THE IMPACT OF THE COVID-19 PANDEMIC, ONLINE-LEARNING ON THE STATE OF VISUAL SYSTEM AND PSYCHOLOGICAL STATE OF STUDENTS

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Abstract

The aim of this study: to identify and analyze changes in the lifestyle and psychological sphere of students who are undergoing online training in quarantine isolation due to the COVID-19 pandemic.

Material and methods: 160 students were examined for the myopic refraction using the Duochrome Test, as well as shifts in the quality of vision as a result of online learning. All participants were also interviewed to ascertain living conditions and psychological status during domestic learning related to COVID-19 isolation.

Result: it was found that 42.5 % participants have myopia, most of them students of 1 and 4 courses (26.5 % and 30.9 %, respectively). 85.6 % respondents noted deterioration in health after long-term visual work with personal computer and/or smartphone. The leading symptoms associated with work on digital displays were: decreased visual acuity and binocular vision disorders (81.9 %), headache (75.6 %), back muscle pain (71.9 %), eyes redness (55.6 %), dry and itchy eyes (45 % of respondents). It has been established what 75.6 % respondents indicated deterioration in their psychological condition as a result of quarantine restrictions: 68.1 % – stress, 48.8 % – emotional instability (irritability), 51.9 % – sleep disorders (insomnia), 16.3 % – depression. It is determined that daily average working time in the conditions of domestic online learning was 6.4 ± 2.6 hours (compared to 4.1 ± 1.7 hours in the pre-quarantine period).

Conclusion: revealed deterioration in the quality of vision, general well-being and the psychological sphere of students who are undergoing online quarantine training due to the COVID-19 pandemic.

Keywords: pandemic, COVID-19, myopia, dry eye syndrome, computer visual syndrome.

DOI: 10.21303/2504-5679.2022.002277

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1. Introduction

There is no doubt that the COVID-19 Acute Respiratory Disease Pandemic has serious consequences in various spheres of life, and the restrictive measures introduced to combat the spread of the SARS-CoV-2 virus have radically changed the way of life and the individual, and the world community in general. The education system is one of the areas that have had to shift the emphasis from full-time learning to the use of electronic (distance) learning technologies. Even at the beginning of the COVID-19 pandemic, scientists and health professionals expressed reservations about the possible long-term effects of COVID-19 disease and anti-epidemiological measures, the possible negative impact of the long-term use of electronic devices on the health of all participants in the educational process.

Numerous studies of the impact of computers and other digital devices on users clearly show the existence of risk factors that affect the human body in a complex way: from the emergence of different physiological perceptions of a negative definition to altered functional states of organs and their systems [1, 2]. «Computer Visual Syndrome», accompanied by subjective and objective symptoms, in particular pronounced accommodation exhaustion (accommodation spasm), visual dysfunctions, «Dry Eye Syndrome» («Dry Eye Disease», DED), headaches, etc., has been a recognized problem for over 20 years [3].

The term «quarantine dry eye» was proposed by Napoli et al. in an article discussing various aspects of lifestyle in pandemic isolation, which were considered as factors influencing eye health: from environmental and behavioural factors to diet, hydration, sleep deprivation and psychological problems associated with pandemic restrictions [4]. According to the results of this survey, the most common symptoms exacerbated by DED during the pandemic were: eye fatigue (84 %),

increased eye dryness (67 %) and impaired/blurred vision (55 %). According to the results of numerous studies, symptoms of «Dry Eye Syndrome» could significantly reduce the quality of human life and interfere with the normal performance of domestic or professional tasks, such as reading, computer work, driving [5]. The investigation of the psychological sphere of people with DED shows significantly higher rates of stress, anxiety and depression in this category of the population, especially in women with «Dry Eye Syndrome» [6, 7].

The purpose of our work is to study the lifestyle and psychological sphere of students of 1–4 courses who are in online learning and quarantine isolation related to the COVID-19 disease pandemic.

2. Materials and methods

The work was performed during September–December 2021 at the Department of human biology, chemistry and methods of teaching chemistry of Sumy State Pedagogical University named after A. S. Makarenko. The survey was conducted among students of 1–4 courses; a total of 160 participants were interviewed. To determine the presence of signs of myopia used the Duochrome (Red-Green) Test, which is a standard tool for verification of the final refraction [8]; the diagnosis of «myopia» was obtained by copying data from the participant's medical records and was established by an ophthalmologist. The Duochrome Test was conducted before classes and at the end of the day after completing all the necessary tasks related to the use of a digital device (computer and/or smartphone), and at the beginning and end of the week. Additional anamnestic data were obtained through a questionnaire; all participants in the study signed an Informed Consent.

