Chapter

Computer Vision Syndrome

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Abstract

Using of computers and other video display terminals (VDTs), such as laptops, smart phones, tablets, e-readers, and even watches, are part of our everyday life and more and more users are experiencing a variety of ocular and non-ocular symptoms related to computer use. These complaints include eyestrain, tired eyes, headaches, eye irritation, eye redness, itching, blurred vision, double vision, dry eye, and neck, back, and shoulder pain as extra-ocular issues, which have been termed computer vision syndrome (CVS). Based on pieces of evidence, between 64% and 90% of computer users experience visual symptoms. Children are also affected as they spend many hours each day using digital devices with visual displays for doing schoolwork, especially after starting the COVID-19 era, playing video games, and sending and receiving text messages on cell phones. With the increased use of these electronic devices, CVS is becoming a major public health issue. Proper identification of symptoms and causative factors is necessary for the accurate diagnosis and management. There are some strategies for reducing the complaints related to prolonged use of digital screen devices.

Keywords: computer vision syndrome, video display terminal, digital eye strain, digital device, electronic device, accommodation, vergence, asthenopia, ocular surface, dry eye

1. Introduction

The use of computers and other digital electronic devices such as tablets and smartphones for both vocational and nonvocational activities including e-mail, internet search, and entertainment such as playing games is almost universal in either developed or developing societies. Computers have made life easier in terms of unlimited access to information, improved work efficiency, and ease of communication that could not have been imagined about a few decades ago.

Despite the improvement in the quality of life, more and more people have become susceptible to the worse effects of working at a computer terminal for long time.

At first, using of computer was restricted to desktop computers located in the workplace (personal computer, PC). Today's visual requirements may include viewing laptop and tablet computers, electronic book readers, smartphones, and other digital devices either in the workplace, at home, or also as a leisure activity in any location at any time. Moreover, using of digital devices is not restricted to adults. A study of over 2000 American children between 8 and 18 years of age showed that in an average

day, they spend approximately 7.5 h using entertainment media, 4.5 h watching TV, 1.5 h on a computer, and over an hour playing video games [1]. Furthermore, these digital devices have now shifted into the pockets of millions of smartphone users [2]. Most smartphone owners have been reported to be adults aged from 18 to 34 years. However, next studies reported that the majority of teenagers between 14 to 18 years in the USA (87%) own smartphones [3].

The American Optometric Association defines CVS as the combination of eye and vision problems associated with the use of computers [4]. With apparently increased use of computers and its related input devices, this well-known clinical object gains significant importance. Asthenopia and symptoms related to dry eye disease are the ocular part of the syndrome. There are also musculoskeletal, dermatological, neurological, and psychological detrimental effects that are experienced in relation to the use of different types of digital devices [5].

The complaints associated with the use of computers and other electronic devices have not yet been known to cause permanent damage. However, it may result in a reduction of work accuracy and quality, which can reduce productivity. The extensive use of different types of electronic devices for various reasons desires consideration into the extent of the detrimental effect on the population.

2. Definition

The advent of computers changed human life. Today, digital display devices are required in houses, offices, and even pockets as smartphones. In 2017, about 95% of individuals aged 18–34 used handheld electronic devices such as smartphones and tablets [6]. Most of the business-related activities are also computer-based. According to the 6th European Working Conditions Survey, more than half of European workers utilize digital devices in their working [7]. The exposure to digital screen devices is not restricted to young adults, especially, after COVID-19 pandemic due to the implementation of the new public health measures such as social distancing. As the elderly people live alone in isolated circumstances during COVID-19 outbreak, these devices help them to communicate with others and stay active socially. Similarly, the children and students have used distance education or virtual leisure after COVID-19 pandemic, which led to an increase in all symptoms associated with the abuse of these devices [8].

