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## RESEARCH ARTICLE

### TREATMENT OF COMPUTER VISION SYNDROME

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#### ABSTRACT

Computer vision syndrome (CVS) is a type of eye strain that occurs when a lot of time is spent on a computer, smartphone or other digital devices. According to the American Association of Optometrists, 70-75% of people who work on a computer and are exposed to the emission of artificial blue light for more than 3 hours a day, have vision problems (Computer vision syndrome | AOA (n.d.)). The most common symptoms are dry and irritated eyes, blurred vision and headaches (Computer vision syndrome, n.d.). In general, CVS refers to a group of symptoms that occur when computers or other digital devices are used for long periods. Specialists (optometrists or ophthalmologists) diagnose CVS with a thorough eye exam and taking a detailed history (types of symptoms, how frequent and severe they are). Treatment usually focuses on moistening the eyes with artificial tears eye drops, correcting refractive errors with eyeglasses, using blue light protective glasses can also be worn to help reduce glare from computer devices and adjusting body position when using digital devices.

## INTRODUCTION

Computer vision syndrome (CVS) is a type of eye strain that occurs when a lot of time is spent on a computer, smartphone or other digital devices. The most common symptoms are dry and irritated eyes, blurred vision and headaches (Computer vision syndrome, n.d.). Treatment usually focuses on moistening the eyes with artificial tears eye drops, correcting refractive errors with eyeglasses, using anti-reflex glasses, and adjusting body position when using digital devices. In general, CVS refers to a group of symptoms that occur when computers or other digital devices are used for long periods of time. It is also called digital eye strain. There may also be eye irritation, blurred vision, and headaches, among other symptoms. These symptoms are usually temporary, but can disrupt the workday or normal daily routine (Tuft & Lakhani, 2008). This syndrome is not serious, but it is unpleasant. Treatment can help to relieve symptoms when using computer screens. In addition, in the long term, recurrent symptoms can impair work productivity or prevent an individual from doing the things they enjoy.

**Causes and risk factors:** According to the American Association of Optometrists, 70-75% of people who work on a computer and are exposed to the emission of artificial blue light for more than 3 hours a day, have vision problems (Computer vision syndrome | AOA (n.d.)).

The reason for this is very clear because computers are used more and more, and the morphology of the eye has not changed for a thousand years. The eye is not ready to adapt to such a great strain on the computer screen. The radiation and effect of artificial blue light on the human organism is one of the factors that with their long-term effect drastically disrupts the overall health of the face, and above all the eye, because it is the most directly exposed to this radiation. The characteristics and high visual demands of computer and digital screen viewing make many individuals susceptible to developing vision-related symptoms (Singh et al., 2023). At the same time, uncorrected refractive errors can increase the severity of CVS or digital eye strain symptoms. Looking at a computer or digital screen is different from reading a printed page. Often the letters on a computer or handheld device are not as precise or sharply defined, the contrast level of the letters against the background is reduced, and the presence of glare and reflections on the screen can make it difficult to see. The viewing distances and angles used for this type of work are also often different from those typically used for other reading or writing tasks. As a result, the eye focusing and eye movement demands of viewing a digital screen can place additional demands on the visual system. In addition, the presence of even small refractive errors can often significantly affect the comfort and productivity when working on a computer or using other devices of the digital world.

Uncorrected or poorly corrected refractive errors can be major contributing factors to excessive computer eye strain. Even people who wear appropriate corrective glasses or contact lenses may find it not convenient and sufficient to accommodate specific viewing distances on a computer screen. Some people tilt their heads at odd angles to avoid glare that adds to their reflection because their glasses are not designed for computer viewing, or they move closer to the screen to clear the computer image. Holding them can result in muscle spasms or neck, shoulder or back pain. Also, the effect of blue light is closely related to the secretion of the hormone melatonin, which in the human body plays a role in regulating the rhythm of life. Excessive or insufficient secretion of the aforementioned hormone brings the body into a state of disturbed hormonal balance. If the biological clock is disturbed, many problems and diseases can occur, such as cardiovascular diseases, diabetes, overweight, insomnia, depression and many other problems. In most cases, CVS symptoms occur because the visual demands and tasks exceed the individual's visual abilities to perform them comfortably. At greatest risk for developing CVS are people who spend two or more continuous hours on a computer or use digital devices every day.

