



Vitamins and Minerals Are Important For Crewmember Health, But More Is Not Necessarily Better

Recommended dietary allowances have been established for all the important vitamins and minerals. Supplements may be necessary at times to fill a deficit caused by eating less than ideally nourishing meals. Nevertheless, dosages far in excess of the standard recommendations are of questionable value and may be dangerous.

*Stanley R. Mohler, M.D.
Wright State University School of Medicine
Dayton, Ohio, U.S.*

Aviation crewmembers can have difficulty maintaining a diet that includes the various nutrients essential to good health. During layovers, between flight segments or when time is limited, “junk foods” or “fast foods” are often the most readily available meals. A basic knowledge of essential nutrients, including vitamins and minerals, is useful to ensure that these essential substances are not neglected.^{1,2,3,4}

A vitamin is a substance required for certain metabolic processes, and plays a role in the life processes of cell; vitamin deficiency can result in illness. A person who becomes deficient in vitamin C, for example, can suffer vascular and connective-tissue problems. Most vitamins can be obtained only from foods and beverages. Thirteen vitamins are recognized as human nutritional requirements.

In the United States, the National Academy of Sciences operates a Food and Nutrient Board within its National Research Council which, through periodic meetings of specialists, establishes



recommended dietary allowances (RDAs). The RDAs for vitamins and minerals vary depending on a person's sex, age and weight, with additional differences for pregnant women.

Average RDA values are the basis for the U.S. Food and Drug Administration's (FDA's) Reference Daily Intakes (RDIs; Table 1, page 2), an easy-to-read guide for obtaining sufficient amounts of each vitamin and mineral, each day. It is not necessary to be compulsive about daily vitamin and mineral intakes. RDAs and their associated RDIs are targets for average daily consumption; if an individual

remains focused on healthful nutrition over time, sufficient intake should result.

Vitamins are classified into two basic categories: fat soluble and water soluble.

Fat-soluble vitamins are not readily dissolved in water, and are stored in body fat or the liver. The fat-soluble vitamins are vitamins A, D, E and K.

Table 1
Reference Daily Intake for
Important Vitamins and Minerals

Vitamin A	5,000 International Units
Thiamin	1.5 milligrams
Riboflavin	1.7 milligrams
Niacin	20 milligrams
Vitamin B ₆	2 milligrams
Vitamin B ₁₂	6 micrograms
Vitamin C	60 milligrams
Vitamin D	400 International Units
Vitamin E	30 International Units
Biotin	0.3 milligrams
Copper	2 milligrams
Folate	0.4 milligrams
Calcium	1,000 milligrams
Iodine	150 micrograms
Iron	18 milligrams
Magnesium	400 milligrams
Pantothenic acid	10 milligrams
Phosphorus	1000 milligrams
Zinc	15 milligrams

Source: U.S. Department of Agriculture

The other nine vitamins are water soluble and are not stored for long periods; whatever is not needed for nutritional processes is metabolized or expelled from the body in the urine. Thus, water-soluble vitamins require more frequent nutritional replenishment than fat-soluble vitamins.

Excess Fat-soluble Vitamins Can Be Toxic

The distinction between fat-soluble vitamins and water-soluble vitamins is worth remembering, because an excess of fat-soluble vitamins that is retained can be toxic. Vitamin A and vitamin D, particularly, can be harmful in excessive doses.

Vitamin A. This vitamin (retinol) is contained in milk, butter, fish and various meats. Vitamin A is associated with beta carotene; beta carotene consists of two molecules of vitamin A. Beta carotene — first discovered in carrots, from which its name is derived — is the usual form of vitamin A supplements, and is found in a wide variety of vegetables.

Orange, yellow and red fruits and berries contain this substance, along with variations referred to as carotenoids.

This vitamin is important for vision, for the maintenance of strong bones and for health of the skin. An excess can be toxic, causing excessive bone thickening (leading to improper functioning of joints, joint pains and possibly arthritis), headache and liver damage.