The term computer vision syndrome (CVS), or digital eye strain, is applied collectively to a complex of visual and ocular symptoms in users of digital display devices such as computers, tablets, and smartphones. These devices have additive effects in the long term. Moreover, any activities that require extra effort for near vision in users of digital devices can enhance CVS symptoms [9]. CVS has been recognized for more than 20 years [10]. The American Optometric Association states CVS as a collection of eye and vision disorders caused by activities that strain near vision and that occur in conjunction with or during the use of computers for long hours [4]. The symptoms of CVS are classified into internal and external categories: [4, 11] Blurred vision, eye strain/fatigue, light/glare sensitivity, delay to change focal point, diplopia, and headache are internal symptoms caused by refractive, accommodative, or vergence anomalies. External symptoms include burning, itching, and tearing, which are rooted from dry eye disease. Some musculoskeletal symptoms, such as pain in the shoulders or neck, are also considered as CVS complexes [4, 12].

The CVS is usually diagnosed subjectively using self-reported questionnaires. However, subjective complaints may not be parallel with objective clinical findings, which cause over- or under-estimation of this condition [13]. Additionally, imprecise definition of CVS and considering various symptoms have led to heterogeneous results that have made it difficult to compare this health problem between populations with different characteristics. There are some validated questionnaires being developed to diagnose this syndrome, including the 17-item computer-vision symptom scale questionnaire, a six-item visual fatigue scale, and the computer vision syndrome questionnaire (CVS-Q) [14, 15].

3. Epidemiology

The CVS is the most common occupational hazard of the twenty-first century with an increasing trend [16]. It is considered a public health crisis that reduces physical and physiological well-being, employees' quality of life, occupational efficiencies, workplace productivity, and job satisfaction [4, 17, 18]. As little as 2 hours of sustained digital device usage a day is likely to develop a range of vision-related problems [9, 13, 18]. Universally, approximately 60 to 70 million individuals suffer from CVS, with 1 million new cases annually [19]. Its prevalence varies from 50% to 90% in different populations, professionals and age groups depending on demographic, environmental, and contextual factors [19–22]. The problem of CVS is extremely high in underdeveloped nations because of the inadequate accessibility and utilization of personal protective equipment, the high workload, and the restricted break time when using a computer [5, 23].

Since 2020, the COVID-19 pandemic has changed the lifestyle of the population by forcing them to follow social distancing protocols, which makes individuals more dependent on digital devices for their communication, education, daily activities, and even entertainment. Based on the strong correlation of overuse of digital devices with the prevalence and severity of CVS, it is expected that COVID-19 pandemic plays a devastative factor for this public health problem. All age groups are affected including children [21, 24], preadolescents [8], adults [25], and elderly [26]. The prevalence of CVS even rose to 80% among students due to virtual education during the lockdown period [8, 27]. Beside students, women were at higher risk for CVS during pandemic because they helped their children in virtual learning platforms [26]. Although the prevalence of CVS has shown an increasing pattern during COVID-19 pandemic, general population suffers from lack of knowledge about CVS, as well as its protective measures [28]. During pandemic, less than 10% of people are familiar with protective devices, protective guidelines for digital device use such as 20-20-20 rule, and even regular ophthalmological visits for optical correction [28]. Meanwhile, COVID-19 infection has ocular manifestations such as conjunctivitis whose additive impact on CVS remains unknown.

4. Causes and pathophysiology

Different variables have contributed to CVS. Generally, three distinct mechanisms have been identified including (1) inappropriate oculomotor responses, (2) ocular surface disease, and, (3) poor environmental conditions [29, 30]. These mechanisms

can interact with each other. Moreover, there are personal factors such as age, which affect CVS through two or three mechanisms.

4.1 Inappropriate oculomotor responses

Two eyes should have efficient vergence and accommodative responses to focus on a target. If the brightness of the target is nonuniform, sustained focus needs more ocular effort. As the components of digital targets (pixels) are brighter at the center, eyes will have repeated struggles to maintain a focus on the digital screens. It makes ciliary body fatigue and the accommodative problems associated with CVS [31].

4.1.1 Vergence

Vergence is a binocular coordination to provide a single image of a visual target by merging the retinal images of two eyes. Prolonged use of digital screen devices and overexertion of the extraocular muscles can alter the ranges of vergence amplitude, horizontally, for both convergence and divergence movements [8, 32]. Therefore, the prevalence of vergence abnormalities such as convergence insufficiency increases among computer users [33]. This non-strabismic binocular dysfunction presents as an exodeviation, which causes the CVS symptoms such as asthenopia, inefficient performance of near activities, and musculoskeletal discomfort due to abnormal head posture [8, 34, 35]. On the other hand, some have proposed that exophoria at near-distance is a compensatory action for over-convergence during long-term computer use [36]. Therefore, the subjects with small amounts of exophoria may have less CVS symptoms compared to those subjects who converged accurately on the monitor for a long time.

