

Nutrition and Health: Incorporation of Food Supplements into a Healthy Diet

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Abstract

The increase in risk factors and the high prevalence of diseases associated with unhealthy lifestyles appear as the backdrop for many of the trends that define the dynamics of current societies around food. Throughout the world, the sustained increase in the number of people suffering from overweight and obesity or other diseases associated with a poor diet, as well as the severity and serious consequences they have for health and quality of life, are being the obligatory reference to implement changes in lifestyles. As part of this logic, changes in eating habits and consumption patterns have given way to a diversity of alternatives that seek a state of balance between health and nutrition. Weight control as a sole objective takes a back seat, instead prioritizing the search for comprehensive health, based on the consumption of healthy diets. As part of this diversity of options, the use of supplements and food supplements seeks to replace dietary deficiencies, as well as reinforce the levels of nutrients that may not be available in food.

Keywords: Healthy diet, Supplements, Complements, Lifestyles, Comprehensive health.

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Introduction

The global prevalence of diseases shows that deficiencies in dietary patterns are at the center of the main public health problems. Unbalanced diets have dissimilar and contrasting behaviors. On the one hand, there are those in which excess fats, refined sugars and calories contribute to increasing the number of overweight and obese people. On the other hand, those that do not meet the minimum essential requirements to guarantee healthy development, causing malnutrition problems (Fonseca et al., 2020). Although there are regions of the world live in a permanent state of food insecurity, this does not mean that there is a high prevalence of malnutrition. The case of Sub-Saharan Africa, one of the most vulnerable regions in the world, shows this situation. According to the FAO in 2014, in this region about 41 million children under 5 years of age were overweight or obese. In percentage terms, by 2016 it increased from 21 to 25%, and finally in 2022, they determined that one in 20 children suffered from one of these conditions (FAO, 2023).

This shows that despite the differences that may exist in different regions, lifestyles, consumption patterns and eating habits play a determining role in the health status of each person. Although there are genetic factors that can predispose to the development of a disease, the knowledge generated that the consumption of a healthy and balanced diet can reduce the risks has given rise to new trends in terms of nutrition. The interest in having a healthy diet is generating various positions that define what is healthy. For some, healthy is synonymous with organic, increasing the costs of foods that are grown under these characteristics, thereby affecting one of the dimensions of food security, related to access (Alzate, 2019).

From a different perspective, followers of veganism interpret what is healthy from a more holistic vision of food, seeking care for the environment and animals. For this reason, they exclude all foods of animal origin from their diet. In a very close position are the followers of vegetarianism. Although, like vegans, they exclude the consumption of meat in their diet, they do consume products of animal origin such as milk and eggs. Both positions assume that adopting these eating styles gives them access to healthy diets. However, opposing trends question the possible effects that the lack of nutrients provided by meat may have on health (Brignardello et al., 2013).

Recent proposals show the emergence of new alternatives, aimed at finding a state of balance between health and nutrition. Weight control as a sole objective takes a back seat, instead privileging the search for comprehensive health, based on the consumption of healthy and sustainable diets. Among these, the Mediterranean, Japanese and detox diets stand out, among others (Pérez-Cueto, 2015). The interest in improving health through food has led to collateral proposals, such as the production of probiotics, supplements and supplements (García, 2024).

Nutrition and Health

Food is a key factor in maintaining health. The consumption of a diet that integrates different types of nutrients in a balanced and varied way, as well as in the quantities necessary for the body to perform its nutritional and energy functions adequately, meets the requirements of a healthy diet (Andújar & Arbonés, 2009). A good diet promotes health by providing essential nutrients for metabolism. Likewise, to strengthen the body's immune response, and by preventing the increase in body weight beyond tolerable limits, it prevents the development of overweight problems, reducing the risks of developing other metabolic diseases (Lentjes, 2019).

Given that food decisively influences health, the composition of the diet must be in accordance with the characteristics and needs of each person, considering both their age, their habits, and the activities they carry out, it is essential. Ideally, a healthy diet should be formulated to provide the necessary energy, according to specific needs, ensuring above all that the calories ingested correspond to the level of activity performed (WHO, 2018).

Food Supplements

Supplements are products that provide nutrients to the body. Their function is to improve the well-being and health conditions of those who consume them. In their composition, they include both macronutrients (carbohydrates, lipids and proteins) and micronutrients (vitamins and minerals). For its preparation, herbs, plant extracts, concentrates or dehydrated fruits are used. Only some incorporate vitamins and minerals in their composition. Marketing forms include capsules, emulsions, suspensions, syrups, powders, solutions and tablets. These products are not drugs. Therefore, its ability to treat, cure, prevent or alleviate symptoms of any disease is null. Its function is to correct nutritional deficiencies, by replacing nutrients (Satia-Abouta et al., 2003; Binns et al., 2018). Table 1 integrates information about supplements and the function they play in the body.

