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Dry eye disease – how our lifestyle choices can affect the disease?

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ABSTRACT

Introduction: In today's world, we know how important it is to keep healthy habits because many diseases begin with daily lifestyle choices. Dry eye disease is a disease of the ocular

surface and there are many risk factors, that lead to developing this disorder. As the possible factors we can underline deficiency of vitamin D or Omega-3 fatty acids, lack of physical exercise, long screen time, or smoking tobacco.

Aim of the study: This review seeks to highlight the issue of dry eye disease linked to everyday routines by examining clinical trial outcomes. Furthermore, it offers an analysis of potential strategies to prevent ocular alterations by critically evaluating the existing data.

State of knowledge: The listed lifestyle choices cause a higher risk of developing dry eye disease and affect ocular health on many levels, leading to unpleasant feelings and affecting people's lives. However, with some lifestyle changes, the risk of developing this disease can be decreased, and negative symptoms can be minimized. It is important to remember vitamin D, and Omega-3 supplementation, daily physical activity, minimalization of the time spent in front of the visual display terminals, and quitting smoking.

Conclusions: Many daily habits are connected to developing dry eye disease, and it is very important to remember about the small daily changes, which can decrease the risk of the disease.

KEYWORDS: dry eye disease; Omega-3 fatty acids; physical activity; screen-time; smoking tobacco; vitamin D deficiency

INTRODUCTION

Nowadays, we know more and more how important is to maintain balance in our lives and how our daily choices affect our health. Many disorders have their beginning points in our daily habits (1). The main risk factors are smoking tobacco, poor nutrition, a sedentary lifestyle, and alcohol consumption (1). One of the diseases that can be initiated by these risk factors is dry eye disease.

Dry eye disease (DED) is a common condition that affects people all around the world. It is a chronic disorder, that affects the ocular surface due to disturbances in tear production and/or evaporation. It is assisted by elevated osmolarity and inflammation and leads to the demonstration of discomfort, visual impairment, and even probable destruction of the ocular surface (2). DED is caused by many factors and cannot be described by one single process, sign, or symptom (3). The prevalence of this disorder is increasing with age, starting from 2.7% among people aged 18-34 years up to 18.6% in elderly people (>75 years), or even up to

75%, depending on the criteria (4, 5). The main symptoms of DED, which cause discomfort for patients are nonspecific and include itching, burning, the perception of a foreign particle within the ocular cavity, increased lacrimation, mucous adhesion affecting the eyelids, ocular pain, and palpebral inflammation (6). The diagnosis of DED is based on the signs and symptoms. There are two established assessments for the detection of dry eye the Dry Eye Questionnaire 5 and the Ocular Surface Disease Index questionnaire (OSDI) (7).

In this review, we would like to present the risk factors of DED, mostly the ones connected to our lifestyle, and propose some changes, which are beneficial for our ocular surfaces.

Material and methods

In this narrative review, search terms including "dry eye disease", "vitamin D deficiency", "Omega 3 fatty acids", "physical activity", "visual display terminals", and “smoking tobacco” were utilized to explore the PubMed and Google Scholar databases. The literature search was performed from February 27th, 2024, through March 10th, 2024. The scope was limited to original research articles published in either Polish or English that reported on the findings of clinical trials. The selection criteria for inclusion in the review were relevant to the topic as determined by the authors. Studies not pertinent to the discussion were excluded. All articles that satisfied the criteria set out for this review were included in the “result” segment. To guide the construction of this narrative review, the SANRA scale for assessing the quality of narrative review articles was applied.

ANALYSIS OF THE LITREATURE

RISK FACTORS OF DRY EYE DISEASE

Several studies have linked many risk factors to dry eye disease, and include different categories as personal, other disorders, used medications, ocular factors, and environmental (5, 8, 9). The category of personal risk factors contains modifiable and unmodifiable factors, as age (risk increases with advanced age), sex (women are more predisposed to develop DED, due to hormonal changes after menopause), Asian ethnicity and prolonged use of contact lenses (5, 9). The diseases which may predispose to developing DED include many autoimmune disorders, such as Sjogren syndrome, rheumatoid arthritis, sarcoidosis. Additionally, thyroid abnormalities, diabetes, rosacea, allergies, and Demodex mite conjunctivitis are linked to a higher risk of DED (5). Also, Parkinson’s Disease (PD) might predispose to DED, because of a highly decreased number of blinks (normally 16-18 times/minute, patients with PD 1-2 times/minute) (10). Some of the medications used daily by

patients are also linked to developing DED, such as beta-blockers, diuretics, antihistamines, anxiolytics, tricyclic antidepressants, selective serotonin reuptake inhibitors, oral contraceptives, and oral isotretinoin (8). To the environmental factors we can include environments of low humidity, strong wind, exposure to extended screen time, and many factors defined as lifestyle (5).