B-vitamin group. This vitamin group contains thiamine (B-1), riboflavin (B-2), niacin (nicotinic acid), pyridoxine (B-6), cobalamin (B-12), folic acid and pantothenic acid.

Meat, especially pork and liver, whole-grain bakery products, yeast, nuts, vegetables, whole-grain cereals and milk contain this group of vitamins. The B vitamins are used in metabolic processes that include brain, spinal and peripheral-nervous-system functions and in the blood-forming tissues.

Thiamine deficiency can lead to heart failure. Riboflavin deficiency has been associated with cracked lips. Nicotinic acid deficiency causes inflammation of the tongue and abnormal brain function. Inadequate pyridoxine can cause nerve and skin disorders. Biotin insufficiency can cause skin inflammation. Cobalamin deficiency causes pernicious anemia. Folic acid deficiency causes decreases in all blood-cell types. Pantothenic acid deficiency causes neurologic problems and burning sensations in the feet.

Vitamin C. This water-soluble vitamin is ascorbic acid. Most animals can manufacture their own vitamin C, an ability that enhances survival in the wild, but humans cannot synthesize this substance and must acquire it from dietary sources. A lack of vitamin C results in capillary fragility, with easily bruised skin. Connective tissue within the body also is markedly weakened.

Various citrus fruits are sources of vitamin C. Fresh orange juice and lemon juice are excellent sources, as are tomatoes and limes.

Vitamin D. Vitamin D may be available as D-2 (ergocalciferol) in yeast that has been subjected to ultraviolet light, or D-3 (cholecalciferol) in the liver oils of fish and the yolks of eggs. Vitamin D-3 is synthesized in the skin through the effect of ultraviolet light. Vitamin D promotes the maintenance of strong, adequately calcified, bones. Vitamins D-2 and D-3 may be found in fortified milk.

Vitamin E. This vitamin (tocopherol) is sold widely because claims have been made that it holds back the aging process, increases athletic endurance, enhances sexual capabilities and reportedly has many other highly beneficial effects. Tocopherol was identified in the mid-1930s as a requirement for rats (both male and female) to produce offspring (the word, tocopherol, means “birth bringing”). In the developing alphabetical listing of vitamins, tocopherol was assigned

“E.” A deficiency leads to fragile red blood cells and to nerve damage.

Vitamin E is cited for its antioxidant effects, that is, its ability to counter any free radicals that may be produced during metabolic processes or by ionizing radiation. It is believed that free radicals may play a role in development of cancer and degenerative diseases such as cardiovascular disease and arthritis.

The evidence for conditions resulting from vitamin E deficiencies comes largely from studies of animals. A human would have to be extremely deficient in nutrition and suffer multivitamin deficiencies before a syndrome of vitamin E deficiency would result. A diet that includes whole-grain products, wheat germ, oils from corn and soybeans, and fresh vegetables and fruits will provide sufficient vitamin E.

Vitamin K. This vitamin is necessary for the proper coagulation of blood. Vitamin K is obtained in leafy vegetables, vegetable oils, pork and liver. Normal intestinal bacteria also produce vitamin K.

Minerals Provide Some Elements In Body Tissues and Structure

Minerals. Various minerals are necessary for health because the body is partly constructed of these elements and uses them in the operation of metabolic-energy cycles. The replenishment of each mineral varies, depending on its use in the body and the body’s ability to retain it.

Minerals are categorized as either macrominerals or microminerals.

Macrominerals (calcium, magnesium, phosphorus, potassium, sodium and sulfur) are so called because they are vital to a good diet and are needed in relatively large amounts.

Microminerals (also called trace minerals) are needed in comparatively small amounts, but are nonetheless considered essential by nutritionists. Microminerals include iron, iodine, zinc, copper, fluoride, selenium, manganese, chromium, molybdenum and cobalt.

Like vitamins, minerals (in the requisite amounts) participate in the process by which cells metabolize carbohydrates, proteins and fats.

