# Dietary Supplements: A Review of Their Types, Benefits, and Harms

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**Abstract:** Dietary supplements include such ingredients as vitamins, minerals, herbs, amino acids, and enzymes. Dietary supplements are marketed in forms such as tablets, capsules, softgels, gelcaps, powders, and liquids. What are the benefits of dietary supplements? Some supplements can help assure that you get enough of the vital substances the body needs to function; others may help reduce the risk of disease. But supplements should not replace complete meals, which are necessary for a healthy diet – so be sure you eat a variety of foods as well. Why not obtain all your vitamins from the foods you eat? Foods we eat often don't always provide all the essential vital substances the body needs to function. For example, a review of studies found that persons who eat enough foods rich in vitamin E, selenium, and beta-carotene had a lower risk of developing lung cancer than persons who ate low amounts of those helpful vitamins. Since the early 1960s, more than studies have shown that eating a lot of fresh fruits and vegetables can prevent and even treat many kinds of diseases and many types of cancer.

**Keywords:** Supplements, Vitamins, Minerals

## 1. Introduction

For centuries, people have used the false hope of benefiting their health via dietary supplements. These people may include those who take supplements of specific vitamins or minerals and those who use such products as chelation therapy, echinacea, glucosamine-chondroitin, or coenzyme Q10. Some consumers are lured by the promise of defying aging or by the thought that similar substances, which are promoted as "natural," will enhance their health. Their reasons for using dietary supplements may be other than or in addition to their not consuming, in our "overfed" society, a balanced and nutritious diet. They may hope for beneficial effects from the supplements. A major adverse effect of low intake of vitamins and the deficiency diseases such low intake can cause took decades to discover [1,2].

At present, with the possibility of hazardous effects on health and quality of life from the use of some dietary supplements, it is time to review the topic. Many industry groups, health professionals, and others overstate the benefits of dietary supplements as part of an effort to encourage wider use of their supplements. After all, Americans currently spend over nine billion dollars a year on fish oil and other omega-3 fatty acids. This act has resulted in a lack of requirements for ensuring standards for these products akin to drugs. Buyers of dietary supplements believe in a myth that these products are safe and effective just because they are natural. No testing is required to ensure their truth [3,4,5].

## 2. Types of Dietary Supplements

Dietary supplements can be found in many forms such as tablets, capsules, soft gels, gel caps, liquids, and powders. For nutritional or dietary supplements, 94 different types of products are classified according to their ingredients. Vitamins are commonly used as dietary supplements. The fat-soluble vitamins are vitamins A, D, E, and K. Vitamin D, for example, can be synthesized in the skin by exposure to sunlight and is also found in foods such as fish liver oils and egg yolks. Vitamin D is necessary for normal calcification of the skeleton and for the maintenance of normal blood levels of calcium and phosphorus. Vitamin C is water soluble and is found in citrus fruits and vegetables (peppers, spinach, cabbage, turnip greens, and other leafy greens, as well as cantaloupe, strawberries, and

other fruits). Vitamin C is necessary for many metabolic processes. The B complex vitamins are all water soluble [6,7].

Based on importance, vitamin B12 is the most potent vitamin; however, this has little practical relevance since it is seldom used in individuals who are not deficient in vitamin B12. Vitamin B12 is involved in the replication of cells. Although marginal biotin deficiencies can be stimulated in large animals, this is rarely encountered in humans and animals. The primary importance of biotin seems to be its role in the intermediate metabolism of fatty acids and gluconeogenesis. The microminerals or trace minerals are needed in smaller amounts compared to the macrominerals, but are also critical for health. They include iron, zinc, copper, manganese, iodine, fluoride, selenium, and cobalt. There are developed guidelines to help individuals determine how much of the various minerals they need to remain healthy. Guidelines have also been developed for the minerals that are used less in dietary supplements and the ones that are used more frequently as individual minerals without considering the other minerals with which they might interact [8,9].