LIFESTYLE CHANGES

DIET

In the modern world, it is hard to maintain a healthy diet and remember to supplement all of the necessary macro- and microelements and other beneficial substances. The deficiency of some of them might predispose to developing DED.

VITAMIN D

According to various studies, there is growing evidence suggesting a potential connection between vitamin D and dry eye disease. Several studies have investigated the association between serum vitamin D levels and dry eye symptoms, as well as the impact of oral vitamin D supplementation (11-17). Recent research has also focused on the potential mechanisms underlying the link between vitamin D and dry eye disease. It has been suggested that vitamin D may play a role in modulating the immune response and reducing inflammation on the ocular surface (12, 18). Another study conducted in Australia investigated the association between vitamin D levels and dry eye symptoms in older adults, which found that lower levels of vitamin D were associated with dry eye. Additionally, the study examined the impact of oral vitamin D supplementation on dry eye symptoms and ocular surface conditions. The results showed that oral vitamin D supplementation led to an increase in vitamin D levels and a significant improvement in dry eye symptoms and ocular surface conditions (19). These findings were also observed in other studies (20-22). provide further evidence for the potential therapeutic role of vitamin D in managing dry eye disease. While multiple studies have shown a potential connection between low levels of vitamin D and dry eye disease, it is important to note that not all research has demonstrated a correlation between the two (23, 24). A study conducted in Korea evaluated the association between serum vitamin D levels and dry eye disease using the Ocular Surface Disease Index questionnaire. The study included data from adult participants, and the severity of dry eye disease was assessed based on symptom frequency and severity. The results of this study showed no evidence of a

connection between DED and vitamin D levels (23). These results were also noted in another research (24).

Further investigation is needed to understand the precise mechanisms involved in the correlation between vitamin D and dry eye disease, as well as to establish the most effective dosage and duration of vitamin D supplementation for individuals experiencing dry eye symptoms. Moreover, more extensive clinical trials are necessary to confirm the effectiveness of using vitamin D supplementation as a standard treatment for managing dry eye disease.

OMEGA - 3

Multiple studies have investigated the potential benefits of omega-3 fatty acid supplementation in relieving symptoms associated with dry eye disease (25-33). Omega-3 fatty acids are essential nutrients that play a crucial role in maintaining the health of the ocular surface, including the tear film and conjunctival tissue (25). One of the key connections between omega-3 fatty acid supplementation and dry eye disease lies in the potential of omega-3 fatty acids to have anti-inflammatory properties, which may help alleviate the underlying inflammation associated with dry eye disease (34-37). The mechanism of action involves the modulation of inflammatory mediators, such as cytokines and prostaglandins, ultimately leading to a reduction in ocular surface inflammation (34, 36). This modulation can potentially reduce the severity of dry eye symptoms and improve tear film stability (36). Moreover, one of the research suggests that omega-3 fatty acids may also play a neuroprotective role in ocular changes associated with dry eye disease. These fatty acids have been shown to possess anti-inflammatory properties, which can help protect the neurological components of the eye and contribute to overall ocular health (37). Furthermore, the protective effects of omega-3 fatty acids on the Meibomian glands, which produce the lipid component of the tear film, have also been proposed as a contributory factor to their efficacy in managing dry eye disease (26, 32, 34, 38). In a study conducted by Deinema et al., participants with dry eye disease who received omega-3 fatty acid supplements experienced a significant decrease in ocular surface inflammation and an improvement in tear film stability. Similarly, the research by Kangari et al. found that omega-3 supplementation led to a decrease in the severity of dry eye symptoms and an increase in tear production (33, 34).

However, it is crucial to acknowledge that some studies have not demonstrated a substantial connection between the use of omega-3 supplements and dry eye disease (39-43). For instance, a multi-center clinical investigation carried out by the DREAM study group did not

observe a notable disparity in the average shift in symptoms between the cohort receiving omega-3 supplementation and the control group (40, 43).