The obtained numerical data were processed by general methods of mathematical statistics. Statistical processing of the results was performed using a spreadsheet MS Office Excel. The results of the questionnaire were subjected to quantitative analysis; the data are presented as percentages.

3. Results

Extracting of medical card data of the students in our study showed that 68 participants (42.5 %) have myopic refraction, most of them students in 1 and 4 years (18 participants (26.5 %) and 21 (30.9 %), respectively). Most myopes were girls – 43 people (63.2 %). The average value of myopic refraction was 4.35 ± 1.7 diopters.

Analysis of daily and weekly use of digital devices showed a significant increase in the duration of work with digital monitors among students. The daily average working time in the conditions of forced online learning on a personal computer and/or smartphone was 6.4 ± 2.6 hours (compared to 4.1 ± 1.7 hours in the pre-quarantine period).

According to the results of the Duochrome (Red-Green) Test, conducted after all types of activities involving digital devices (long-term visual work), 137 students (85.6 %) reported about vision impairment and decrease in psychological comfort at the end of the day, and 149 students (93.1 %) – at the end of the working week. Most of this category of respondents were participants with myopia (67.2 % and 73.8 %, respectively).

A survey of participants showed that the leading symptoms associated with prolonged use of digital video displays were: decreased visual acuity and binocular vision disorders (81.9 %), headache (75.6 %), back muscle pain (71.9 %), redness of the eyes (55.6 %), dry and itchy eyes (45 % of students). In addition, this trend was most expressed in students with myopia, among which symptoms were more common.

Our results revealed that 121 respondents (75.6 %) indicated deterioration in their psychological condition because of quarantine restrictions; 109 people (68.1 %) – a constant stress state, 78 people (48.8 %) – emotional instability (irritability), 26 people (16.3 %) – signs of depression. Sleep disorders (insomnia) were found in 83 respondents (51.9 %). At the same time, 86 (53.8 %) respondents are confident of a rapid return to normal psychological conditions after the lifting of the quarantine restrictions, while 37 (23 %) respondents give the opposite answer; the rest of the participants could not clearly indicate their response.

Also, in the course of our survey, it was found that 70.6 % of students know gymnastic exercises to relieve eye strain after prolonged work on a digital monitor and prevent the development

of myopia, but only 42.5 % regularly perform them. At the same time, the analysis of questionnaires showed that 58.1 % of students take breaks in visual work while using digital devices, 36.9 % additionally use moisturizing eye drops and started doing this in connection with «quarantine» online learning.

4. Discussion

Assessing the possible impact of the isolation constraints associated with the COVID-19 pandemic and forced online training is an important issue in view of WHO predictions of widespread myopia on the planet. As noted in the WHO report, in 2050 almost 5 billion people could become myopic [9]. Our results of studying the prevalence of myopia among students (42.5 % of myopia cases) reflect the data available in the literature on a high incidence of myopia among young people [10], as well as a tendency towards an increase in the number of myopic persons by the end of the learning period [11, 12]. The study of the myopia values presented in our group of respondents (4.35 ± 1.7 diopters) confirms the worldwide trend in the phenomenon of myopia that the most common forms of this refractive error are its low and moderate degree [13]. There has already been an increase in the myopia of schoolchildren and students during COVID-19 lockdown [14, 15], indicating the seriousness of the problem.

As a result of the introduction of anti-epidemiological measures, students at all levels of education were transferred to distance learning, which involves visual work on devices with video displays. It is established that when working with a digital screen image that has specific lighting properties (discreteness, flicker, increased brightness, etc.), after 30 minutes in the visual analyzer changes in its functions: visual acuity, accommodation volume, peripheral fields of vision are reduced, intraocular pressure is increased, the threshold of light and color sensitivity is changed, and as a result, a state of temporary myopia develops. The degree of such «false myopia» after 4 hours of continuous work with a computer could reach 0.25 diopters, after 6 hours – 0.5 diopters, according to other authors – up to 1.1 diopters [3, 16]. Such a «myopic functional system» disrupts the functioning of the entire visual system. Qualitative changes in the visual analyzer that occur under the influence of long-term work at close eye-distance are also shown in our study: the impact of digital devices is evidenced by the shown cases of reduced vision at the end of the working day in 85.6 % of students.