Table 1: Food supplements

Type Of Supplement	Description	Organic Function
VITAMINS AND MINERALS	Known in the pharmaceutical industry as Multivitamins and minerals, in quantities according to each age stage. They generally include Vitamin C, Vitamin D, Zinc and Magnesium. They are the most basic and most consumed supplements.	They provide a correct supply of vitamins and minerals to the body. Adjuvants, in establishing dietary balance. Sometimes the resources obtained from food are insufficient. Especially in cases where the preparation method reduces the presence of said substances.
ESSENTIAL FATTY ACIDS	Supplementation of fatty acids commonly known as Omega 3, 6 and 9. They are fatty acids that the body is unable to synthesize. Its supplementation is of vital importance for organic functions. They come from fatty fish, such as tuna, sardine, herring, salmon, trout, anchovy, horse mackerel, sea bass and sea bream. Krill and algae.	They promote proper brain functioning. They provide eye protection mechanisms. They participate in the immune and inflammatory response. They regulate blood pressure. They contribute to the regulation of serum cholesterol and triglyceride levels. They reduce the risks of cardiovascular diseases. Regulation of blood pressure, platelet aggregation and blood lipids. They reduce inflammation. Control of Crohn's disease and ulcerative colitis. Induction of apoptotic cell death in cancer cells.
PROTEINS	Protein supplements or branched chain amino acids have a wide variety of presentations on the market. They are prepared based on whey, casein or albumin. It also includes some (amino acid supplements), whose presentation allows for faster absorption due to their composition (amino acids and peptides). They are available in ready-to-eat powders, gummies, protein bars, and shakes. Generally prepared with whey, egg albumen, casein, and beef. For vegans they are prepared with peas and soy.	They are frequently consumed by high-level athletes, regular gym goers, the military, police or similar, for whom the wear and tear and performance is greater. They help in the regeneration of muscle fibers. Regulation of blood pressure. Reduction of postprandial glucose levels in diabetic people. Improvements in performance and muscle mass. At the hospital level, the use of high-protein enteral formulas, used in patients whose nutritional status affected, mostly with sarcopenia.

Own elaboration

In recent years, the use of supplements is widely distributed throughout the world. Compounds such as minerals and vitamins, previously used as medicine to cure deficiency diseases. Today they fulfill the function of dietary supplements, created with the purpose of minimizing the risks of contracting a chronic disease (Lentjes, 2019). The impetus given to the development of these products is largely due to knowledge about the role of nutrients in health and physical condition, as well as the recognition of the importance of supplying them to strengthen the body. Part of this knowledge highlights the characteristics of nutrients, the interrelationships they establish and the determinants for their bioavailability, which has to do with the conditions necessary to assimilate and fulfill their well-being and health purposes (Fonseca et al., 2020):

a) Factors dependent on the conditions of the organism and effects on health

- The use of nutrients determined by the interactions they carry out in the body, as well as the nutritional status of the individual (Valencia et al., 2016).

- The homeostatic mechanisms of the body partly affect the breadth of the absorption ranges of minerals and vitamins, due to factors associated with the food matrix or diet (Valencia et al., 2016).
- The presence of the nutrient in structures resistant to the digestive process and the interaction in the gastrointestinal tract with other components decrease its absorption (Valencia et al., 2016).
- Calcium absorption in young women has a wide range, attributed to the different amounts of fat and fiber in the diets (Wolf et al., 2000).
- The lack of adequate consumption of minerals in the daily diet can have serious effects on health, generating impacts on the morbidity and mortality rates of the population (Tobón et al., 2009).
- Supplements made from amino acids interact with the microbiota. The use of amino acids by beneficial bacteria represents an important advantage both in health, nutrition, and in the efficiency of supplementation (Abdallah et al., 2020).

b) Determinants associated with nutrients.

- The nutrients contained in food do not exist in isolation. They depend on interactions with other components of the food matrix (Valencia et al., 2016).
- The chemical determination of the proportion of nutrients in a food does not determine the degree of actual use that the organism may have (Valencia et al., 2016).
- The absorbed nutrients, with the intrinsic capacity to be transported to the different tissues to be used by the organism through their incorporation into the metabolic processes in which they are necessary (Valencia et al., 2016).
- Lipophilic compounds such as vitamins A, D, E and K require the presence of lipids in the gastrointestinal tract for effective absorption (TFT, 2024).
- Hydrophilic compounds, such as vitamin C, dissolve rapidly in the gastrointestinal fluid. Sometimes this process happens too quickly without being completely absorbed (TFT, 2024).
- To provide their benefits, nutrients depend on the interactions they establish with other natural components of food. As well as those used to add them during their fortification, with the purpose of correcting highly prevalent nutritional deficiencies that affect the health of a certain population (Valencia et al., 2016).
- The size of the particles influences the solubility and dissolution rate of the solids, affecting the bioavailability, stability, rheology and content uniformity of the supplement (Valencia et al., 2016; TFT, 2024).
- The dissolution process, determined by the physicochemical properties of the functional groups, as well as the geometry and distribution of the surface active sites (Huang & Tong, 2004).
- Nutrients with smaller particles have a greater contact surface with the gastrointestinal environment, which facilitates their dilution and absorption (TFT, 2024).

