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Nutrition and Visual Diseases

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ABSTRACT

Nutrition has influence in vision. Important nutrients such as vitamins A, C, D and E, lutein and zeaxanthin have essential function on visual health. The objective of this study is to demonstrate the nutrition´s influence in the beginning or prevention of visual diseases like dry eye syndrome, cataracts and age-related macular degeneration. A search was made in PubMed, Infomed, EBSCO, HINARI, Scielo; using as key words: nutrition, visual diseases, vitamin. Were used 32 articles in Spanish and English languages. The 60% corresponds to the last five years. Trials have reported a prevalence of dry eye syndrome twice higher in females than in males; it´s related with vitamin D deficiency. Trials with vitamin D and omega-3 supplements have shown relief of the illness. Cataract, the principal cause of reversible blindness on the world, it´s related with vitamin C and E deficiency. Vitamin A, lutein and zeaxanthin have influence in age-related macular degeneration. As conclusions, this study gives information about the actual stated of nutrition and its relationship with the beginning or prevention of some visual diseases.

Introduction

Influence lifestyle has on health is a well-known fact, and an important parameter of it is nutrition. In the clinical field, nutrition has been mainly considered in relation to the prevention of chronic systemic diseases, and has been given less importance, in practice, to the role of optimal nutrition as a factor to achieve a prophylactic good eye health, despite there are some studies in this respect, which we will discuss later. Since remote times research in relation to the participation of certain foods in eye health have been done. As Olmedilla explains: "the Papyrus of Ebers, thousand five hundred years before Christ, describes the use of liver in the treatment of the hemeralopia, early symptom of vitamin A deficiency. However, disease research, in concrete, in relation to the diet and components, with a certain methodological rigour, does not start until the end of the 19th century, stressing in the following century the discovery of vitamin A and description symptoms associated with its deficiency (such as blindness) "[1].

There are also interesting studies about this subject in the 20th century. It is the case of the report of 1995, from Paredes Campos et al, where he makes a comparison between food and visual health in school, he concludes that: "feeding with sufficient amount of food but poor quality in micronutrients and essential amino acids would be causing change in the general development with visual prejudice" [2]. Nutrition intervenes in both development and function of the vision. Through it we incorporate into the body the vitamins necessary for the proper functioning of the visual apparatus. Visual disorders are a health problem of high impact to the individual, the family and society. It is estimated that worldwide there are approximately 285 million of visually handicapped person, of which 39 million are blind and 246 million have low vision [3]. In Cuba, the prevalence of blindness is 56 000 persons (1:200 inhabitants) and the prevalence of low vision is 180 000 personas [4]. Visual loss may be due to various causes. In global terms, uncorrected refractive errors are the leading cause of visual impairment, but in low- and middle-income countries, cataracts remain the leading cause of blindness [3]. These are followed by glaucoma, age-related macular degeneration (AMD), corneal opacities or disorders, diabetic retinopathy, among others; and many of these entities are related with the nutrition [1]. For this reason, we propose as aim to demonstrate the influence of nutrition on the appearance or prevention of visual disturbances such as dry eye syndrome, cataracts and AMD.

Methods

We conducted a search in databases: PubMed, Infomed, EBSCO, HINARI, Scielo, and others; using key words: nutrition, visual diseases, vitamin, AMD, cataract, dry eye syndrome. We used 32 articles in Spanish and English, of which more than 60% corresponds to the last five years. The information was processed, and the document was written in Office Word 2016 with an operating system Windows 10.