Fatty acids. Fats are stored in the body and are used as long-term energy resources, components of cell membranes and for maintenance of appropriate shape of body parts and insulation. Fats are made of constituents referred to as “fatty acids.” The human body cannot manufacture certain fatty

acids, which are referred to as “essential.” These essential fatty acids are obtained in various vegetable, meat and fish products.

Vitamins Surrounded by Many Facts and Claims

For many years, the merits of vitamin and mineral supplements (in the form of tablets or capsules) have been debated. The essence of the debate is whether there is a benefit in taking supplements that provide vitamins and minerals in quantities that go well beyond the RDAs.

Vitamins were discovered by identifying unknown substances whose lack caused diseases. For example, the British navy found that supplying its sailors with limes prevented scurvy. But it was many years later — in the 1920s — that ascorbic acid, the agent for scurvy prevention (and contained in limes), was identified in the laboratory and named “vitamin C.” (The word “ascorbic” means “without the disease, scorbutus [scurvy].”) It was relatively easy to determine how much of each vitamin was needed to prevent its associated deficiency disease, such as pellagra from niacin deficiency or rickets from vitamin D deficiency, but it has been much more difficult, scientifically, to assign additional benefits to vitamin use.

Nevertheless, according to some sources, dosages far higher than the RDAs do more than prevent deficiency diseases; they support “optimum” health.

In the United States, the FDA has jurisdiction over claims made in the labeling and packaging of supplements, and the Federal Trade Commission (FTC) publishes guidelines for advertising claims about supplements.

The FDA prohibits claims that supplements can cure diseases and requires that a supplement’s ingredients be listed, although it does not test products to certify that their contents match what is listed on the label.

The FTC describes its guidelines as based on two principles: “Advertising must be truthful and not misleading”; and “before disseminating an ad, advertisers must have adequate substantiation for all objective product claims.”⁵ The commission gives advertisers extensive information about factors that affect the validity of studies that purport to justify claims.

Implied Claims for Treatment Are Misleading

Nevertheless, some carefully worded claims *imply* that supplements can prevent or cure a vast range of illnesses. One Internet-based merchant of supplements, for example, says that

a combination of vitamin E and selenium in tablet form “possibly neutralizes certain carcinogens and provides protection from some cancers.”

If the word “possibly” applies to the whole sentence, it may be legally or technically correct, given that the word “possibly” is weaker than “probably” or “certainly,” and “some” offers a further hedge. Nevertheless, such statements are essentially meaningless, and give the false impression that there is a consensus on the subject.

There is no consensus about the value of supplements. Some nutritionists and medical doctors believe that some or all RDAs are unrealistically low. For example, one physician recommends a dosage of 100 milligrams (mg) a day of zinc, although the RDA is 15 mg.⁶ Another physician recommends that vitamin C be taken in dosages of 1,000 mg to 2,000 mg, two times to three times a day⁷ (compared with an RDA of 60 mg). The U.S. National Institutes of Health has proposed raising the RDA of vitamin C to 200 mg,⁸ and a recent article in *The New England Journal of Medicine* said that “on the basis of what we know about vitamin D, sick adults, older adults and perhaps all adults probably need 800 [International Units (IU)] to 1,000 IU daily” (compared with an RDI of 400 IU).⁹

At certain times, for medical or environmental reasons, a person may need more than the minimal amount of a particular vitamin or mineral. Medical doctors and nutritionists acknowledge that supplements of *specific* dosages of specific vitamins and minerals may be warranted for *specific* populations — for example, vegetarians or those on very-low-calorie weight-loss diets. Only on the advice of a physician should significantly more than a generally recommended level be taken regularly.

Individual Nutritional Requirements Vary

“Individual requirements of each nutrient are related to a person’s age, sex, level of physical activity and state of health,” said the British Nutrition Foundation. “Also, some people absorb or utilize nutrients more efficiently than others, and so will have lower-than-average nutritional requirements.”¹⁰

Nevertheless, most physicians are skeptical about the benefits, and concerned about the possible dangers, of drastically increasing the intake of vitamins and minerals through supplements. The medical literature on the subject frequently uses terms such as “unproven,” “questionable” and “controversial” in connection with the claimed health-giving properties of supplements.

