not receive an iron supplement. (McClung, Karl, et al., 2009)

LOW INTAKES OF CALCIUM

Calcium is a nutrient that is hard to get in adequate amounts from normal diets, except for people who consume large amounts of dairy products. Dietary Reference Intakes for calcium were established by the Food and Nutrition Board in 1997 and revised in 2010. The recommendations are relatively high, equivalent to three or four servings of dairy products per day for many age groups. For example, the following table shows the Adequate Intakes (AIs) for calcium established in 1997 and the RDAs established in 2010 for teens and adults. (Institute of Medicine, 2006, 2010)

DIETARY REFERENCE INTAKES ESTABLISHED FOR CALCIUM

POPULATION GROUP	AI, 1997	RDA, 2010
Teenage boys and girls	1300 mg	1300 mg
Men and women, age 19-50	1000 mg	1000 mg
Men, age 51-70	1200 mg	1000 mg
Women, age 51-70	1200 mg	1200 mg
Men and women over age 70	1200 mg	1200 mg

National survey data show that about 90 percent of teenage girls, over two-thirds of women ages 19-50, and over 90 percent of women over 50 fall short of reaching these levels of calcium from diet alone. (Moshfegh, Goldman, et al., 2009) Men do somewhat better, but still fall short. Over 40 percent of men 19-50 and over 80 percent of men over 70 fail to get recommended amounts of calcium from diet alone. Obviously, the vast majority of girls, women, and older men could benefit from calcium supplementation. Most calcium supplements provide about 500 mg per tablet, plus some vitamin D. One tablet in the morning and one in the evening would virtually ensure adequate calcium intake and also provide a boost in vitamin D.

MULTIPLE SHORTFALLS

The previous tables show what percentage of the population falls short of obtaining recommended amounts of individual nutrients. Few analyses have ever reported how many people fall short in multiple nutrients, but one did. Many years ago, some researchers undertook an exhaustive analysis of the findings of the 1977-78 USDA National Food Consumption Survey, which included information on three-day dietary records from more than 21,500 people. Their analysis found that only 12 percent of the population consumed 100 percent of the RDA (averaged over three days) for *all seven* of the following nutrients: protein, calcium, iron, vitamin A, thiamin, riboflavin, and vitamin C. When they added three more nutrients to the list (vitamin B-6, vitamin B-12, and magnesium), they found that *not a single person* got 100 percent of the RDA for all 10 nutrients. (Crocetti & Guthrie, 1982) It would be very interesting to see such an analysis of current nutrition survey data; the results would undoubtedly be similar.

SUPPLEMENT USE IMPROVES DIETARY ADEQUACY

Researchers from the Department of Agriculture observed that "a large proportion of older adults do not consume sufficient amounts of many nutrients from foods alone" and examined whether supplement use helped fill the gaps. (Sebastian, Cleveland, et al., 2007) They confirmed that supplement use permitted more than 80 percent of supplement users to meet Estimated Average Requirements (EAR) for

eight nutrients, but some still fell short while others exceeded the UL for some nutrients.

Recognizing that "low intake of nutrients is associated with poor health outcomes," other researchers also examined whether supplement use helped people meet recommended levels of intake of several nutrients. (Burnett-Hartman, Fitzpatrick, et al., 2009) In a study of over 6,000 people, they found that supplement users were much more likely than non-users to achieve recommended intakes of calcium, vitamin C, and magnesium. Supplement users were also more likely than non-users to exceed the UL for these nutrients.

A recent analysis examined total calcium intakes from diet and supplements recorded in NHANES 2003-2006. Calcium supplements were used by more than half of men over 50 and women over 30, and the supplements contributed markedly toward achieving adequate intakes. (Bailey, Dodd, et al., 2010) In women over 50, the prevalence of inadequate calcium intake was about 92 percent when considering diet alone but decreased to 61 percent when the contribution of supplements was included. In these same groups, the prevalence of vitamin D supplementation was also substantial and contributed markedly toward adequacy.

Another recent analysis of data from NHANES 2003-2006 examined the contribution of dietary supplements and fortified foods to requirements for many nutrients by the U.S. population. (Fulgoni, Keast, et al., 2011) They found, for example, that 46 percent of the population fell short of the EAR for vitamin C, when considering intake only from naturally-occurring vitamin C in foods. The percentage falling short of the EAR was reduced to 37 percent when fortification was taken into account and was reduced to 25 percent when dietary supplement use was taken into account. For vitamin E, 93 percent of the population fell short of the EAR, when considering intake only from naturally-occurring vitamin E in foods. The percentage falling short of the EAR was reduced to 91 percent when fortification was taken into account and was reduced to 60 percent when supplementation was taken into account. Thus, fortification and supplementation both made a significant contribution to meeting nutrient requirements.

RATIONALITY OF NUTRITIONAL SUPPLEMENTS

Dietary improvement is a desirable goal, but changing dietary patterns is extremely difficult. On the assumption that it is better for people to obtain recommended amounts of vitamins and minerals than to limp along with low intakes, a multivitamin with minerals which can be purchased for less than a dime a day would clearly fill a number of known nutrient gaps. Additional calcium with vitamin D is also advisable for a large fraction of the population.

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