Some Vitamins that Influence Visual Function

Vitamin A: Vitamin A (retinol) is a fat-soluble vitamin that is naturally present in the food. It is essential in the regeneration of rhodopsin; whose light decomposition allows the process of vision. It also participates in the growth and development, epithelial cell integrity, immune function, and the reproduction [5]. The amount of vitamin A you need depends on the age and reproductive stage. According to the National Institutes of Health of the United States [6]: the doses recommended for over 14 years of age vary between 700 and 900 micrograms per day retinol equivalents. Intakes recommended for breastfeeding women vary from 1200 to 1300 retinol equivalents. For infants and children under 14 years of age, the recommended values are lower. Considering the importance of vitamin, A in visual function and statement posed before, it is easy to understand that a certain deficit of it entails serious health consequences. In the world, reported data regarding its lack, and these have been reflected in a prevalence study covering several countries in South Asia; in which they propose that: "between 44-50% of the preschool-age children have been affected by a severe deficiency of vitamin A. Similar studies indicate that 85% of the total number of children living in the India presented xerophthalmia." A study among pregnant women in five districts of Sri Lanka from 1988-1989 showed that 1.0% and 1.2% of these women had night blindness. At least 5.7 million children under 5 years of age, have been identified with deficiency of vitamin A in Pakistan" [7]. According to a Cuban research [7] it does not happen in Cuba, where vitamin A deficiency is not common. It is important to know foods rich in vitamin A [6]: beef liver; salmon; vegetable greens, orange and yellow, broccoli and carrots; fruits such as melon, apricot and mango; and dairy products.

Vitamin C: Vitamin C, known as Ascorbic acid, is a water-soluble nutrient that is found in certain foods, especially citrus. In the human body acts as an antioxidant, helping to protect cells against the damage caused by the free radicals [9]. In addition, people that consuming more vitamin C present in food, are at lower risk for falls, which we will explain later. Therefore, its deficiency contributes to the emergence of this visual alteration, although the best-known effect of its deficit is the scurvy [9]. In terms of daily requirements, according to the National Institutes of Health [9]: for men is 90 mg and for women 75 mg; while for children, adolescents, pregnancy, and lactation, conform specific amounts for each group. Foods that are sources of vitamin C include citrus fruits (oranges and grapefruit) and their juices, as well as kiwi, red and green peppers; other fruits and vegetables, such as broccoli, strawberries, melon, baked potatoes and tomatoes [9].

Vitamin D: Vitamin D is a hormone produced by the skin whose function is to capture calcium from the external environment. Evolutionarily it is one of the oldest hormones, so 1% of the dry weight of the phytoplankton corresponds to ergosterol. This back it to 750 million years ago, forming part of the beginning of the alimentary string [10]. Vitamin D deficit generates diseases like osteomalacia, Hypovitaminosis D [10], myopathy, and it´s also related to dry eye syndrome [11], which we will develop later.

Vitamin E: Vitamin E is a fat-soluble nutrient present in many foods. It acts as an antioxidant, protecting cells against damage from free radicals. It stimulates the immune system; it helps to dilate blood vessels and prevent the formation of blood clots in our interior. In addition, the cells use vitamin E to interact with each other and perform numerous functions. Some authors consider that its deficit is related to the appearance of AMD and the cataracts [12]. The National Institutes of Health explains as a daily requirement of vitamin E [12]: for teenagers, pregnant women and adults 15 mg, in breastfeeding 19 mg, and in children varies from 4-11 mg, according to specific ranges of ages. It´s found in foods such as vegetable oils, wheat germ, sunflower and safflower; oils from corn and soybean; nuts (peanuts, hazelnuts and almonds); sunflower seeds; and green vegetables such as spinach and broccoli [12]. Once known the importance of these vitamins, we go into the study of the fundamental visual disturbances in which play a key role.

Dry Eye Syndrome : Dry eye syndrome was identified in 2007 by the Dry Eye Workshop as follow: "It´s a multifactorial disease of tears and ocular surface that produces symptoms such as eye pain and instability of the tear film with potential damage to the ocular surface. It´s accompanied by an increase in osmolality of the tear film and ocular surface inflammation"[13]. Kanski and Bowling, alleged these four definitions [14]:

1. The **dry keratoconjunctivitis** refers to an eye with some degree of dryness.
2. The **xerophthalmia** describes a dry eye associated with deficiency of vitamin A.
3. The **xerosis** explains the extreme ocular dryness and keratinization appearing in eyes with severe conjunctival scarring.
4. The **Sjögren's syndrome** is an autoimmune inflammatory disease in which dry eye is a typical sign.