Nevertheless, the majority of evidence suggests that low levels of omega-3 fatty acids in the diet may indeed be a risk factor for dry eye disease and that supplementation with omega-3 fatty acids can potentially improve symptoms and reduce inflammation associated with the condition (25-27).

Moving forward, future research should aim to address these complexities by standardizing study protocols and exploring the optimal dosage and formulation of omega-3 fatty acids. Additionally, long-term studies are needed to evaluate the sustained effects of omega-3 supplementation on dry eye symptoms and ocular health.

DAILY ACTIVITIES

PHYSICAL ACTIVITY

Studies have shown that physical activity can have a significant impact on the ocular surface. Researchers have found a connection between low levels of physical activity and dry eye disease (44-50). According to a study conducted by Kawashima et al., there is a positive association between DED and physical activity (45). Evidence suggests that physical inactivity and sedentary behavior can lead to various chronic disorders, including systemic inflammation-related diseases. The potential mechanisms behind this association could be linked to the anti-inflammatory effects of exercise, as well as the improvement in systemic circulation and blood flow to the ocular tissues (51, 52). Moreover, regular physical activity is also known to promote better tear production and distribution, which are essential for maintaining a healthy ocular surface (51, 53, 54). The increase in blinking frequency during physical activity may also contribute to better lubrication of the eyes, reducing the symptoms of dryness and discomfort (55). In addition to the physiological benefits, engaging in regular physical activity can also have a positive impact on mental well-being, which in turn may help reduce the perception of ocular discomfort and fatigue associated with dry eye disease (48). However, not all studies have shown a clear correlation between physical activity and dry eye disease. A study conducted by Cheng et al. did not find a significant relationship between exercise frequency and dry eyes (56). It is important to note that the screens' brightness and the angle at which one looks at a screen may be contributing factors to most vision symptoms (56).

Overall, the existing literature suggests a link between physical activity and the prevention or reduction of DED. Encouraging individuals to adopt an active lifestyle and engage in regular exercise may not only improve their overall health but also contribute to the management of dry eye symptoms.

INDOOR WORK WITH VISUAL DISPLAY TERMINALS

The usage of visual display terminals (VDTs) has become increasingly prevalent in today's society, with many individuals relying on computers, smartphones, and other digital devices for work, communication, and entertainment (57). The use of visual display terminals has been identified as a potential risk factor for dry eye disease. The extensive use of VDTs in modern society has raised concerns about their potential effects on ocular health, specifically dry eye disease (49, 57-61). One of the main ways in which the use of visual display terminals is connected to the ocular surface is through reduced blink rate (62-65). Portello et al. conducted a study on VDT users and found that the blink frequency was reduced to one-third of non-VDT users, which indicates a significant decrease in blink rate (66). This reduced blink rate can lead to incomplete blinks, characterized by a decrease in the complete closure of the eyelids during blinking. It has been observed that incomplete blinks lead to tear film instability promoting dry eye disease (5, 65, 67). Moreover, prolonged use of visual display terminals can also result in decreased tear production (61, 68). Recent studies have also highlighted the impact of blue light emitted from visual display terminals on ocular health. However, the empirical evidence regarding the correlation between DED and blue light exposure remains indeterminate, with no in vivo studies to date definitively establishing such an association (69). Furthermore, the efficacy of employing blue-blocking filters as a preventive measure has not been sufficiently validated by current research (70). This disruption may contribute to the development and progression of dry eye disease. Furthermore, the close viewing distance and prolonged screen time associated with visual display terminal use can lead to increased evaporation of the tear film, exacerbating dry eye symptoms (68). The scientific community remains divided regarding the effects of prolonged electronic device usage on lacrimal gland activity (71). While certain investigations propose that extended screen exposure may precipitate a deficiency in aqueous tear production, others report no significant alterations in lacrimal gland functionality (61, 67).

On the other hand, while it's acknowledged that prolonged screen time can lead to increased eye fatigue and decreased blink rate, there is a lack of consensus on whether these factors

directly result in the development or exacerbation of dry eye disease. Some argue that the discomfort experienced during and after VDT use may be temporary and not necessarily indicative of a chronic condition like dry eye disease (72).