#### **Factors contributing to CVS**

- **Refractive errors:** Even small refractive errors (especially astigmatism) can worsen CVS symptoms (Wiggins & Daum, 1991).
- **Abnormal binocular coordination:** Vergence abnormalities can cause asthenopia and can worsen CVS symptoms (Petricek, Prost & Popova, 2006). These disorders include: convergent insufficiency, poor vergence, decompensated heterophoria, abnormal accommodation.
- **Uncorrected presbyopia:** Symptoms include difficulty in near vision at the usual reading distance, headache, fatigue, and the need for bright light when reading small print. This is the most common abnormality of accommodation usually seen around age 40. In women, onset may be earlier (Singh & Tripathy, 2023).

**Dry eye or abnormal ocular surface:** Dry eye and ocular surface disorders are an important source of discomfort for VDT (video or visual display terminal) users (Saito et al., 1994). Several factors increase the risk of dry eye among users of digital devices, especially computers (Tuft & Lakhani, 2008). One factor is reduced blinking. Although the normal blink rate is about 15-20/min, the blink rate is significantly reduced while working on the VDT (Acosta, Gallar & Belmonte, 1999). Another factor is incomplete closing of the eyes. Larger palpebral fissure while looking at a screen compared to reading down (increased open eye area) (Kanski, 2003). Other factors are older age, gender (especially postmenopausal women), as well as the environment (air conditioning, dry air - low humidity, airborne particles including dust, digital printer toner, ventilation, etc. Also, the use of contact lenses can lead to dry eyes.

- **Eyelid:** Anterior blepharitis, Meibomian gland dysfunction (Petricek, Prost & Popova, 2006).
- **Drugs:** Anticholinergic drugs and diuretics (Kanski, 2003).

- **Digital device properties and quality:** Most digital displays (especially LEDs) are known to emit blue light (400-500nm). Blue light can cause retinal damage. Maximum damage is thought to occur at 440 nm (LEDs & blue light, n.d). The circadian rhythm depends on exposure to light, especially blue light. Melatonin is secreted at night and plays a key role in the sleep cycle in humans (Beaulé et al., 2003). Intrinsically photosensitive retinal ganglion cells (ipRGCs) or photosensitive RGCs (pRGCs) or melanopsin-containing RGCs (mRGCs) play a key role in the circadian rhythm by sending messages to the pineal gland. These cells have the highest sensitivity at 482 nm. Thus, exposure to blue light that is not synchronized with the sun can alter the coupling of the biological clock to the geographic clock of that area resulting in an abnormal circadian rhythm and sleep pattern. A large study of patients after cataract surgery found no clear advantage of blue-light-filtering intraocular lenses over non-blue-light-filtering lenses in the incidence or progression of nonexudative age-related macular degeneration. Bright characters on a dark background (negative display polarity) should be avoided. A dark sign against a light background (positive screen polarity) is recommended. With digital screens, the screen is recolored with a frequency measured in Hz. The critical flicker coupling frequency (CFF) is the refresh rate at which the human visual system fails to recognize the flickering nature of the screen and the screen appears to be constantly lit. The normal value of CFF is 30-50 Hz. Low refresh rates can cause fatigue, headache, anxiety, decreased accommodation, increased blink interval, decreased blink time, and decreased reading speed (Saito et al., 1994). The standard desktop and laptop monitor refresh rate is 60Hz or 64Hz, but newer monitors have higher refresh rates of 120Hz, 144Hz or 240Hz.
- **Inadequate lighting:** external light (such as a window behind the monitor), reflection.
- **Other risk factors:** Use of electronic materials outside of work, frequent switching between digital display and hard copy that have different backgrounds.