In terms of their epidemiology, we found that in Korea the prevalence of dry eye syndrome was 10.39% and it showed significant differences in age, gender, residential region, occupation, history of rheumatoid arthritis, eye surgery, time exposure to the Sun and serum levels of 25-Hydroxyvitamin D, which are considered

at the same time as risk factors [11]. Other scientists have reported a prevalence of two times greater in women than in man [15,16]. For his part, Sjögren's syndrome is a chronic autoimmune disease whose main clinical manifestation is the eye and oral dryness that is characterized by progressive mononuclear infiltration of exocrine glands and can affect variety of organs and systems. Complications include corneal ulcerations, bacterial keratitis and ocular infections [16]. It has been reported that vitamin D deficiency is present in patients with Sjögren's syndrome [11]. It can be explained from the mechanism that describes the existence of vitamin D at the level of the cell barrier eye receptors, and suggested that this vitamin has a relevant role in immune regulation and barrier function in the epithelial cells of corneal eye, where it performed in addition to regulating the so-called intercellular junctions gap and tight junction; and also at the level of the lacrimal gland by a non-well elucidated mechanism [11].

Another approach found in the consulted literature, is that vitamin D has shown a suppression of inflammation at the level of the surface of the eye by inhibiting the migration of Langerhans cells in the cornea [17]. In addition, studies have been conducted in which Vitamin D supplements are used to corroborate its influence on improvement of this eye disease. One of them reports that high levels of vitamin D were significantly associated with a reduction of the symptoms of dry eye syndrome (−1. 24 decreased for every 10 more units of vitamin D p = 0.01) [18]. In one of the issues of the PlosOne Journal of 2016, another investigacio [11] poses that low serum levels of 25-Hydroxyvitamin D and inadequate sunlight exposure are associated with dry eye syndrome in Korean adult population, which suggests that sufficient sunlight exposure or vitamin D supplementation may be useful as treatment. Other article [19] whose authorship also belongs to Korean scientists and was published in this magazine, says the same above and also goes beyond, in the study of the relationship of vitamin D not only with dry eye syndrome, but with other eye diseases as AMD and cataracts. These researchers proposed that for the prevention or treatment of dry eye syndrome the use of vitamin D in topical form is better than systemic use. Within the broad range of nutrition, related to dry eye syndrome, not only talked about vitamin D, but it has been dealt with another important nutrient: omega 3. About this micronutrient there are currently some contradictions, because we have found that in a study of 2014 is claimed that the daily intake of nutritional supplement with omega-3 at a rate of 1 g, was associated with an increase in 2.43 times the risk of suffering from severe symptoms of dry eye syndrome [18]. However, other authors argue that there is a beneficial effect of omega-3 health ocular [20]. Oral omega-3 supplements have been effective in improving dry eye syndrome of moderate to severe intensity. Mechanisms postulated about the omega-3 in the ocular surface include an anti-inflammatory effect and modification of the properties of the Meibomian glands, as well as his clearance after 3 months of oral supplements with omega-3 [21].

Cataract: Cataract is the leading cause of reversible blindness worldwide; it is defined as the opacity of the lens that may be due to different causes and can be total or parcial [22]. Among risk factors of this disease are, in addition to age, the presence of certain diseases (e.g., Diabetes Mellitus), the use of cigar and alcohol consumption, as well as prolonged exposure to the sunlight [1]. Also, the American Academy of Ophthalmology [22] recognized as a cause of the appearance of cataract severe malnutrition and oxidative stress. Antioxidants such as vitamins C and E, are natural defenses against oxidative stress. Vitamin E protects cells from oxidation by protecting its fatty acids. It can prevent the onset of cataracts neutralizing the action of free radicals. In this area, it has shown that vitamin C is present normally in the lens in a concentration 50 times greater than that found in plasma [23], which invites to think that it plays a fundamental role in the maintenance of transparency of the lens, acting against the free radicals that cause oxidative stress; by which its lack would lead more quickly to the emergence of lenticular opacities. Other micronutrients are also involved in this important structure of ocular anatomy, so that we have identified in some studies that a high intake of total vitamin A, lutein or zeaxanthin, and foods rich in lutein or zeaxanthin (e.g., spinach and kale) were associated with a 20% to 30% lower risk of cataract extraction, which is definitive and surgical treatment of this ophthalmological entity [23]. According to Kang et al, the National Eye Institute indicates eating "green leafy vegetables, fruit, and other foods with antioxidants as a factor that may protect against age-related cataract" [23]. It is also important to mention that lutein and zeaxanthin may also improve vision by purely biological mechanism, protecting retina and lens from oxidative stress acting as lipid antioxidant, contributing to reduction of risk of age-related ocular diseases [1]. Not only vitamins have a key role in eye health, there are minerals whose properties contribute to reduce or delay the onset of visual disturbances. Selenium, magnesium, copper and zinc, are antioxidant minerals that protect against damage from free radicals. They are found in wheat, yeast of beer, onions, tomatoes, broccoli, whole-grain products, nuts, celery, asparagus, liver, figs, and potatoes [24].