4.1.2 Accommodation

Inappropriate accommodative responses, whether under or over-accommodation, result in eyestrain during computer using [37]. More accommodative demand leads to more accommodative fatigue. Therefore, the closer eye-screen distance in devices such as smartphones induces more accommodative fatigue and eye strain. Some subjects with symptomatic CVS also have an increased lag of accommodative response. The delay becomes more after extended viewing due to accommodative fatigue [29]. On the other hand, transient decrease in accommodative function can occur after using digital screen devices, which returns to baseline values by the end of the workday or week [33]. In other words, computer use may produce a decline in the ability to make dynamic oculomotor changes, possibly due to fatigue. Especially, patients with CVS have poor accommodative response that produces blurred vision, diplopia, myopia, and delay in the change of focus.

4.1.3 Uncorrected refractive errors

From the perspective of refractive errors, close work can induce transient myopic shifts due to accommodative effort [30, 38, 39]. This transient refractive error remains uncorrected during near-working with computer. Therefore, computer users with myopic change can complain of asthenopia [39]. Luberto et al. [39] have suggested that the temporary myopic shift can be an objective assessment parameter for evaluation of CVS fatigue. Beside transient refractive change, having baseline

refractive error, particularly myopia, adds to the risk of developing CVS [24, 38, 40]. To achieve and maintain clear and single vision of targets on digital screens, the retinal image should be focused appropriately. Thus, spherical hyperopia and high myopia should be corrected [24, 29, 30]. Astigmatic errors, as low as 0.5 to 1 diopter, are also important to increase symptoms of CVS [29]. In presbyopia, an insufficient addition in near correction makes the patient to tilt the neck backward (extension) to see the screen clearly [41]. This inappropriate posture can increase CVS symptoms. Progressive additive lenses, especially occupational types, provide good vision at near and intermediate distances for computer workers with presbyopia, which can influence both ocular symptomatology and the neck posture [42, 43].

4.1.4 Eyeglasses

Those who wear eyeglasses have a higher prevalence of CVS [9, 27, 44]. Incorrect prescriptions may cause under-correction of refractive errors, especially in individuals with presbyopia who require close proximity to the device to keep the images in focus. Indeed, computer screens are formed by pixels instead of solid images, which make focusing harder [44].

4.1.5 Contact lens

Wearing contact lenses increases the severity of ocular discomfort in patients with CVS [45, 46]. Contact lenses irritate the ocular surface, make unstable tear film, and alter the blink rate. Therefore, contact lens comfort of computer users is highly dependent on lubrication of the eye. Moreover, lens type is a key factor in the development of these symptoms. Silicone hydrogel lenses are more preferred than conventional hydrogel lenses by computer users [47]. Residual refractive errors, especially astigmatism, may also contribute to CVS among contact lens users. It is a routine practice pattern that spherical contact lenses are prescribed for subjects with astigmatism <1.0 D. Therefore, increased CVS symptoms occur, not as a result of the contact lens inducing dry eye, but rather as a result of the uncorrected refractive error.

4.2 Ocular surface disease

Decompensation and desiccation of ocular surfaces are common in computer users, which are related to corneal dryness, reduced blink rate, and increased corneal exposure.

4.2.1 Ocular and systemic disease

The likelihood of CVS is higher among computer users with a previous ocular disease either chronic or acute with long-term side effects [5, 9]. Underlying dry eye is the most important ocular disease in developing CVS among computer users. Any several systemic disease or medications contributing to ocular drying can also enhance CVS.

4.2.2 Blink rate and pattern

Normal blinking rate is 22 blinks per minute while relaxed. Using a computer over a long period alters the pattern and rate of blinking [48]. The blink rate is

significantly decreased during using digital screen devices. It decreased to 10 and 7 blinks per minute during reading a book and computer texts, respectively [48]. This reduction is more as font size and contrast decrease or the cognitive demand of the task increases [49]. Additionally, the downward movement of upper eyelid is not complete during computer use. Therefore, the upper eyelid does not touch lower eyelid and does not cover exposed cornea, which causes an incomplete blinking pattern. Infrequent and incomplete blinking contributes to a poor tear film quality, insufficient wetting of the ocular surface, and temporary stresses the cornea, resulting in symptoms of dry eye.