**Symptoms:** Digital eye strain can cause many symptoms, including: blurred vision, double vision (diplopia), dry eye, eye discomfort, eye fatigue, itchy eyes, red eyes, fluttering eyelids, headaches, neck pain and shoulder poor alignment and posture when using a computer or digital device. Most of these symptoms are short-term (temporary). They often diminish or disappear when the computer is stopped (Computer vision syndrome | AOA, n.d.). But the symptoms may continue for a longer time. The severity of the symptoms can vary depending on: how long the computer or digital device is used, the existence of any eye problems, and other factors that cause eye strain.

**Dyagnosis:** How is computer vision syndrome diagnosed? Specialists (optometrists or ophthalmologists) diagnose CVS with a thorough eye exam and taking a detailed history (types of symptoms, how frequent and severe they are). The more information the patient shares, the easier it will be to diagnose the problem. Also important information from the patient's side are: the amount of time spent using digital devices; work environment and posture; any medical conditions the patient has; medications taken and family history.

**Treatment:** Solutions to vision problems related to digital display are varied. However, they can usually be alleviated by providing regular eye care and making changes to the way you view the screen. Treatment of computer vision syndrome includes: management of dry eye, refractive vision correction; and changing the daily routine and environment.

*-Treatment of dry eye:* Using digital devices for a long time causes dry eyes. Treatment focuses on moisturizing the eyes (Davitt et al., 2010). Artificial tears (over-the-counter eye drops) are recommended to add moisture to the eyes. It is advised to blink more often.

**Refractive errors:** Even small ones can worsen the symptoms of CVS, so glasses or contact lenses are recommended to help with clearer vision (Kanski, 2003). For some people, computer glasses are a useful solution. Computer glasses correct vision for medium distance objects. This can help when viewing computer screens that are not as close to the face (eg, a book) but not as far away (eg, a TV) (Computer Monitors and Eye Problems, n.d.). Blue light protective glasses can also be worn to help reduce glare from computer devices.

**Changing the routine and environment:** Advice on changing the routine and adjusting the space around the patient when using digital devices is always useful. The time spent in front of digital devices, sitting and room lighting are very important here. Making some small changes can make a big difference in CVS symptoms.

## METHODOLOGY

The aim of this paper is to determine whether the use of protective glasses reduces the symptoms of CVS. The sample consisted of a total of 20 patients of different ages and different professions, but all with symptoms of CVS. All subjects were examined in the optometric office "Retina" in Tetovo, from August 1, 2023. until 31.01.2024 A questionnaire about the ocular pain and habits of the CVS patient was used in this study. The questionnaire consisted of six questions, namely:

- Do you work more than 3 hours a day on the computer (yes/no);
- Do you feel ocular pain (weak/moderate/strong);
- Do you have any of the following symptoms: eye fatigue, itching, eye discomfort, redness, dry eye, diplopia, blurred vision.
- Do you feel pain in your neck and shoulder (yes/no);
- Do you have a headache (yes/no);
- Do you already wear glasses? If yes, are you satisfied (yes/no);

After conducting the survey questionnaire, all respondents were prescribed protective glasses for computer work. In addition, the following written advice was given:

- Reduction of time spent in front of digital devices, less than 4 hours per day.
- Frequent breaks, i.e. 15-minute breaks every two hours. During this break, do not look at any screen.
- Using the 20-20-20 method. Every 20 minutes, look at something at least 20 feet (about 6 m) away for 20 seconds.

- Comfortable position. To prevent twisting of the neck while working on the computer.
- Limitation of blue light flare. Correct position of the screen, to prevent the light from the window from reflecting on the computer screen and causing additional eye fatigue.
- Lowered blinds if there is strong sunlight.
- Using lower wattage light bulbs near the computer and avoiding bright lights.
- Adjust screen brightness and contrast. The brightness of the screen should be approximately the same as the level of brightness in the room. This means that the brightness of the screen needs to be adjusted depending on the time of day. A screen contrast of around 60% to 70% should be comfortable on the eyes.
- Appropriate text size.