Age-Related Macular Degeneration: It´s defined, according to Kanski and Bowling, as "a disorder degenerative that affects the macula, which is characterized by specific clinical findings including drusens and changes in the retinal pigment epithelium as initial features without data that signs are secondary to other disorders. Advanced stages of the disease are associated with the vision disorder" [25]. It is the leading cause of irreversible legal blindness in people older than 50 years in developed countries, being the third of the global causes of visual impairment (prevalence of 8.7%) but, despite this, is a disease pretty unknown by the public, as said Olmedilla [1]. Evidence of association between the consumption of fruit and vegetables, and the risk of AMD were reported in 1988 [26] starting from the first US National Health and Nutrition Examination Survey. Some authors continue reporting studies that

arise the prevalence of AMD is approximately 6.5% among people 40 years old or older, and more than 15% among people older than 85 years old [23]. Wong WL et al. [27] have estimated that the number of cases of AMD will rise to 196 million in 2020 and 288 million to the year 2040.Various causes of this disease have been reported, but a recent Australian study, published in February 2017, reported that eating habits can contribute significantly to the progressive development of the diseases [28]. Around 700 carotenoids have been described in nature; about 20-30 of them have been identified in blood and tissues human, but only lutein and zeaxanthin have been found in the eye [28].

As part of nutrition, lutein, zeaxanthin, and meso-zeaxanthin, play a crucial role, as they are carotenoids naturally in high concentrations in the macula [23]. In the retina, these three compounds (lutein, zeaxanthin and meso-zeaxanthin) exhibit regional dominance with meso-zeaxanthin being the dominant carotenoid at the epicenter, zeaxanthin at the mid-periphery, and lutein at the periphery of the macula [28]. These nutrients, which also give name to the central part of the retina, the macula lutea (in latin, yellow spot) have great importance in the appropriate visual behavior. The light crosses the zone of lutein and zeaxanthin before it is processed by the photoreceptors, then it is absorbed by these pigments. The amount of lutein and zeaxanthin present in the macula is assessed by means of the density of pigment macular, which may vary with the dietary intake of these compounds and the age [1]. In AREDS (Age-Related Eye Disease Study), the first study of intervention on a large scale with components of the diet in high quantities, attended by more than 3 500 people, showed that supplementation with vitamins (C, E, and beta-carotene) and minerals (zinc and copper) showed a 25% reduction in the risk of progression of AMD after 5 years [29]. A secondary study (AREDS2) showed an additional 10% reduction of risk when beta carotenes in the AREDS were replaced with lutein and zeaxhantin [30]. An English study [31] also enhances the function of these macular pigments in the vision. Zinc is another nutrient that plays an important role in the metabolism of the retina and may be beneficial for AMD [32], so people with advanced AMD, or with loss of vision in one eye, should take supplements with antioxidants and zinc as the used in the AREDS [1]. The main contributor's lutein foods are spinach, chard, lettuce and oranges; about zeaxanthin, are oranges, potatoes and spinach [1]. Also, Eisenhauer et al. [28]. say that other investigations have found that daily consumption of three eggs for 12 weeks, increases levels in serum of lutein and zeaxanthin in 21% and 48% respectively. Vitamin E, in form of α-tocopherol, ascorbic acid, glutathione (and enzymes such as superoxide dismutase and Glutathione peroxidase), lutein and zeaxanthin, interact into the tissue of the retina and the retinal pigment epithelium in a way that probably permit optimum protection of the tissue and its correct work [1].

Conclusion

Nutrition has an important role in the appearance or prevention of visual diseases, specifically dry eye syndrome, cataract and age-related macular degeneration. The nutrients that most improve eye health are vitamins A, C, D and E, lutein and zeaxanthin, and minerals such as zinc and copper. A balanced diet allows to get the sufficient amounts of vitamins and minerals needed to prevent ophthalmological diseases.

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