## 3. Vitamins and Minerals

Micronutrients are an essential type of dietary supplement that provides the body with necessary nutrients, even on the days when a deficit in a particular nutrient is present. The fat-soluble vitamins A, D, E, and K, as well as water-soluble B vitamins and vitamin C, need to be taken daily from food or supplements, as the body cannot produce them in sufficient amounts. Vitamins play crucial roles in natural processes such as growth, digestion, nerve functions, and maintaining an endocrine balance while also repairing cells and tissues. Water-soluble vitamins—B group vitamins and vitamin C—are essential in daily cell and tissue renewal processes. Fat-soluble vitamins participate in metabolic processes, including blood clotting and the transportation of nutrients through membranes. The negative effects of vitamin deficiencies affect, among others, relationships between macro- and micronutrients in the body, such as the dysregulation of calcium due to decreased levels of vitamin D. Aging and illness reduce the body's ability to take up nutrients from food, but dietary supplement intake may still correct specific nutrient deficits [10,11].

Minerals are essential nutrients the body requires to function appropriately. They catalyze essential reactions and participate in protein synthesis, bone mineralization, and muscle contraction, and minerals are essential to fluid management. The main minerals needed by humans are calcium, phosphorus, magnesium, sodium, potassium, chloride, and sulfur. Nutrient intakes should be evaluated regularly through dietary assessments in order to understand population-wide nutrient intakes and to inform public health policy. Dietary reference values for the intake of nutrients have implications for setting priorities for food and nutrition policy. Low intakes of vitamin D, calcium, potassium, and lower-than-recommended iron and iodine intakes have all been reported. Low levels of iron in the blood associated with anemia were related to a greater frequency of infection, while high levels were associated with perinatal mortality. The benefits and harms of mineral intake from dietary supplements are both potential concerns [10,12].

### 3.1. Common Types

Dietary supplements are meals or capsules containing different sorts of substances, such as dietary vitamins, minerals, amino acids, and other substances that may be essential for various bodily functions. As a result, the dietary supplements industry has grown tremendously, and consumers may take these dosage forms regularly wishing to enhance health, improve quality of life, or prolong longevity. Dietary supplements include a wide range of products, ranging from vitamins and minerals to protein powders, to biosynthetic products that support body metabolism, and to the products related to building muscle. The claims of reforming, supporting, or strengthening the body, without harming the balance or metabolism, are of particular interest to athletes. Nutritional and performance-enhancing dietary supplements regularly claim numerous benefits, including increased endurance, energy, muscle mass, recovery time from exercise-induced injury, and many others. Health and performance dietary supplements include three basic established categories, namely sports dietary supplements, weight management dietary supplements, and performance enhancement dietary supplements [13,14].

### 3.2. Benefits

An estimated 50% of adults in the United States reported having used at least one dietary supplement in the past 30 days. Because increased consumption of dietary supplements has been reported to enhance overall health, a wide variety of dietary supplements are currently available for use. More than 50,000 dietary supplement products are marketed and consumed in the United States alone. In this review, we considered the following dietary supplements: vitamins; minerals, including trace elements and lipid-soluble minerals; essential fatty acids; botanical and algae supplements; animal supplements; and biofractions, such as coenzyme Q10 and antioxidants [13,15].

Dietary supplements are distinct from nutrients present in the food that we consume. Dietary supplements are designed to augment our diets. Since the beginning of human life on Earth, it has been customary for humans to consume dietary supplements in order to enhance their well-being. For example, large ancient human populations that had no access to synthetic vitamins and minerals obtained these nutrients from fruits, vegetables, and whole grains. Widespread access to synthetic dietary supplements is a relatively recent phenomenon [7,16].

### 3.3. Potential Harms

Most dietary supplements have few proven benefits and lack thorough evaluation of indications and long-term effects. The use of specific substances as dietary supplements has hazardous aspects; for instance, the legal framework allows permissible concentrations of active ingredients to have unknown pharmacodynamics, possible additive or synergistic effects, and even competition among substances with different profiles. There is also the use of preparations that already have pharmacological effects. Often, the psychology of the patient refers to the association "natural = good," whereas the natural character of a substance does not imply that it has no potential for damage. Counseling services are needed to avoid possible harm from interactions between prescribed medicines and substances taken as dietary supplements, with patients often hiding their real consumption. The lack of a convenient flow of information about products taken as dietary supplements or environmental pollutants, or evidence of their harm, creates dangerous diagnostic and therapeutic voids [17,18].

