Vitamins for Chronic Disease Prevention in Adults
Clinical Applications

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In the absence of specific predisposing conditions, a usual North American diet is sufficient to prevent overt vitamin deficiency diseases such as scurvy, pellagra, and beriberi. However, insufficient vitamin intake is apparently a cause of chronic diseases. Recent evidence has shown that suboptimal levels of vitamins, even well above those causing deficiency syndromes, are risk factors for chronic diseases such as cardiovascular disease, cancer, and osteoporosis. A large proportion of the general population is apparently at increased risk for this reason.

Suboptimal Amounts of Vitamins
Suboptimal levels of a vitamin can be defined as those associated with abnormalities of metabolism that can be corrected by supplementation with that vitamin. For example, many people in the general population have serum homocysteine levels from 1.62 to 2.03 mg/L (12-15 µmol/L), which fall to baseline levels of 1.08 to 1.35 mg/L (8-10 µmol/L) after a few weeks of supplementation with folate, along with vitamins B6 and B12. Similarly, in many elderly people, methylmalonic acid levels fall with vitamin B12 supplementation, and elevated levels of parathyroid hormone fall with vitamin D supplementation. Measurements of vitamin levels in blood, serum, or red blood cells, at least with current reference points for abnormality, are not a reliable guide to this form of deficiency; in one study, supplementation substantially reduced serum homocysteine levels in elderly patients with normal serum folate concentrations.

For some vitamins, the concept of suboptimal levels is also supported by randomized trial evidence that supplementation reduces the rate of clinical deficiencies. Thus, in one study, supplementation substantially reduced serum homocysteine levels in elderly patients with normal serum folate concentrations. For some vitamins, the concept of suboptimal levels is also supported by randomized trial evidence that supplementation reduces the rate of clinical deficiencies.
VITAMINS FOR CHRONIC DISEASE PREVENTION

The high prevalence of suboptimal vitamin levels implies that the usual US diet provides an insufficient amount of these vitamins. Fruits and vegetables are the main dietary source of many vitamins, and health experts have long recommended at least 5 daily servings. A recent survey showed that only 20% to 30% of the population actually meet this goal. Although vitamin D is added to milk, many people (especially the elderly) do not consume enough dairy products to meet the generally recommended dose of 1000 to 1600 mg, well below the usually purchased dose of 1000 to 1500 mg, so people do not meet the goal of 400 mg/d. Food preparation may decrease the activity for some vitamins; for example, keeping food hot for more than 2 hours results in a more than 10% loss of vitamin C, folate, and vitamin B12. Vitamins are also lost during chilling, storage, and reheating, including more than 30% of vitamin C and folate. Alcohol consumption increases folic acid requirements, and aging is associated with decreased absorption of some vitamins such as B12.

Correcting Suboptimal Vitamin Levels

Three options exist for correcting suboptimal vitamin intake. First, physicians could counsel patients to improve their diet. This approach would be relatively inefficient if the only goal were to increase vitamin consumption because patients would have to be counseled individually, and it is difficult to get individual patients to change their diets. Nevertheless, dietary change is a central component of an overall program of preventive care. Foods contain thousands of compounds that may be biologically active, including hundreds of natural antioxidants, carotenoids, and flavonoids. For these reasons, vitamin supplementation is not an adequate substitute for a good diet.

A second option is to add vitamins to generally consumed foods. The United States has been adding vitamin D milk and some other dairy products since the 1930s because of the high prevalence of rickets and osteomalacia in northern climates at that time. Beginning in 1996, folate has been added to cereals to reduce the rate of neural tube defects. However, this approach is limited by popular mistrust of adding chemicals to food.

A third option is for individuals to take vitamin supplements. All major pharmacies carry their own brands of multivitamins as well as a variety of other brand name and generic multivitamins. The contents of basic multivitamins are remarkably similar across brands, with each having at least 100% of the daily value for nearly all vitamins (with the exception of vitamin K). In addition to vitamins, so-called multivitamins often contain other food supplements such as minerals and herbs. The amount of calcium in multivitamins is typically between 40 and 160 mg, well below the generally recommended dose of 1000 to 1500 mg, so one cannot depend on multivitamins for meeting calcium needs. Most multivitamins contain iron, whose supplementation may not be advisable for men and women menstruating women, given the high prevalence of the gene for hemochromatosis.

The cost for brand-name multivitamins may be around $20 to $30 annually, and some special formulations may cost a great deal more. However, one can easily buy large quantities (eg, 250-500 pills) of generic multivitamins for around $10 annually. We are aware of no evidence that the various multivitamins differ in bioavailability because of the way they are formulated. Patients can buy individual vitamins at an even lower price, which may make sense for women in the childbearing years, for whom folate supplementation might cost only $5 to $10 annually. Special multivitamins are sold for subgroups of the population such as active men, perimenopausal women, and the elderly. The Internet and health-food stores are filled with promotions for these special-purpose multivitamins, which are often costly. The only evidence-based arguments for taking more than a common multivitamin once a day pertain to the elderly and women who might become pregnant. The recommended intake for vitamins B12 and D in the elderly is closer to 2 times the dietary reference intake. For women who might become pregnant, folate at 800 µg/d is appropriate.