4.2.3 Line of sight (angle of gaze)

People usually have small angle of gaze and look downwards when they read texts on the paper. In small angle of gaze, the upper eyelid covers a substantial portion of the cornea, thus preventing tear evaporation and ocular discomfort symptoms [48, 50]. On the contrary, computer users usually view the digital screens in a horizontal gaze with a wider palpebral fissure. More corneal exposure accelerates tear film instability and CVS. Angle of gaze can also alter the accommodative and vergence response, and therefore the level of CVS symptoms [51].

4.3 Poor environmental conditions

Poor ergonomic conditions and worse posture in front of digital screen devices can cause musculoskeletal symptoms. Poor lighting, imbalance of light between the computer screen and working room, and poor contrast can exacerbate CVS severity [52, 53].

4.3.1 Lighting condition

The appropriate lighting levels vary according to the tasks. Writing and reading need higher lightening levels because they are tasks with greater visual demands [54, 55]. Improper environmental lighting levels, whether low or high intensities, adversely affect ocular comfort during using computers [29, 30, 41, 56]. The weak lighting condition can cause the eyes to tire gradually [29, 41, 56]. In dark environment, blink rate is decreased that accelerates desiccation of cornea. On the other hand, bright light sources (overhead fluorescent, large windows, and desk lamps) appear to significantly reduce the accommodation amplitude, wash out screen character images, and create reflection and glare [29, 56, 57]. Nowadays, the brightness of digital screens can be adjusted according to environmental lightning levels, which provides better performance for users.

4.3.2 Workplace air conditions

The office air conditioning can influence ocular surface of computer users. A low ambient humidity, a high temperature, and ventilation fans increase the evaporation of tear film, which accelerates ocular dryness [58]. The humidity of 45% has been recommended as a lower limit for workplaces [59]. Air pollution, such as airborne paper dust, laser and photocopy toner, and building contaminants, can also affect the comfort of computer users in office, negatively [58, 60].

4.3.3 Seating position

The inappropriate seating position of computer users is associated with CVS [9, 41]. Unfortunately, the ergonomic practices are not usually applied by most of the computer users [40]. The incorrect posture causes ocular discomfort, glare, and muscular spasm. Moreover, short eye-digital screen distance exposes users to more electromagnetic radiation emitting from the computer. On the other hand, the visual demands due to poor ocular accommodation and/or under-corrected refractive errors can also result in inappropriate posture leading to musculoskeletal difficulties. Oculomotor fatigue may change the innervation to the postural muscles in the neck, shoulder, and upper back, resulting in discomfort in these areas.

4.3.4 Distance

Each type of digital screen device has its own recommended viewing distance. Eye-screen distance is 50–70 cm for computers and 20–30 cm for mobile phones and tablets with smaller screens [48, 61]. Maintaining a proper viewing distance from digital screens decreases the symptoms of CVS [20, 40]. Closer eyes to digital screens require more accommodative effort and ocular muscle stress [5, 20]. In addition, more ocular surface decompensation and exacerbation of dry eye occur in proximity of eyes to digital screens [62].

4.3.5 Time

The symptoms of CVS appear to increase as the duration of exposure increases [5, 8, 9, 20, 21, 24, 44]. This may be because a computer generates electromagnetic radiation or high-energy blue light, which stresses the ciliary muscle in the eye, resulting in eye strain after continued exposure to the computer screen. Beside the amount of daily hours, the years of computer use also affect CVS development [5]. The CVS appears to have a cumulative nature rather than to be an acute condition. Therefore, long years of using a device equal more accumulated stress on the eyes, which might intensify the risk of developing CVS.

4.3.6 Rest break

Taking rest break is a protective factor for CVS [44, 63]. Dividing the work hours by short rest times during continuous computer work results in relaxing intraocular muscles, which can then decrease eye strain and headache [18]. Additionally, tear film is refreshed during rest break.