Many studies have shown a significant increase in time spent on digital devices during quarantine learning, from 0.67 hours per day before the COVID-19 pandemic to 5.24 hours per day [17]. According to other data, the average increase in electronic gadgets usage during isolation was 4.8 ± 2.8 hours per day, resulting in an average usage time of digital devices of 8.6 ± 3.7 hours [18]. Our survey results also showed a significant increase in time spent on digital devices as a result of distance learning during the COVID-19 pandemic (from 4.1 ± 1.7 hours in the pre-quarantine period to 6.4 ± 2.6 hours per day), which undoubtedly affects the total weekly load on the body of students and, in particular, on the visual system.

The whole complex of negative symptoms experienced by a person after long visual work with video-playing terminals unites in the concept «Computer Visual Syndrome». Summarizing the data of many studies, users conducting on a monitor from 2 to 6 hours per day more often than in control group develop functional disorders of the central nervous system (4.6 times), including visual and sensory diseases, diseases of the cardiovascular system (2 times), upper respiratory tract (1.9 times), musculoskeletal system (3 times) [1, 2]. We investigated that the most common negative phenomena that cause discomfort after daily online learning among students are symptoms in the visual system (decreased visual acuity and binocular vision disorders (81.9 %), eyes redness (55.6 %), dry and itchy eyes (45 %)), muscular (back muscle pain (71.9 %)) and nervous systems (headache (75.6 %), insomnia (51.9 %)).

The results of the research conducted in 2020–2021 in different countries of the world show an increase in the incidence of «Dry Eye Syndrome» diagnosis in the context of the COVID-19 pandemic among people with normal vision and, especially, among people with myopia [19]. «Dry Eye Disease» as a multifactorial disease is characterized by disturbance of tear film homeostasis (shift of balance towards hyperosmolality), which leads to superficial inflammation, damage

to its membrane, the development of related neurosensory abnormalities. Because the tear film is unstable and unable to maintain its structure and function, to perform protective properties, people experience symptoms of discomfort associated with dry eye, namely burning, tingling, dryness, itching, redness of the conjunctiva and eyelids, foreign body sensation in the eye [20, 21]. Lacrimal duct dysfunction, although the initial stage in the pathogenesis of this syndrome, but with its persistence, the pain symptom becomes due to concomitant damage to the sensory nervous system of the eye: chronic pain leads to the development of neuropathological changes, including peripheral and central sensitization of neurons [22]. This translates the problem of «simple» dry eye into a more serious chronic neuropathic disease and requires increased attention from both doctors and ordinary people to prevent disease progression and irreversible loss of vision.

However, the manifestations DED syndrome are more pronounced in people with refractive errors and may worsen their condition [18], for example, it is shown that even after 30 minutes of working with the display, the coefficient of fatigue of the accommodation apparatus in myopic children is 9 %, in children with normal vision – 2.4 % [16], and the reserve of relative accommodation after computer load in groups with myopia is reduced in 53 % of cases [23]. The results of our study indicated that, firstly, the symptoms associated with «computer vision syndrome» were more common among people with myopia than people with normal vision, and secondly, the negative manifestations are more pronounced in myopes. In our work revealed that the majority of students reporting a decrease in the quality of vision and psychological discomfort both at the end of the learning day and at the end of the week are myopic students (67.2 % and 73.8 %, respectively).

Based on the results of our survey, we could talk about the cumulative effect of the negative impact of long-term use of digital devices and the associated visual load. This is evidenced by the increase in the number of students with negative health symptoms by the end of the learning week. The data obtained by us coincide with other studies. Thus, in the work of Bahkir et al. [24] reported that 95.8 % of respondents were affected by at least one symptom associated with «computer vision syndrome», and 56.5 % reported an increase in their frequency and intensity. Prolonged focusing on the surface of the visual display of any digital device (computer, smartphone, TV) is known to prolong the period between blinking, which in turn accelerates the evaporation of lacrimal secretions and ultimately increases the risk of DED [18]. During this phenomenon, called «digital eye strain», the frequency of flicker could be reduced from about 18 blinks per minute to three or four [25]. It was also found that during prolonged use of the screen reduces the intensity (strength) of blinking, which is an important element in replenishing and maintaining the integrity of the tear film. In other words, due to the formation of a state of «incomplete blinking», in which the eyelid does not completely cover the surface of the cornea; evaporation of tear secretions from the surface of the eye is stronger, especially in dry environments [3].