Iron is the most abundant metal in the human body and is essential in many physiological processes, crucial for almost all living organisms. Iron supplementation is generally safe, but errors in dosage, misuse, or non-medical prophylaxis can result in iron toxicity, liver failure, and death. In previous case reports, the most frequent cause of exposure to elemental iron was the intake, ingestion, or chewing of vitamins. The problem can be solved by public awareness initiatives, reducing the availability of supplements containing harmful high doses of iron, time-locking the iron formulations, or placing the supplements in child-proof containers. Powdered substances consumed for weight loss are also available in health food stores or through shop-front clinics. Data on the intake and the adverse effects from these compounds are very rare [19,20]. Dietary supplements often contain multiple active ingredients that might cause more than one adverse event or interact with each other, leading to health problems. Despite the vital role of physical exercise in the prevention and treatment of most diseases and despite its health benefits, the use of dietary supplements promoting muscle mass gain, weight loss, or performance enhancement is a risky practice. Those that were banned or restricted are those that contain active substances that have been demonstrated to be harmful [15,21].

## 4. Herbal Supplements

Herbal supplements are products made from parts of a plant that are used for their flavor, scent, and/or potential therapeutic properties. In 2007, 17.7% of Americans used an herbal supplement. The passage of the Dietary Supplement Health and Education Act likely facilitated the use of herbal supplements in the United States. The act allows herbal products to be sold as dietary supplements without any proof of their effectiveness or safety. Herbal supplements alone were estimated to account for $7.5 billion of the $23.7 billion U.S. supplement market in 2007 [22,23].

In discussing herbal supplements, it is important to distinguish between two other types of supplements: supplements derived from plant sources and pharmaceutical plant extracts. Plant-derived supplements are widely used and include products such as cranberry, garlic, green tea, and soy. Cranberry supplements are commonly used to prevent urinary tract infections. Multiple clinical trials of cranberry products found that using the products did not decrease the frequency of urinary tract infections [24,25].

### 4.1. Types and Examples

Dietary supplements are products taken by mouth that contain a "dietary ingredient." The "dietary ingredients" in these products may include vitamins, minerals, herbs or other botanicals, amino acids, and substances such as enzymes, organ tissues, glandulars, and metabolites. Dietary supplements can also be extracts or concentrates and may be found in many forms such as tablets, capsules, softgels, gelcaps, liquids, or powders. They can also be in other forms, such as a bar, but if they are, information on their label must not represent the product as a conventional food or a sole item of a meal or diet. Whatever their form may be, dietary supplements are meant to supplement the diet and should not be substituted for a variety of foods [26,27]. For example, dietary supplements cannot take the place of fruits and vegetables, which are instrumental sources of nutrients including dietary fiber. The amount of nutrients in fruits and vegetables can be significant, and the proportion of nutrients possibly effective in reducing cancer risk may often occur at amounts greater than those provided in supplements [28,29].

Types of dietary supplements include, but are not limited to, the following findings: 1) Vitamins and minerals: Also known as micronutrients, vitamins and minerals are required in very small quantities relative to the other nutrients. Essential nutrients are compounds that the body cannot make or cannot make in sufficient quantity. So, the body must get them from the diet, and if it cannot get them, or cannot get enough of them, then a dietary supplement may be useful. 2) Bacteria and fatty acids: Fatty acids are also called micronutrients and are called "probiotics." These are organisms such as bacteria and yeasts, usually as part of dietary supplements, that are similar to organisms that naturally inhabit the human body. An organism may be used to maintain or restore the balance of related organisms in humans, animals, or the environment; such supplementation, while maintaining the balance of organisms in the gastrointestinal tract, for example, is considered beneficial to human health [30,31].