One study, following the 10,758 participants in the first (U.S.) National Health and Nutrition Examination Survey, concluded that cancer mortality and overall mortality were similar in

regular users and nonusers of supplements.¹¹ Another group of researchers, examining the same data, reported that men with high dietary vitamin C consumption who used vitamin C supplements had lower overall mortality compared with otherwise-equivalent subjects who did not take vitamin C supplements.¹²

“These reports exemplify the limitations of survey data, which can yield different conclusions from different analyses of the same data set,” said the American Dietetic Association. “Rarely can a single study stand alone as scientific verification of a hypothesis. The results may be a statistically rare chance occurrence, results may not be representative of results in other populations, or beneficial effects may require longer studies or more sensitive testing.”¹³

If the benefits of high dosages of vitamins and minerals remain unestablished, there is less doubt about the toxicity of high dosages of vitamins A, B-6 and D, and some minerals. Vitamins A and D, both fat soluble, are toxic in dosages beginning at 10 times the RDA. Toxic effects of vitamin D, for example, can include nausea, headache, excessive urination, high blood pressure, kidney damage and other problems.

“Supplements of iron, zinc, chromium and selenium can be toxic at just five times the RDA,” said the Mayo Clinic.⁸

Vitamins Cannot Substitute For Good Diet

Vitamins are nutrients, but they are not food and do not in themselves provide energy. They are catalysts that enable the body to metabolize food efficiently. Taking the RDAs — or greater quantities — for every vitamin will not compensate for a poor diet.

There are reasons why it is better, if possible, to get vitamins and minerals from food than from supplements.

“Food contains hundreds of additional nutrients, including phytochemicals,” said the Mayo Clinic. “Phytochemicals are compounds that occur naturally in foods and may contain important health benefits. Scientists have yet to learn exactly what role phytochemicals play in nutrition, and there’s no RDA established for them. However, if you depend on supplements rather than trying to eat a variety of whole foods, you miss out on possible health benefits from phytochemicals. In addition, only long-term, well-designed studies can sort out which nutrients in food are beneficial and whether taking them in pill form provides the same benefit.”⁸

In the circumstances under which flight crews and cabin crews operate, it sometimes may be difficult to obtain the RDAs of vitamins and minerals from meals. If so, nutritional supplementation of vitamins based on a given individual’s

circumstances may be beneficial. Rather than guessing the value of a specific vitamin for supplementing a particular diet, a crewmember could take a multivitamin preparation to provide the major known requirements. ♦

References

1. Berkow, R. (ed. in chief). *The Merck Manual of Medical Information, Home Edition*. Whitehouse Station, New Jersey, United States: Merck Research Laboratories, 1997: 642–664.
2. Eades, M. *The Doctor's Complete Guide to Vitamins and Minerals*. New York, New York, United States: Dell, 1994: 1511.
3. Meydani, S. "Assessment of the Safety with Different Amounts of Vitamin E in Healthy Older Adults." *American Journal of Clinical Nutrition* Volume 68 (1998): 311–318.
4. Smith, S. et al. *Complete Book of Vitamins and Minerals*. Lincolnwood, Illinois, United States: Publications International, 1998.
5. U.S. Federal Trade Commission (FTC). *Deception Policy Statement and Advertising Substantiation Policy Statement*. Washington, D.C., United States: FTC.
6. Strum, S.B. "Recommendations: Vitamins, Minerals & Trace Elements." World Wide Web site <http://www.realtime.net/anrrda.html>.
7. Weil, A. "Vitamin Adviser." World Wide Web site <http://cgi.pathfinder.com/drweil/vitaminprofiler/results>.
8. Mayo Clinic. *Medical Essay*, a supplement to *Mayo Clinic Health Letter*, June 1997.
9. Unger, R.D. "The Need for More Vitamin D." *The New England Journal of Medicine* Volume 338 (March 19, 1998): 828–829.
10. British Nutrition Foundation. World Wide Web site <http://www.nutrition.org.uk>.
11. Kim, I.; Williamson, D.F.; et al. "Vitamin and Mineral Supplement Use and Mortality in a U.S. Cohort." *American Journal of Public Health* Volume 76 (1986): 287–289.
12. Enstrom, J.E.; Kanim, L.E.; Klein, M.A. "Vitamin C Intake and Mortality among a Sample of the United States Population." *Epidemiology* Volume 3 (1994): 194–202.
13. American Dietetic Association. "Straight Answers about Vitamin and Mineral Supplements." World Wide Web site <http://www.eatright.org/nfs66.html>.