The composition of Omega 3, 6 and 9 in the different supplements depends on the oil extraction technique used, the processes used and the raw material (Pasini et al., 2022).

c) Aspects related to the bioavailability of nutrients

- In a food supplement, bioavailability corresponds to the proportional part of the nutrient, digested, absorbed and used by the body to meet the purposes of improving the well-being and health of those who consume it (Valencia et al., 2016).
- Bioavailability, related to the speed at which nutrients are absorbed into the circulatory system and made available to the body for use (TFT, 2024).
- The level of utilization of a nutrient, determined by bioavailability (Valencia et al., 2016).
- Bioavailability represents the integration of an interaction between the diet and the individual who consumes it (Valencia et al., 2016).
- In a supplement, it is essential to know the bioavailability of the added nutrient, to determine the necessary amount to add, as well as to foresee the impact on correcting the nutritional problem that is intended to be solved (Valencia et al., 2016).
- Interactions between ingredients within a supplement, sometimes with significant impact on the bioavailability of its active components (e.g. iron is better absorbed when combined with vitamin C, as this vitamin reduces ferric iron to its more absorbable ferrous form) (TFT, 2024).
- For bioavailability, the minerals added to supplements must be in soluble form at the pH of the gastrointestinal tract to be absorbed (Valencia et al., 2016).
- The solubility of an active ingredient represents one of the most important determinants of its bioavailability (TFT, 2024).
- Ligands capable of forming soluble and absorbable complexes increase mineral bioavailability (Valencia et al., 2016).
- Interactions between ingredients within a supplement can have a significant impact on the bioavailability of its active components (e.g. iron is better absorbed when combined with vitamin C, as this vitamin reduces ferric iron to its more absorbable ferrous form) (TFT, 2024).
- Excipients (inactive substances used to transport the active ingredient) can influence bioavailability (TFT, 2024).
- Some additives can act as permeabilizers, improving the intestinal absorption of ingredients (Valencia et al., 2016).

d) Factors affecting the bioavailability of nutrients from supplements

Physiological (dependent on the subject)

- Age group
- Nutritional status of the individual
- Physical condition
- Previous intake
- Efficiency of the digestive process

- Intestinal transit time
- Gastrointestinal diseases
- Various pathologies
- *Alimentary (dependent on the food matrix)*
- Composition of the food matrix
- Intrinsic content of the food
- Chemical form of the nutrient
- Presence of other components and/or active substances
- Adding extrinsic components (ingredients, additives, fortifiers, among others).
- Processing methods and techniques
- Storage methods (Valencia et al., 2016).

Food Supplements in Health Promotion and Care

Of the physiological aspects, which affect the bioavailability of nutrients, the age group, the nutritional status and the physical condition of the individual, correspond to the references based on which the frequency and quantities recommended for the consumption of food supplements are usually established (Valencia et al., 2016; Campos et al., 2024). Ideally, its consumption should come from recommendations made by a nutrition professional, or, where appropriate, a doctor. Reality shows the opposite, since a high percentage of people who consume them do not meet this condition. A study carried out in a gym in Venezuela sought to establish the relationship between the frequency of consumption of nutritional supplements against purpose and sex. For sex, the highest percentage (61.7%) corresponded to men and 38.3% to women. Regarding the reason for attending the gym, 63.3% indicated doing so for aesthetics and fashion. Regarding the purpose of consuming supplements, only 37.8% (29.7% women and 8.1% men) reported obtaining health benefits. For the professional who recommended the consumption of supplements, the highest percentage (43%) pointed to the gym trainer. The majority (45.9%) consume vitamins, followed by proteins (29.7%) and 10.8% L-carnitine, to help with weight loss, the remaining 13.6% do not consume supplements and opt for a diet balanced (Bruce et al., 2019).

Although free sale and informal recommendation promote high consumption, there are two distinguishable situations due to monitoring and control by trained personnel, both with objectives linked to health. The first includes supplementation for the maintenance of good health, as a preventive measure against the development of diseases (includes health for high-performance sports) (Table 2). The second, specific supplementation, aimed at both prevention and control of people with particular conditions and specific requirements (Table 3). In both cases, supplementation addresses the principle of individualized consumption, so the variations will depend on the specific needs of each person, considering both their age and their particular condition (Binns et al., 2018).

Adverse Events Associated with Dietary Supplements

Despite the wide acceptance of these products due to the positive results obtained in many cases, there is one aspect to consider. With a greater frequency than desired, use without medical supervision reports incidents of poisoning, generally due to consumption that exceeds the recommended doses. Thus, although it is indicated that the use of these products should only be carried out when there is a deficiency or imbalance, indiscriminate use is contravening their function of improving health (Hassan, 2020). The dimension of the problem they face derives from the following:

- In intervention studies, supplements have shown their ineffectiveness as adjuvants in lung cancer and cardiovascular diseases (Hassan et al., 2020).
- When evaluating its effects on nutrition, the results have a greater link with dietary patterns than with the consumption of nutritional supplements (Lichtenstein & Russell, 2005).
- In risk identification, toxic reactions generated directly or by interaction with other supplements or drugs stand out (Binns et al., 2018).
- It has been observed that under certain conditions the bioavailability of supplements is affected (Campos et al., 2024).
- Excessive consumption of protein-based supplements causes hyperfiltration, as well as increased calcium excretion in the urine, which can lead to the development of chronic disease (Patel et al., 2023).