### 4.2. Efficacy and Safety

Dietary supplements are used to prevent or treat chronic diseases and are derived from plants, vitamins, minerals, amino acids, enzymes, tissues of organs and glands, and animal and algal substances. About half of all American adults use supplements, consuming an average of about 11 different compounds, and nearly two-thirds of all American adults use supplements of vitamins, minerals, or nutritional supplements. For most individuals, supplementing the diet with small amounts of specific nutrients will correct a deficiency. Rarely do people need to supplement the diet with more nutrients than what food can provide naturally. A marginal deficiency may result in small but significant reductions in performance, such as mineral or vitamin supplements. Vitamin and mineral supplements are also given to children who are medically poor, but individuals with anorexia or difficulty eating because of chronic illness are at increased risk of poor performance [32,33].

Concern for the efficacy and safety of dietary supplements stimulates nationwide health professional organizations to publish position statements to guide the public. Dietary supplements, they conclude, are not the first line of defense against chronic disease, nor is it acceptable to supplement the diet with large doses of individual nutrients or nutraceuticals, as the potential for misapprehension exists. Concerns about the safety of dietary supplements are well established. The Food and Drug Administration examines and identifies a new dietary ingredient within the environmental aspects of releasing a new genetically modified organism. The non-toxic dietary ingredient can be administered to humans and animals and is expected to be fully assessed by animal and non-human tests. Dietary supplements containing over-the-counter vitamins are mostly safe; however, they are also hazardous according to the study limitations. However, man and animal surveys suggested a characteristic profile of supplement-related adverse effects on human and rodent animal models, in which the dosing regimen is related to patient age, intrinsic disorder risk, timing of exposure, substance involved, study design, and study duration [34,35].

## 5. Protein Supplements

Protein supplementation is popular among athletes and gym-goers. In addition, it is often sold for people who have problems with protein absorption and oxidation or for pre- and post-operative use. Nevertheless, there is no scientific evidence proving the benefits of protein supplementation in healthy people. Many dietary protein supplements contain rice syrup, rice protein, and pea protein as the top three ingredients, while some contain amino acids as the top three ingredients. This contradictory fact reflects the confusion in legal regulations and consumer

knowledge about protein supplements. Nevertheless, it is certain that these two ingredients pose a public health risk. It is suggested to assess the content of ingredients and amino acids in protein supplements [36,37].

Protein is the material basis of life, and it has a significant effect on the human body. Generally, the more protein intake, the better the repair and recovery of the human body. Even during rest, when the body is warmed to its core temperature, protein provides 1–2% of the total energy. Typically, 1% of lean body mass is lost every 24 hours during extreme exertion, leading to body weight loss. During prolonged exercise, muscle protein synthesis is not balanced by protein breakdown; rather, much of the required amino acids are free from skeletal muscle protein, some using endogenous substances such as the tricarboxylic acid cycle intermediates or the plasma protein pool, and hungry eating habits or increasing protein intake. Sources of dietary protein, such as milk, soy, and eggs, are known to be equally effective. However, there is no scientific evidence proving the benefits of protein supplementation in healthy people. Many scientific studies using protein supplementation have concluded that protein supplementation has no additional benefit and that this group of people is already experiencing a higher protein intake than non-athletes [37,38].

### 5.1. Whey vs. Plant-Based

In the bodybuilding subculture, the choice of diet is important. This includes the use of dietary supplements such as whey protein, despite it being derived from animal milk, particularly when the latter would include a liquidation procedure that many vegans and bodybuilders are unlikely to agree on. So, is there a difference between whey and plant-based protein in terms of both muscle mass gain and nutrition? An experiment addressed this question with forty-two male physically active subjects aged between 25 and 30 who were first brought together physically on three sessions of resistance training per week during eight weeks. While there were six subjects that did not normally consume meat, there were eight that were deemed vegans. During this anabolic window, proteins derived from a supplement based on peas compared negatively to those derived from whey. There were no significant differences between the groups in terms of lean mass, rates of perceived exertion, or other side effects resulting from supplementation. This meant that isolation of the compounds in a given diet mattered less than whole foods to support muscle mass gain, and the provided proteins of either origin were used by the muscle being built [39,40].