In a detailed research by Wong et al. [26], it is said that the increase in the use of digital technologies and online learning during this pandemic may lead to an increase in the incidence of myopia through the formation of behavioural changes that contribute to the emergence and progression of myopia. According to the authors of the article, the unambiguous factors of myopia are: increased time spent on the digital screen and the total time spent on «digital» work, reducing the time spent outdoors. This opinion is confirmed by other experimental works. So, in a cohort study of children Enthoven et al. [27] an association was found between more frequent use of the computer and myopia, which was most pronounced for children 9 years old. It states that near visual work, including computer use, and time spent reading create a combined effect that increases the likelihood of myopia at this age. A study conducted by Ma et al. [17] on the impact of digital learning in children 7–12 years of age with myopia confirms the progression of myopia (increasing the spherical equivalent) in this category of people already 4 months after domestic quarantine. Authors emphasized the fact that the shift in myopia was greater when using tablets and mobile phones than TV and projectors, and time spent outdoors was not such a decisive factor. It is important to understand that each additional diopter of myopia is associated with an increase in the prevalence of concomitant maculopathy by 67 % [28], which is a potential threat of vision loss.

Even before the introduction of global quarantine, studies have shown the negative impact of long-term near-eye work on visual acuity and myopic formation, which refers to actions performed

at short working distance from the eyes (reading, studying, doing homework, writing, using digital screen devices, including a computer, television, etc.). Huang et al. [12] talks about the higher risk of myopia when working closely for long periods and that the chances of myopia increase by 2 % for each additional diopter-hour per week. In addition, the authors point out that the influence of such activities on myopia may accumulate over time, but other factors, such as lighting, work breaks, physical activity outside the home, also have a significant impact on the final state of visual acuity. After examining 1.443 children aged 16–17, Hansen et al. [29] found that using devices with digital screens for more than 6 hours a day, the risk of myopia doubled from less than 2 hours a day; physical activity of less than 3 hours per week is an aggravating factor. Therefore, lifestyle, outdoor exercise and near-life work can be important antagonistic factors associated with short-sightedness [30].

The other side of the study is the effect of the COVID-19 pandemic on the psychological state of people. There is evidence in the literature about the interaction between lifestyle changes and psychosocial stress caused by home isolation, which could worsen physical and mental health and create a disease-causing vicious cycle [30]. Most of such works indicate a high prevalence of symptoms of psychological stress, emotional distress, depression, bad mood, increased irritability, sleep disorders [31–33].

After studying the state of the psychological sphere of the participants, we found that the majority of students (75.6 %) experienced a decrease in psychological comfort and general well-being in the conditions of domestic online learning. The most frequent changes in the psychological state in our study were: general stress (68.1 %), insomnia (51.9 %), emotional instability and irritability (48.8 %), depression (16.3 %). At the same time, a favourable prognosis is identified the high percentage of respondents (53.8 %) who are confident in the rapid recovery of their health after the end of quarantine restrictions. However, a rather low number of students (42.5 %) using health-care technologies when working with digital devices, including during online learning, raises concerns about possible long-term consequences and indicates the need to develop and implement appropriate preventive and educational activities among young people.

Study limitations. During the study, the lifestyle and psychological data (including day mode, time spent online studying, time spent using digital devices, subjective and objective health indicators, use of medications, level of physical activity) of 160 students 17–20 years were assessed. The main criteria for inclusion in the study was online training using digital video display devices (personal computer, tablet, smartphone). The study conducted from September to December 2021.

Prospects for further research. Study of the impact of domestic online learning on visual system (refractive disorders, visual fields, selectivity of vision, accommodative eye strain) as well as psychophysiological processes (memory, attention, thinking), in order to establish the long-term effects of the COVID-19 pandemic on the health state of students.

5. Conclusions

The restrictive measures associated with the COVID-19 pandemic may be factors contributing to the appearance and/or progression of refractive errors and visual dysfunctions, especially among young people. Cases of visual impairment with a characteristic symptom complex (in particular, myopia, «Computer Visual Syndrome» and «Dry Eye Syndrome») are due to environmental factors and/or visual mode.

The obtained data illustrate the impact of home quarantine caused by COVID-19 on the visual system and lifestyle of students undergoing forced e-learning. More time spent in front of a digital screen during online learning is a risk factor for the formation and/or progression of myopia, deterioration in general physical and psychological health.

Negative symptoms associated with long-term use of digital devices are mainly due to progressive damage to the ocular surface, internal structures of the eye, or impaired physiological functions, and have current and long-term consequences on the quality of vision and human life in general.

Conflict of interest statement

The authors declare that they have no conflicts of interest.

Financing

The study was performed without financial support.

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Received date 19.12.2021

Accepted date 26.01.2022

Published date 31.01.2022

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How to cite: Kushch, Yu. (2022). *The impact of the COVID-19 pandemic, online-learning on the state of visual system and psychological state of students*. *EUREKA: Health Sciences*, 1, 49–55. doi: <http://doi.org/10.21303/2504-5679.2022.002277>