Further Reading from FSF Publications

Mohler, S.R. "Routine Lifestyle Choices Can Reduce Performance and Increase Susceptibility to Diseases." *Human Factors & Aviation Medicine* Volume 43 (September–October 1996).

About the Author

Stanley R. Mohler, M.D., is a professor, vice chairman and director of aerospace medicine at Wright State University School of Medicine in Dayton, Ohio, U.S.

Mohler, an airline transport pilot and certified flight instructor, was director of the U.S. Federal Aviation Agency's Civil Aviation Medicine Research Institute (now the Civil Aeromedical Institute) for five years and chief of the Aeromedical Applications Division for 13 years.

Mohler received the 1998 Cecil A. Brownlow Publication Award for journalism that enhances aviation-safety awareness.

Mark the Date!

Hosted by

Embraer

Lider

TAM

Transbrasil

Varig

VASP

Enhancing Safety in the 21st Century



RIO
de Janeiro, Brazil

November 8-11, 1999

A Joint Meeting of the
52nd FSF annual International Air Safety Seminar,
29th IFA International Conference and IATA



International Federation
of Airworthiness



Flight Safety Foundation



International Air Transport
Association

For information, contact Ahlam Wahdan or Ann Hill at +1 (703) 739-6700

Visit our World Wide Web site at <http://www.flightsafety.org>

HUMAN FACTORS & AVIATION MEDICINE

Copyright © 1999 FLIGHT SAFETY FOUNDATION INC. ISSN 1057-5545

Suggestions and opinions expressed in FSF publications belong to the author(s) and are not necessarily endorsed by Flight Safety Foundation. Content is not intended to take the place of information in company policy handbooks and equipment manuals, or to supersede government regulations.

Staff: Roger Rozelle, director of publications; Mark Lacagnina, senior editor; Wayne Rosenkrans, senior editor; John D. Green, copyeditor; Rick Darby, editorial consultant; Karen K. Ehrlich, production coordinator; Ann L. Mullikin, production designer; Susan D. Reed, production specialist; and David A. Grzelecki, librarian, Jerry Lederer Aviation Safety Library.

Subscriptions: US\$60 (U.S.-Canada-Mexico), US\$65 Air Mail (all other countries), six issues yearly. • Include old and new addresses when requesting address change. • Flight Safety Foundation, Suite 300, 601 Madison Street, Alexandria, VA 22314 U.S. • Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708

We Encourage Reprints

Articles in this publication, in the interest of aviation safety, may be reprinted, in whole or in part, in all media, but may not be offered for sale or used commercially without the express written permission of Flight Safety Foundation's director of publications. All reprints must credit Flight Safety Foundation, *Human Factors & Aviation Medicine*, the specific article(s) and the author(s). Please send two copies of the reprinted material to the director of publications. These reprint restrictions apply to all Flight Safety Foundation publications.

What's Your Input?

In keeping with FSF's independent and nonpartisan mission to disseminate objective safety information, Foundation publications solicit credible contributions that foster thought-provoking discussion of aviation safety issues. If you have an article proposal, a completed manuscript or a technical paper that may be appropriate for *Human Factors & Aviation Medicine*, please contact the director of publications. Reasonable care will be taken in handling a manuscript, but Flight Safety Foundation assumes no responsibility for material submitted. The publications staff reserves the right to edit all published submissions. The Foundation buys all rights to manuscripts and payment is made to authors upon publication. Contact the Publications Department for more information.