### 5.2. Benefits for Athletes

Athletes may need to increase their daily intake of several vitamins to maintain their performances. In fact, biotin, pantothenic acid, folic acid, and the vitamins of the B group (i.e., B1, B2, B6, and B12) might be needed to sustain baseline energy requirements as well as the more specific requirements related to oxygen intake and utilization, and blood formation. Moreover, antioxidant supplements (i.e., vitamins A, C, and E), magnesium, zinc, calcium, iron, and proteins are usually taken by athletes as they have been shown to have positive effects on their physical performances. Sports nutrition has been shown to have a positive effect on the immune function of both untrained and trained individuals. However, more research needs to be conducted to verify these preliminary findings. If necessary, oral supplements of some herbal or botanical products are advocated as they have been shown to improve power or strength production, maintain homeostasis, and reduce the use of corticosteroids, anabolic steroids, or stimulants [41].

The effect of antioxidants on the immune response and the training process, reduction of exercise-induced muscle damage, anti-inflammatory effects, and volume replacement is significant. Vitamins may also contribute to the training process by reducing muscle pain and energy depletion during physical exercises. Athletes who engage in strenuous exercises may experience an increase in the production of free radicals. Moreover, after intense exercise, the body's first line of immune defense may suffer, with neutrophils that may be unable to adequately protect the body from infections. During recovery from intense exercise, there occurs a temporary immunosuppression, with an increased risk of the appearance of infections [42,43].

## 6. Regulation and Quality Control

Substantial federal regulation of dietary supplements passes through the U.S. Food and Drug Administration and other federal agencies, and this regulation appears to be ameliorating some of the most heightened public health concerns. The FDA does not regulate dietary supplements in the same way that it regulates conventional foods and

drugs. Manufacturers do not have to register most of their products with the FDA, and production facilities and marketing outlets for dietary supplements face lighter agency inspections compared with those of pharmaceuticals. There are "good manufacturing practice" regulations for dietary supplements, but compliance is spottier and there are no specific performance standards [44].

The Dietary Supplement Health and Education Act set forth the main current statutory regime governing dietary supplements in the United States. Products marketed as supplements have to meet the Act's definitions in order to qualify, and that definition is expansive and includes such items as vitamins, minerals, herbs, amino acids, and other natural substances. Moreover, manufacturers who market products under the mantle of a dietary supplement are not allowed to claim that the product treats, prevents, or cures a disease. That prohibition needs further explanation, as the qualifier "disease" is not defined in the Act or by the agency. Due in large part to the efficacy bar created by the Act, dietary supplements are allowed onto the market without the FDA's clearance for safety or efficacy. Subsequent to the marketing of these products, additional legal regimes come into play to police label claims, including health fraud, advertising, and trade law principles like unfair competition and false advertising [45,46].

## 7. Conclusion

In conclusion, many adults and children take dietary supplements to improve their health or well-being. Researchers have conducted extensive studies to evaluate their effectiveness and safety; more studies are ongoing. The evidence from final conclusive trials and systematic studies shows few benefits alone in using dietary supplements in a dose that's significantly higher than the recommended diameter for vitamins and minerals for general health and well-being among dietary supplement users. Foods and nutrient-dense beverages can provide the benefits of most nutrients and fiber needs. People's diets should contain the number of nutrients they need, and the nutrient measures should not exceed the recommended levels for nutrients. Small nutrient quantities are considered possible alternatives for certain health issues, but their effectiveness for these purposes varies.

Some adverse reactions have been linked with dietary supplements, with some being inefficient in treating or avoiding adverse conditions, providing a minimal health impact or presenting an unsafe health risk. In contrast to food, minerals, and fortified fibers, dietary supplements are not authorized and checked for health and wellness before they are developed and released into the market. Therefore, we need to understand the negative effects after their release for use, and their contribution is forbidden if found to be dangerous. Dietary supplements are a complete guide and a resource for individuals, consumers, policymakers, researchers, academics, and health care professionals that are available.

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