Overall, the literature suggests that there is a potential connection between the use of visual display terminals and dry eye disease. However, more research is needed to establish a conclusive link and to determine the extent of VDT use as a risk factor for dry eye disease.

LOCAL ENVIRONMENT

SMOKING TOBACCO

One lifestyle choice that has been studied in relation to dry eye disease is smoking tobacco. Smoking has been shown to have detrimental effects on various aspects of ocular health, including the ocular surface (73-76). According to a study conducted among university students, it was found that smoking is associated with a decrease in tear film stability and an increase in punctate staining of the cornea (77). Based on a study conducted by Yu et al., a total of 168 smokers of the medium age of 58 and gender-matched non-smokers were evaluated for ocular surface changes. The study found that smokers had significantly higher OSDI scores, indicating more severe symptoms of ocular surface disease compared to non-smokers (78). Another study conducted by Khalil et al. supported these findings, showing that smokers had significantly lower tear film break-up time and higher irritation levels compared to non-smokers (73). These suggest that smoking tobacco may be a risk factor for the development of dry eye disease. Moreover, some research studies have indicated a link between dry eye disease and smoking, as smoking has the potential to harm the Meibomian glands. This harm could result in changes to the tear film and play a role in the onset of symptoms associated with dry eyes (79, 80). As the studies show, smoking might affect ocular health on many levels, which leads to developing DED.

However, it is important to acknowledge that not all studies have consistently found this correlation. According to a larger cross-sectional study conducted by Vehof et al., there was no statistically significant relationship between current smoking and the risk of dry eye. Additionally, the study has shown that current smokers have less probability of dry eye. However, the ex-smoking might lead to a higher risk of developing symptoms of DED (81).

In conclusion, there is substantial evidence suggesting a connection between smoking tobacco and dry eye disease, but further research is needed to fully understand the relationship between smoking and dry eye disease.

PREVENTIVE MEASURES

As we know what are the risk factors of developing DED, we can undertake some actions to prevent the disease, especially among people with some additional conditions. We want to present some of the preventive measures.

According to the published studies, including supplementation of vitamin D, and Omega-3 fatty acids can reduce the risk of dry eye disease and improve symptoms. It is observed that a moderate daily intake of both types of fatty acids, eicosapentaenoic acid (EPA) – 1000mg and docosahexaenoic acid (DHA) – 500 mg can result in increased tear stability, which alleviates the symptoms of DED (34). Additionally, the use of topical eye drops of Omega-3 has a beneficial effect on decreasing disruptive signs and symptoms (82, 83). The usual daily supplementation with vitamin D (2000 IU) leads to reducing tear instability and decreases the symptoms of DED (21). Moreover, intramuscular injection of a high dose (500000 IU) improves the eye parameters and alleviates the symptoms (20).

Additionally, it is important to remember that daily physical activity alleviates the ocular symptoms, and also symptoms from other systems (45). It is not said how many hours should be spent on physical activity, but the studies have shown that it is important to maintain an aerobic workout and that duration might be essential (46, 54).

Furthermore, it is necessary to remember about some rules during the time in front of VDTs. Firstly, to keep the right viewing distance around 30 centimeters for smartphones, and 40-75 centimeters for larger devices (84, 85). Incorporating breaks into VDT work can protect against dry eye (86). One common suggestion is the 20-20-20 rule: every 20 minutes, pause to look at a distance of at least 20 feet for 20 seconds (87). Moreover, blinking exercises can improve the quality of tear film, which leads to decreased unpleasant feeling of dry eye (88).

CONCLUSIONS

In today's world, when we know how important is the prevention of diseases, we should remember about the actions that can be undertaken to keep the health of the ocular surface. Patients should receive education on how to minimize the risk of developing dry eye disease and how important is to keep a healthy lifestyle.

DISCLOSURE

Author's contribution

Conceptualization, M.Dyr.,; methodology, M.Dyr.; software, A.M., P.M.; check, E.B., U.K., and C.K.; formal analysis, J.W.; investigation, A.P., resources, K.G.; data curation, M.Dyd.; writing M.Dyr., A.M., P.M., E.B., U.K., C.K.; visualization, J.W.; supervision, M.Dyr.
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Data Availability Statement

Data supporting the results of this study shall, upon appropriate request, be available from the corresponding author.

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