The selected cases on contaminated products deserve special mention:

- Reports of contaminated supplements are frequent. They include the detection of metals, toxins, pesticides, dioxins and pharmacologically active ingredients, mainly (Costa et al., 2019). Presence of substances not reported on product labels, doses above or below those reported (Martínez-Sanz et al., 2021).
- Location of substances prohibited by WADA (World Anti-Doping Agency) in sports supplements. Particularly identified as prohormones and stimulants. They resulted in cases of unintentional doping (Martínez-Sanz et al., 2017).
- The consumption of Advocare Arginine Extreme, recommended by a nutritionist, contaminated with clenbuterol (beta agonist with anabolic properties), a substance prohibited by world and United States anti-doping agencies. It resulted in a positive doping test that caused swimmer Jessica Hardy's participation in the Olympic games to be canceled and a one-year suspension (Mathews, 2017).

With this, it is clear that although in general nutritional supplements offer many benefits. In particular, there is an important area of opportunity that cannot be ignored, and it is related to the contamination of products.

Table 2: Preventive benefits of supplementation

Activity	Context Of Supplementation	Benefits
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SPORTS PERFORMANCE	The use of supplements is not yet widespread throughout the sports environment. High performance athletes are the ones who use them the most.	Achieving performance goals Improvements in nutrient intake. Resources for tissue repair after wear.
(Muñoz-Maldonado et al., 2021; Castillo & Cabrera, 2022)	This type of athlete requires establishing a balance between caloric intake and nutritional intake, to have the energy and repair resources required in each discipline. They can access supplements in various consumption formats, mainly from gels, gums, bars, powders and capsules. Likewise, depending on the composition, there are various options, many of them with specific purposes. From supplements of specific composition, such as those made from proteins, amino acids and carbohydrates. Even those with a joint composition, such as multivitamins. Additionally, depending on their requirements, they can consume probiotics, creatine (for muscle size, performance and endurance), as well as caffeine.	Increased muscle mass, especially for weightlifting and bodybuilding practitioners. Improvements in muscle recovery They prevent dehydration Better resistance weight loss Disease prevention Decreased tiredness and fatigue Better results after training
DIGESTIVE HEALTH	The high incidence and diversity of pathologies that affect the gastrointestinal tract has led to the implementation of preventive measures and the search for alternatives for the management, treatment and monitoring of these pathologies. Supplementation with the use of probiotics, digestive enzymes, soluble fiber, glutamine and plant-based supplements has allowed a wide spectrum of care and improvement in clinical cases.	Improvements in the digestive health of the gastrointestinal tract. Greater absorption of nutrients. Maintenance of healthy balance in intestinal microbiota bacteria.
(Ganesh & Hettiarachchy, 2016)		
BONE HEALTH	Bone health becomes more important in elderly men and women. The main causes of deterioration in bone health are organic deterioration caused by aging itself. The decrease in caloric intake, due to metabolic or mechanical causes (oral health status) and polypharmacy. These factors cause calcium levels to decrease. In supplementation, not only Ca appears as a supplementary source, but also some other minerals such as Cu, B, Mg, Zn, Se, vitamins such as K and D. Likewise, phytochemicals contribute to bone health using soy isoflavones, known as antioxidants or phytoestrogens.	Prevention of osteopenia and osteoporosis. Improvements in caloric intake. Improvements in bone density. Reduction of bone turnover in postmenopausal women. Helps combat bone loss. Strengthening the twisting process of bone collagen fibers. Improvement in the absorption of Ca from food. Promotion of the functioning of muscles and the immune system.
(del Campo et al., 2005; Shenkin, 2006; Martín & López-Sobaler, 2017)		
BRAIN HEALTH	Correct brain functioning does not only depend on the bioavailability of glucose and oxygen. Other elements are decisive in the state of health and correct neuronal functioning. The supplements most used to promote brain health include fatty acids (Omega 3 and 6), B complex vitamins, antioxidants such as polyphenols, vitamins E and C, as well as minerals such as Zn, Se and Mn.	Help improve synapses. Strengthens the health of the central and peripheral nervous system. Strengthens memory and concentration. It helps metabolize homocysteine, thereby protecting cerebral blood vessels. Strengthens mental and physical well-being. Reduces fatigue. Reduces inflammation and blood pressure. Reduces the risk of heart disease and dementia.
(Ramírez & Mecola, 2006; Gil-Tamayo et al., 2017; Narrea & Ramos, 2022)		