Some vitamins, such as thiamin, riboflavin, and niacin, have received little mention in this review. Although by definition severe deficiency of these vitamins is associated with disease, they have not so far been associated with chronic diseases. The absence of evidence that these vitamins are associated with chronic diseases might be because those associations do not exist, ordinary diets provide sufficient amounts to prevent chronic disease, or the research has not yet been done to discover these relationships.

Testing

Tests for vitamin levels in blood, serum, or red blood cells are now offered by commercial laboratories, as are tests for substances such as homocysteine that mark abnormal vitamin-related metabolism. The availability of these tests raises these questions: Would this additional information lead to better preventive or therapeutic interventions than might be offered without the test? If so, what kind of patients would benefit?

It is certainly possible that some individuals, because of their diets or genetic polymorphisms, have unusual vitamin needs. Many of these people can be identified by a simple review of their medical problems, including alcoholism. The MTHFR polymorphism, which is associated with low folate levels and perhaps increased rates of cardiovascular disease, is the best studied. The abnormal MTHFR gene occurs in 5% to 15% of the population and might have effects on diseases related to folate deficiency. The MTHFR gene would be detected only by specific testing not yet...
commercially available. However, re-
search into the metabolic and clinical ef-
facts of these disorders is in its infancy and not strong enough to confidently
lead to tailored supplementation pro-
grams. Therefore, we believe that test-
ing individuals who do not have a well-
recognized indication is premature.

Recommendations
We recommend that all adults take one
multivitamin daily. This practice is jus-
tified mainly by the known and sus-
pected benefits of supplemental folate
and vitamins B₁₂, B₉, and D in prevent-
ing cardiovascular disease, cancer, and
osteoporosis and because multivita-
mins at that dose are safe and inexpen-
sive. It is reasonable to consider a dose
of 2 ordinary multivitamins daily in the
elderly, specifically because of the high
prevalence of suboptimal vitamin B₁₂ and
D intake. However, it might be safer to
supplement 1 multivitamin with addi-
tional vitamins B₁₂ and D, taken sepa-
rately, given the possibility that in-
creased vitamin A intake might increase
the risk of hip fracture 9 and that the iron
in most multivitamins may increase the
risk of hemochromatosis in some people.
The increased folate requirement in people with high alcohol intake can be
met with 1 multivitamin daily or folic
acid supplementation alone. For women
attempting to conceive, a multivitamin
plus folate at 400 µg/d is appropriate,
given evidence of additional benefit with
higher folate levels. We recommend
multivitamins, rather than individual vi-
tamins, because multivitamins are sim-
pler to take and cheaper than the indi-
vidual vitamins taken separately and
because a large proportion of the popu-
lation needs supplements of more than
one vitamin.

Physicians often do not ask about vi-
tamin use. Patients may not volunteer
information about their vitamin use, fear-
ing that the physician would disapprove
of unconventional use of vitamins. There-
fore, physicians should specifically
ask about vitamin use with 2 goals in
mind. First, they should be sure that
patients know about the vitamin supple-
ments they clearly should be taking, such
as folate during the childbearing years.
Second, physicians should be sure the pa-
tient is not taking vitamins in harmful
doses, such as very large doses of vita-
misin D or even moderate doses of vita-
misin A during the first trimester of preg-
nancy. Within these rather broad limits,
we believe that physicians should be in-
terested and not directive, even when it
seems the patient has unfounded be-
iefs or apparently unhelpful practices.
In this way, physicians can avoid in-
curring a substantial chance of losing ac-
cess to important information about pa-
tients' vitamin use.

Additional Information
About Vitamins
The evidence base for the clinical ef-
facts of vitamins is increasing rapidly.
For physicians to keep up with new de-
velopments, there is no good alterna-
tive to electronic sources. The World
Wide Web includes a vast array of in-
formation on vitamins, most of it pro-
motional and self-serving. Physicians
can find the most updated and cred-
ible information at the National Insti-
tutes of Health Web site (http://www
.ni h.gov/ccc/supplements). In addi-
tion, Tufts University maintains an
excellent nutrition Web site, as well as
a Nutrition Navigator that provides
quality ratings for other nutrition
Web sites (http://www.navigator
.tufts.edu). This site includes appro-
priate information for patients and
health care professionals. Some text-
books and Web publications are con-
tinually updated as new research find-
ings are published. The Institute of
Medicine has published a series of
books on this subject as well, with ex-
tensive review of the existing litera-
ture at the date of publication.

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