4.3.7 Personal factors

4.3.7.1 Sex

Females display a significantly greater number of CVS symptoms [5, 11, 40–42]. This association with sex could be related to dry eye [64]. Nevertheless, some symptoms may be more frequent in males such as burning sensation, dry eyes, red eyes, and blurred vision [44].

4.3.7.2 Aging

By aging, the quality of retinal image has been decreasing due to the decrease of lens transparency, which increases the ocular aberrations and light scattering. Additionally, presbyopia is an important factor associated with asthenopia. Presbyopic digital device users experience more accommodative stress during focusing at near distance [10]. The prevalence of dry eye and ocular surface disease, as contributor factors of dry eye, are also higher among older people. However, some protective mechanisms, such as senile miosis counteract with this process, improve the depth of focus and reduce accommodative strain in elderly.

4.3.7.3 Socioeconomic level

Occupational factors such as monthly income, employment status, and job stress or exhaustion affect the prevalence of CVS [65, 66]. High-paid workers are able to afford the protective facilities such as antiglare devices, eyeglasses as well as ocular medications and lubricants. These subjects may also have better workplace conditions and good awareness on computer ergonomics [65]. In general, there is a reverse relationship between knowledge on safety measures of computer use and the severity of CVS among computer workers [65].

4.3.7.4 Multiple digital device usage

The use of digital screen devices outside work is an important factor of CVS [20, 24]. Some possible reasons may be smaller screens of smartphones and tablets, closer eye-screen distance, and longer exposure times, which aggravate the risk of experiencing CVS.

5. Ocular signs and symptoms of CVS

The most common ocular and non-ocular complaints associated with CVS or digital eyestrain are:

- Eyestrain
- Eye fatigue
- Ocular pain
- Blurred vision
- Double vision
- Dry eyes
- Stinging
- Itching
- Red eyes

Symptom category	Symptoms	Possible causes
Asthenopic	Eye strain Tired eyes Sore eyes	Binocular vision Accommodation
Ocular surface related	Dry eyes Watery eyes Irritated eyes Contact lens problems	Infrequent blinking
Visual	Blurred vision Slowness of focus change Double vision Presbyopia Transient blindness	Refractive error Accommodation Binocular vision Presbyopic correction Bleaching of photopigment, with the viewing eye becoming light-adapted
Extraocular	Neck pain Back pain Shoulder pain	Computer screen location

Table 1.
Major categories of symptoms in computer vision syndrome.

- Headache
- Neck and shoulder pain

We can put these complaints in four categories (**Table 1**).

In most occasions, symptoms of CVS occur because the visual demands of the task are more than the visual abilities of the individual to comfortably perform them. In a review of asthenopia, Sheedy et al. detected that symptoms commonly associated with this syndrome incorporated eyestrain, eye fatigue, discomfort, burning, irritation, pain, ache, sore eyes, diplopia, photophobia, blur, itching, tearing, dryness, and foreign body sensation. While investigating the effect of several symptom-inducing conditions on asthenopia, the authors determined that two vast categories of symptoms existed. The first group, termed external symptoms, included burning, irritation, ocular dryness, and tearing and was related to dry eye. The second group, termed internal symptoms, included eyestrain, headache, eye ache, diplopia, and blur and is generally caused by refractive, accommodative, or vergence anomalies. Consequently, the authors proposed that the underlying problem could be detected by the location and/or description of symptoms [67].

There are some investigations that compared visual problems in using digital devices and hard copy, and it is very interesting that even when using a modern flat panel monitor; subjects reported significantly greater blur during the computer task (increasing the demands placed upon ocular accommodation and vergence), when compared with a hard-copy printout of the same material and environmental conditions [68, 69]. Many of the visual symptoms experienced by users are only transient and will decline after stopping computer work or use of the digital device and in rare occasions it persists.

CVS, or digital eyestrain, can be diagnosed through a comprehensive eye examination. We should pay attention to patient history, visual acuity measurements, refraction, accommodation, and binocular vision status. Prolonged VDTs usage has been shown to cause reduced power of accommodation, removal of the near point of convergence, and deviation of phoria for near vision [70].

6. Treatment

Certainly, the management of CVS requires a multidirectional approach because of the variety of complaints between users. When treating a patient, it is essential to consider both ocular therapies, as well as adjustment of the user's workstation, environment, and habits in an ergo-ophthalmologic approach.