Own elaboration

Table 3: Specific supplementation

Condition	Supplementation And Benefits	References
PREGNANCY	During pregnancy, supplementation appears to be essential for the correct growth and development of the fetus. As well as the maintenance of the mother's nutritional status. In addition to a balanced diet. Use of nutritional supplements, recommended. Supplementation: From the group of vitamins, the priority contribution in the first trimester corresponds to the intake of folic acid (B9). Likewise, the consumption of multivitamins that contain vitamins B6, C, A, E and D. In the case of minerals, supplementation with Iron and Calcium mainly. Benefits: Folic acid (B9) prevents any damage or malformation in the neural tube. Minerals (Ca and Fe) are crucial to avoid some type of anemia and therefore, also severe decalcification. In some cases, the use of Omega 3 favors the formation of the neural network of the fetus, helping the mother to control and reduce cholesterol and triglyceride levels typical of the gestational stage, thus avoiding dyslipidemia.	(Martínez et al., 2016; Moran-Lev et al. 2019; Brown & Wright, 2020)

OLDER ADULT	<p>In the geriatric stage, the priority is aimed at compensating for the gradual loss of muscle (Stough & Pase, 2015; mass, bone density and some micronutrients that may be scarce due to multiple factors. Campos et al., 2024)</p> <p>Among them, the use of polypharmacy, the significant decrease in nutrients that older adults present due to the reduction in food intake. In addition to this, the progressive deterioration caused by the natural aging process.</p> <p>Supplementation: Use of multivitamins that provide both vitamins and minerals. In some cases, the B complex and calcium, handled separately for a greater contribution, as well as enteral formulas in some cases where the mechanical condition makes an optimal digestive process impossible.</p> <p>Benefits: Provide the necessary conditions for older adults to enjoy a state of health good enough to provide them with a decent quality of life.</p>
VEGANS / VEGETARIANS	<p>In the vegan community, they present several problems from an early age due to the style (Elorinne et al., 2016; they adopt regarding their diet. Deficiencies due to the lack of consumption of animal Gallego-Narbón et al., protein determine the need for supplementation from the early stages of life. 2019; Dawczynski et al.,</p> <p>Supplementation: It is necessary to integrate supplements from early stages, which 2022; Gasmi et al., counteract the protein deficiencies in your diet. The most common supplement is protein 2023)</p> <p>powder. Of the minerals, Ca and Fe. For the vitamins, vitamin D, since it can not only be obtained from the sun's rays. Its main sources are organ meats and eggs.</p> <p>Supplementation should also include long-chain polyunsaturated fatty acids and B Complex vitamins, especially vitamin B12.</p> <p>Benefits: Ca and Fe prevent long-term complications due to the lack of these minerals. Although many vegetables and seeds contain them, they are not enough to cover daily requirements. The supply of vitamin D prevents bleeding. Fatty acids promote proper organic functioning. In addition, they participate in the regulation of blood pressure and the immune system. B12 is essential to avoid blood, neurological and psychiatric problems. Likewise, to avoid delays in growth and development and motor disorders.</p>
BARIATRIC PATIENTS	<p>In the case of patients with bariatric intervention, it is vitally important to have constant (Steenackers et al., control and monitoring not only in the evolution of the surgery but also in their 2022; Van der Schueren nutritional status, which is why supplementation in them is crucial to achieve recovery & Jager-Wittenaar, and reincorporation. to their daily activities in the shortest period of time possible. 2022)</p> <p>Supplementation: Calcium is one of the main minerals to supplement. Iron, zinc, copper and selenium should also be included. A multivitamin with an emphasis on vitamins B1 and B12 also recommended.</p> <p>Benefits: Ca, in addition to helping with the integrity of cell membranes and neuromuscular activity, also has endocrine, coagulation and metabolism functions of the bone system. Fe helps prevent iron deficiency anemia, which is sometimes present due to dietary restriction. In conjunction with Zn, it helps the process of gradual weight loss due to its intervention in lipid metabolism. Cu and Se work together to form red blood cells, which promotes proper cardiac functionality. In the case of vitamins B1 and B12, they participate in carbohydrate metabolism, DNA duplication and the synthesis of Acetyl CoA in the Krebs cycle.</p>

Conclusions

Without a doubt, there is a consensus on the undeniable interdependence that exists between nutrition and health. This common site makes it easy to understand why today, attention to eating problems occupies a privileged place. This is not coincidental, much less arbitrary, but reflects an undeniable reality: as long as dietary problems cannot be resolved, cases of health problems will continue to increase. Each person with a poor diet increases their own risks and possibilities of suffering from diseases that, in addition to damaging their state of health, affect their quality of life. That is why, in addition to continuing to insist on the importance of generating changes in eating habits and patterns, through the adoption of healthy diets, efforts seek to influence other determining areas. One of them makes efforts to search for alternatives that provide the possibility of accessing the necessary nutrients so that the body is able to perform its nutritional and energy functions, for the benefit of health.