After 3 months of using the protective glasses and applying the recommendations, all respondents were surveyed again.

## RESULTS

Out of a total of 20 respondents, nine were female (45%). From table 1 it can be concluded that they are aged from 10 to 50 (26.65+11.03) years old. All of them declared that they spend more than three hours on the computer during the day.

**Table 1. Demographic data**

Respondent	Sex	Age	Profession
1	M	48	an architect
2	F	14	student
3	M	31	banker
4	F	27	manager
5	F	15	student
6	F	22	student
7	F	35	teacher
8	M	50	An architect
9	F	37	IT programmer
19	M	30	Marketing manager
11	M	10	student
12	M	20	IT student
13	M	11	student
14	M	32	Marketing manager
15	F	34	banker
16	M	29	gamer
17	F	19	Architect student
18	M	26	Marketing manager
19	M	30	graphic designer
20	F	13	student

All 20 respondents have one or more symptoms of CVS, but the predominant symptom is the so-called dry eye (table 2). 13 or 65% of them do not have any refractive error. 17 (85 %) of the above patients who were part of this study (after 3 months they were contacted by phone) their vision improved with the disappearance of accompanying symptoms. These glasses contributed to the improvement of contrast perception, as well as a more pleasant and relaxed vision during work/activity at medium distance.

Table 2. Simptomi CVS-a ikoristodzaštihnnaočala

Испитаник	Symptoms	Correction	Benefit from anti-reflex glasses
1	discomfort when working in front of digital devices, headache and poor concentration	near vision glasses	NO
2	daily headaches	no refractive error detected	YES
3	constant headache and burning eyes	prescription glasses	YES
4	burning and watering of the eyes	no refractive error detected	YES
5	burning and watering of the eyes	he is myopic for the last 5 years	YES
6	excessive eye strain	Myopia	YES
7	straining, tearing and pain	no refractive error detected	YES
8	pain in the neck and spine	no refractive error detected	NO
9	burning and tearing of the eyes, discomfort at work	no refractive error detected	YES
19	constant headache	no refractive error detected	YES
11	headache, straining and nictitation	strabismus from the age of 2, which has been corrected with hyperopic glasses	YES
12	tingling and blurred vision	no refractive error detected	YES
13	stinging eyes	no refractive error detected	NO
14	double images when working and feeling of a foreign body in the eyes	no refractive error detected	YES
15	red eyes and blurred vision sometimes with double vision	no refractive error detected	YES
16	redness, double vision, straining and tearing	has been wearing glasses for the last 2 years	YES
17	unpleasant feeling as if there is a foreign body and lacrimation	no refractive error detected	YES
18	eye fatigue and double vision when looking at a computer	no refractive error detected	YES
19	eye fatigue and blurred vision	no refractive error detected	YES
20	blurred vision and frequent itchy eyes	strabismus operated 3 years ago. He wears hyperopic glasses.	YES

## CONCLUSION

The human eye is exposed to blue-violet light throughout the day, which can lead to eye fatigue, reduced concentration, headache, blurred vision, red and dry eyes and even serious permanent degenerative changes in the cornea and other parts of the eye. (Computer Monitors and Eye Problems, n.d.). Harmful radiations are found in natural light, but also in conditions of artificial, digital, neon and LED lighting. Safety glasses, which are specially developed to provide complete protection against harmful blue-violet radiation emitted by artificial lighting sources via LCD TVs, monitors, tablets, smart phones and GPS devices, were recommended to all 20 patients in this study. These safety glasses have a coating that repels the spectrum of harmful blue-violet light in the 400-500 nm wavelength range that corresponded to the visible blue-violet region. Also, these glasses have a UV filter that provides 100% protection from harmful UV radiation because they do not pass rays with a wavelength less than 400 nm. Also, all respondents were given advice on eye care, such as the use of lubricant artificial tears, correct posture when working at the computer and taking frequent breaks. In general, it can be concluded that the use of protective glasses and the above-mentioned advice had a positive effect in reducing the symptoms of CVS in a high percentage of respondents (85 %).

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