Potential therapeutic interventions for patients with symptoms of CVS can be divided into three main parts namely:

1. Refractive and accommodative disorders.

2. Vergence anomalies.

3. Ocular surface problems.

In examining patients with CVS, the following clinical parameters should be evaluated [with all near testing being performed at the distance(s) at which the electronic screen(s) are positioned]:

1. Best corrected visual acuity.

2. Refractive error (including binocular balancing)

3. Accommodative error (lag) at the appropriate working distance.

4. Monocular and binocular amplitude of accommodation.

5. Monocular and binocular accommodative facility.

6. Negative and positive relative accommodation.

When examining patients with CVS, the following clinical vergence parameters should be measured [with all near testing being performed at the distance(s) at which the electronic screen(s) are positioned]:

1. Near point of convergence.

2. Near heterophoria.

3. Horizontal and vertical fixation disparity and/or associated phoria.

4. Vergence facility.

5. Vergence ranges (negative and positive relative vergence)

6. Stereopsis.

7. AC/A and CA/C ratios.

Computer use has been associated with both a reduced rate of blinking and a high number of incomplete blinks when compared with viewing hard-copy materials. Dry eye therapies, which have been proposed to minimize symptoms of CVS, include the use of lubricating drops, ointments, and topical medications for blepharitis or allergic conditions. Additionally, blink training to increase the blink rate during computer use [71], as well as changes in ambient humidity (around 45%), hydration (drinking more water) and redirection of heating and air conditioning vents have all been proposed.

Some important points in preventing or reducing the complaints of CVS have to do with the computer and how it is used. This includes lighting conditions, chair comfort, location of reference materials, the position of the monitor, and the use of rest breaks. American optometric association has given some recommendations for proper body position during using computer, which emphasize on proper height of the chair, table, and monitor for straight position of the neck and back, as well as 90-degree angle of elbow. Moreover, a support for the feet can prevent hanging of the legs (**Figure 1**) [72].

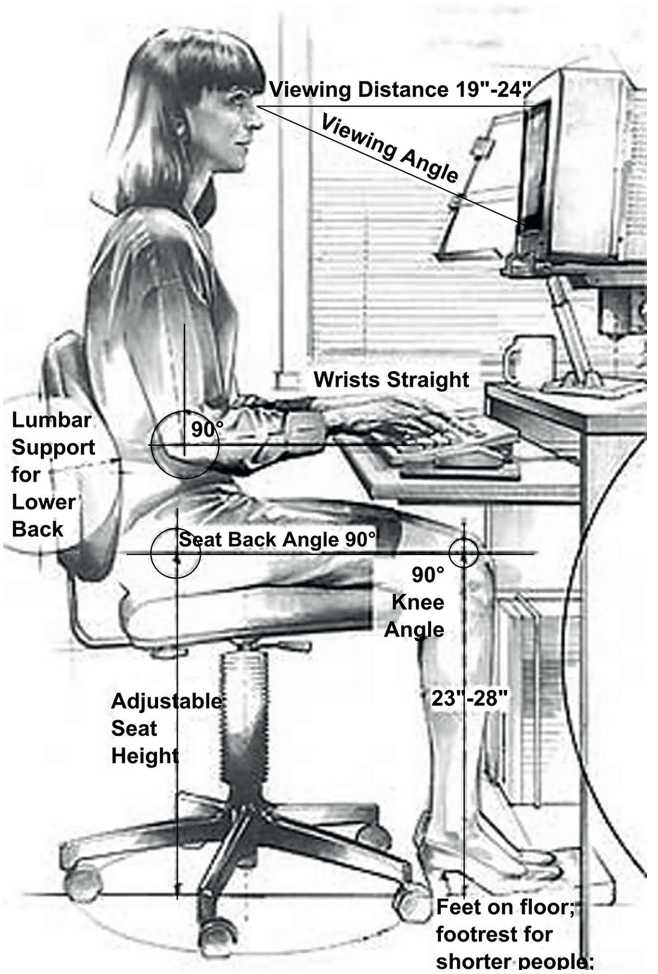

Figure 1.
Proper body positioning for computer use. Yamavu, CC0, via Wikimedia commons.