References

- Abdallah, A., Elemba, E., Zhong, Q., & Sun, Z. (2020). Gastrointestinal Interaction between Dietary Amino Acids and Gut Microbiota: With Special Emphasis on Host Nutrition. *Current Protein & Peptide Science*, 21(8), 785-798. <https://doi.org/10.2174/1389203721666200212095503>.
- Alzate, Y. T. (2019). Dieta saludable. *Perpectivas en Nutrición Humana*, 21(1), 9-14. <https://doi.org/10.17533/udea.penh.v21n1a01>
- Andújar, C., & Arbonés, F. L. (2009). Nutrition and Health. *Medicina de Familia. SEMERGEN*, 35(9), 443-449. [https://doi.org/10.1016/S1138-3593\(09\)72843-6](https://doi.org/10.1016/S1138-3593(09)72843-6)
- Binns, C. W., Lee, M. K., & Lee, A. H. (2018). Problems and prospects: public health regulation of dietary supplements. *Annual Review of Public*

- Health*, 39(1), 403-420. <https://doi.org/10.1146/annurev-publhealth-040617-013638>.
- Brignardello, J., Heredia, P. L., Ocharán, P. M. P. & Durán, A. S. (2013). Food knowledge of Chilean vegetarians and vegans. *Revista Chilena de Nutrición*, 40(2) 129-134. <http://dx.doi.org/10.4067/S0717-75182013000200006>
- Brown, B., & Wright, C. (2020). Safety and efficacy of supplements in pregnancy. *Nutrition Reviews*, 78(10), 813-826. <https://doi.org/10.1093/nutrit/nuaa009>
- Bruce, G., Becerrin, H., Paredes, Y., & Holold, M. (2019). Relationship of the frequency of the consumption of nutritional supplements with the purpose and gender of the users of the gym in Mérida, 2018. *Revista del Grupo de Investigación en Comunidad y Salud*, 4(1), 16-24. <http://erevistas.saber.ula.ve/index.php/gicos/article/view/15206/0>
- Campos, M. J., Czlapka-Matysik, M., & Pena, A. (2024). Food Supplements and Their Use in Elderly Subjects—Challenges and Risks in Selected Health Issues: A Narrative Review. *Foods*, 13(16), 2618. <https://doi.org/10.3390/foods13162618>
- Castillo, D. P., & Cabrera, O. V. M. (2022). Development of nutritional supplements for high-performance Cuban athletes. *Revista Cubana de Medicina del Deporte y la Cultura Física*, 17(1), e-529. <https://revmedep.sld.cu/index.php/medep/article/view/529/553>
- Costa, J. G., Vidovic, B., Saraiva, N., Cosra, M. do C., del Favero, G., Marko, D., Oliveira, N. G., & Fernandes, A. S. (2019). Contaminants: a dark side of food supplements? *Free Radical Research*, 53(Sup.1), 1113-1115. <https://doi.org/10.1080/10715762.2019.1636045>.
- Dawczynski, C., Weidauer, T., Richert, C., Schlattmann, P., Dawczynski, K., & Kiehntopf, M. (2022). Nutrient intake and nutrition status in vegetarians and vegans in comparison to omnivores-the Nutritional Evaluation (NuEva) Study. *Frontiers in Nutrition*, 9, 819106. | <https://doi.org/10.3389/fnut.2022.819106>
- del Campo, M. T., Aguado, P., & Martínez, M. E. (2005). Vitamina D y salud ósea: ¿es necesario revisar la administración de sus suplementos en poblaciones de riesgo de osteoporosis?. *Medicina Clínica*, 125(20), 788-793. [https://doi.org/10.1016/S0025-7753\(05\)72191-6](https://doi.org/10.1016/S0025-7753(05)72191-6)
- Dwyer, J.T., Holden, J., Andrews, K., Roseland, J., Zhao, C., Schweitzer, A., Perry, C. R., Harnly, J., Wolf, W. R., Picciano, M. F., Fisher, K. D., Saldanha, L. G., Yetley, E. A., Betz, J. M., Coates, P. M., Milner, J. A., Whitted, J., Burt, V., Radimer, K., Wilger, J., Sharpless, K. E. & Hardy, C. J. (2007). Measuring vitamins and minerals in dietary supplements for nutrition studies in the USA. *Analytical Bioanalytical Chemistry*, 389, 37-46. <https://doi.org/10.1007/s00216-007-1456-z>
- Elorinne, A. L., Alfthan, G., Erlund, I., Kivimäki, H., Paju, A., Salminen, I., Turpeinen, U., Voutilainen, S. & Laakso, J. (2016). Food and nutrient intake and nutritional status of Finnish vegans and non-vegetarians. *PloS one*, 11(2), e0148235. <https://doi.org/10.1371/journal.pone.0148235>
- Fonseca, G. Z., Quesada, F. A. J., Meireles, O. Y., Cabrera, R. E., & Boada, E. A. M. (2020). Malnutrition; World-wide public health problem. *Multimed*, 24(1), 217-229. <https://scielo.isciii.es/pdf/renhyd/v26n3/2174-5145-renhyd-26-03-217.pdf>
- FAO (2023). Overweight among children under five years of age. Africa Regional Overview of Food Security and Nutrition 2023. Food and Agriculture Organization of the United Nations. <https://openknowledge.fao.org/server/api/dca947e8-08ca-47df-a686-48499811a2e5/content/sofi-statistics-africa-2023/overweight-among-children.html>
- Gallego-Narbón, A., Zapatera, B., Álvarez, I., and Vaquero, M.P. (2019). Methylmalonic Acid Levels and their Relation with Cobalamin Supplementation in Spanish Vegetarians. *Plant Foods for Human Nutrition*, 73:166-171. <https://doi.org/10.1007/s11130-018-0677-y>
- Ganesh, V., & Hettiarachchy, N. S. (2016). A review: supplementation of foods with essential fatty acids—can it turn a breeze without further ado? *Critical Reviews in Food Science and Nutrition*, 56(9), 1417-1427. <https://doi.org/10.1080/10408398.2013.765383>
- García, G. (2024). Más allá de las vitaminas: la evolución de la industria de suplementos en 2024. Tendencias de consumo. <https://thefoodtech.com/tendencias-de-consumo/mas-alla-de-las-vitaminas-la-evolucion-de-la-industria-de-suplementos-en-2024/>
- Gasmi, A., Björklund, G., Mujawdiya, P. K., Semenova, Y., Dosa, A., Piscopo, S., Pen, J. J., Benahmedm A. G. & Costea, D. O. (2023). Dietary supplements and bariatric surgery. *Critical Reviews in Food Science and Nutrition*, 63(25), 7477-7488. <https://doi.org/10.1080/10408398.2022.2046542>
- Gil-Tamayo, S., Mosos, J.D., Faria, A.C., Rueda-Rodríguez, M.C., Castañeda-Cardona, C., Rosselli, D. (2017). Dietary supplements in cognitive impairment and Alzheimer's disease: a literature review. *Acta Neurológica Colombiana*, 33(1), 37-45. <https://doi.org/10.22379/24224022129>
- Hassan, S., Egduna, C., Habibu, T., Ifemeje, J. C., Olisah, M. C., Patrick-Iwanyanwu, K.C., Oneyke, P. C., & Benson, C. E. E. (2020). Dietary Supplements: Types, Health Benefits, Industry and Regulation. In Egbuna, C., & Dable, T. G. (Eds) *Functional Foods and Nutraceuticals*. Springer, Cham. https://doi.org/10.1007/978-3-030-42319-3_3
- Huang, L. F., & Tong, W. Q. (2004). Impact of solid state properties on developability assessment of drug candidates. *Advanced Drug Delivery Reviews*, 56 (3), 321-334. <https://doi.org/10.1016/j.addr.2003.10.007>
- Kärlund, A., Gómez-Gallego, C., Turpeinen, A.M., Palo-Oja, O.M., El-Nezami, H., & Kolehmainen, M. (2019) Protein Supplements and Their Relation with Nutrition, Microbiota Composition and Health: Is More Protein Always Better for Sportspeople? *Nutrients*, 11(4):829. <https://doi.org/10.3390/nu11040829>.
- Lentjes, M. A. (2019). The balance between food and dietary supplements in the general population. *Proceedings of the Nutrition Society*, 78(1), 97-109. <https://doi.org/10.1017/S0029665118002525>.
- Lichtenstein, A. H. & Russell, R. M. (2005). Essential Nutrients: Food or Supplements? Where Should the Emphasis Be? *JAMA*, 294(3):351-358. <https://doi.org/10.1001/jama.294.3.351>
- Manson, J.E., & Bassuk, S.S.(2018). Vitamin and Mineral Supplements. What Clinicians Need to Know. *JAMA*, 319(9):859-860. <https://doi.org/10.1001/jama.2017.21012>
- Martín, S. C., & López-Sobaler, A. M. (2017). Beneficios de la soja en la salud femenina. *Nutrición Hospitalaria*, 34, 36-40. <https://dx.doi.org/10.20960/nh.1569>
- Martínez, G. R. M., Jiménez, O. A. I. & Navia, L. B. (2016). Supplements in pregnancy: the latest recommendations. *Nutrición Hospitalaria*,

- 33(Supl. 4), 3-7. <https://dx.doi.org/10.20960/nh.336>
- Martínez-Sanz, J. M., Sospedra, I., Mañas, O. C., Baladía, E., Gil-Izquierdo, A., & Ortiz-Moncada, R. (2017). Intended or Unintended Doping? A Review of the Presence of Doping Substances in Dietary Supplements Used in Sports. *Nutrients*, 9(10):1093. <https://doi.org/10.3390/nu9101093>.
- Martínez-Sanz, J. M., Mata, F., Ripoll, M. S., Puya, B. J. M., Martínez, S. A., Sánchez, O. A. J., & Cortell, T. J. M. (2021). Fraud in nutritional supplements for athletes: a narrative review. *Nutrición Hospitalaria*, 38(4), 839-847. <https://dx.doi.org/10.20960/nh.03413>
- Mathews, N. M. (2018). Prohibited Contaminants in Dietary Supplements. *Sports Health*, 10(1):19-30. <https://doi.org/10.1177/1941738117727736>
- Moran-Lev, H., Bauer, S., Farhi, A., Nehama, H., Yerushalmy-Feler, A., Mandel, D., & Lubetzky, R. (2019). Nutrition and the use of supplements in women during pregnancy: a cross-sectional survey. *Food and Nutrition Bulletin*, 40(2), 231-240. <https://doi.org/10.1177/0379572119833857>
- Muñoz-Maldonado, G. E., Ochoa-Ahmed, F. A., Díaz-Ochoa, E. A., Ramírez-Orozco, R. E., & Gómez-Renaud (2021). Sports supplements: How do we define these products? *Revista Lux Médica*, 16(48), 1-11. <https://doi.org/10.33064/48lm20213235>
- Passini, F., Gómez-Caravaca, A. M., Blasco, T., Cvejić, J., Caboni, M. F., & Verardo, V. (2022). Assessment of Lipid Quality in Commercial Omega-3 Supplements Sold in the French Market. *Biomolecules*, 12(10):1361. <https://doi.org/10.3390/biom12101361>
- Patel, V., Aggarwal, K., Chawan, A., Singh, B., Shah, P., Sawhney, A., & Jain, R. (2023). Protein supplementation: the double-edged sword. *Proc (Bayl Univ Med Cent)*. 2023 Dec 20;37(1):118-126. <http://doi.org/10.1080/08998280.2023.2280417>
- Pérez-Cueto, F. J. A. (2015). Sustainable and healthy diet? Retrospective and implications for public health nutrition. *Revista Chilena de Nutrición*, 42(3), 301-305. [http://dx.doi.org/10.4067/S0717-7518201500030001210.1016/s0749-3797\(02\)00571-8](http://dx.doi.org/10.4067/S0717-7518201500030001210.1016/s0749-3797(02)00571-8)
- Ramírez, L. S., & Mecola, Q. V. (2006). Beneficios para la salud del aceite de pescado. *Ciencia & Desarrollo*, (10), 131-136. <https://doi.org/10.33326/26176033.2006.10.855>
- Satia-About a, J., Kristal, A. R., Patterson, R. E., Littman, J., Stratton, K. L., & White, E. (2003). Dietary supplement use and medical conditions: the VITAL study. *American Journal of Preventive Medicine*, 24, 43-51. [http://doi.org/10.1016/s0749-3797\(02\)00571-8](http://doi.org/10.1016/s0749-3797(02)00571-8)
- Shenkin, A. (2006). Micronutrients in health and disease. *Postgraduate Medical Journal*, 82(971), 559-67. <http://dx.doi.org/10.1136/pgmj.2006.047670>
- Steenackers, N., Vandewynckel, S., Boedt, T., Deleus, E., Hoekx, S., Lannoo, M., Mertens, A., Vangoitsenhoven, R., Van der Schueren, B. & Matthys, C. (2022). Compliance and patients' perspectives towards nutritional supplementation following bariatric surgery. *Obesity Surgery*, 32(6), 1804-1813. <https://doi.org/10.1007/s11695-022-06047-3>
- Strigley, C. T., & Orr-Tokle, I. C. (2018). Presence of Fatty-Acid Ethyl Esters in Krill Oil Dietary Supplements. *Lipids*, 53(7), 749-754. <https://doi.org/10.1002/lipd.12078>.
- Stough, C., & Pase, M. P. (2015). Improving cognition in the elderly with nutritional supplements. *Current Directions in Psychological Science*, 24(3), 177-183. <https://doi.org/10.1177/0963721414565449>
- TFT (2024). Factores que afectan la biodisponibilidad de ingredientes activos en suplementos alimenticios. TFT Nutrición y Salud. *Redacción The Food Tech*. <https://thefoodtech.com/nutricion-y-salud/factores-que-afectan-la-biodisponibilidad-de-ingredientes-activos-en-suplementos-alimenticios/>
- Tobón, Z. G. E., Benavides, A. J. F., & Flórez, A. O. A. (2009). Copper glycinate: an approach to its solubility. *Revista Cubana de Farmacia*, 43(1), 1-9. <https://www.imbiomed.com.mx/articulo.php?id=56347>
- Valencia, M. E., Ronayne, de F. P. A., y Martín, de P. M. L. P. (2016). Biodisponibilidad de nutrientes minerales. *Revista Farmacéutica Reviews*, 155(1-2), 18-35. <https://www.anfyb.com.ar/wp-content/uploads/2016/07/REVISTA-155-2013.pdf>
- Van der Schueren, M. A. E., & Jager-Wittenaar, H (2022). Malnutrition risk screening: New insights in a new era. *Clinical Nutrition*, 41(10), 2163-2168. <https://doi.org/10.1016/j.clnu.2022.08.007>.
- Narrea, V. J. J., & Ramos, E. M. A. (2022). Creatine supplementation and the brain: A narrative review that deserves to be assessed. *Revista de Investigación de la Universidad Norbert Wiener*, 11(1), 1-14. <https://doi.org/10.37768/unw.rinv.11.01.00002>
- WHO (29 April 2020). Healthy diet. World Health Organization. <https://www.who.int/news-room/fact-sheets/detail/healthy-diet>
- Wolf, R. L., Cauley, J. A., Baker, C. E., Ferrell, R. E., Charron, M., Caggiula, A. W., Salamone, L. M., Heaney, R. P., & Kuller, L. H. (2000). Factors associated with calcium absorption efficiency in pre- and perimenopausal women. *The American Journal of Clinical Nutrition* Volume 72(2), 466-471. <https://doi.org/10.1093/ajcn/72.2.466>