6.1 Location of the computer screen

Most people find it more comfortable to view a computer when their eyes are looking downward. Ideally, the computer screen should be 15 to 20 degrees below eye level (about 4 or 5 inches) as measured from the center of the screen and 20 to 28 inches from the eyes. This position reduces the width of palpebral fissure and consequently decreases the evaporation of tear.

6.2 Reference materials

These materials should be located above the keyboard and below the monitor. If this is not possible, a document holder can be used beside the monitor. The aim is to position the documents, so the head does not need to be repositioned from the document to the screen.

6.3 Lighting

Position the computer screen to avoid glare, particularly from overhead lighting or windows. Use blinds or drapes on windows and replace the light bulbs in desk lamps with bulbs of lower wattage.

6.4 Anti-glare screens

If there is no way to minimize glare from light sources, consider using a screen glare filter. These filters lessened the amount of light reflected from the screen.

6.5 Seating position

Chairs should be comfortably padded and conform to the body. Chair height should be adjusted so the feet rest flat on the floor. Arms should be adjusted to provide support, while typing and wrists should not rest on the keyboard when typing.

6.6 Rest breaks

To prevent eyestrain, try to rest eyes when using the computer for extended period of time. Resting the eyes for 15 minutes after 2 hours of continuous computer use. Also, for every 20 minutes of computer viewing, look into the distance 20 feet away for 20 seconds to allow the eyes a chance to refocus (20:20:20 rule).

6.7 Blinking

To minimize the chances of developing dry eye when using a computer, try to blink frequently and completely. Surface of the eye is moistened by regular and effective blinking.

7. Prevention

In providing an appropriate form of spectacle correction, practitioners must consider both the viewing distance and gaze angle (both horizontal and vertical). A mild glasses prescription may be needed to reduce vision stress on the job. It has a good

idea for computer users to get a complete eye exam every year. If glasses are worn for distant vision, reading or both, they may not provide the most efficient vision for viewing a computer screen, which is about 20 to 30 inches from the eyes. Tell the doctor about job tasks and measure on-the-job sight distances. Accurate information will help get the best vision improvement. Patients may benefit from one of the new lens designs made, specifically for computer work.

Blue light from LED and fluorescent lighting, as well as monitors, tablets, and mobile devices, can negatively affect vision over the long term. Special lens tints and coatings can diminish the harmful effect of blue light. Minimize glare on the computer screen by using a glare reduction filter, repositioning the screen, or using drapes, shades, or blinds. Also, keeping screens clean, dirt-free and removing fingerprints can decrease glare and improve clarity.

7.1 Adjust work area and computer for comfort

In terms of viewing distance, the United States Occupational Safety and Health Administration state that the preferred viewing distance for a desktop monitor is between 50 and 100 cm (representing an accommodative stimulus in a corrected individual of between 1 and 2D). Additionally, they recommend that the center of the computer monitor should normally be located 15–20° below the horizontal eye level, and the entire visual area of the display screen should be located so the downward viewing angle is never >60° [73]. When using computers, most people prefer a work surface height of about 26 inches. Desks and tables are usually 29 inches high.

7.2 Use an adjustable copyholder

Place reference material at the same distance from eyes as the computer screen and as near to the screen as possible. That way the eyes will not have to change focus when looking from one to the other.

7.3 Take alternative task breaks throughout the day

Make phone calls or photocopies. Consult with coworkers. After working on the computer for an extended period, do anything in which the eyes do not have to focus on something up close.

7.4 Limit screen time for using electronic devices in children

Recommended amount of screen time for children (the Canadian Pediatric Society and the American Academy of Pediatrics):

- Infants and Toddlers (0–2 years): **None**, with the possible exception of live chatting, for example,. with grandparents.
- Preschool children (2–5 years): No more than 1 hour per day of age-appropriate.
- School-age children (5–18 years): Ideally, no more than 2 hours per day of recreational screen.

Using of special apps. Such as Microsoft's "Night light," Apple's "Night shift," and Samsung-blue Light Filter.

Adequate work environments. Appropriate room temperature (20–22°C), ambient humidity (around 45%), and no direct horizontal or upper air from ventilation fans.

Regular breaks during digital display. Take a break from the screen every 30–60 minutes is mandatory. The use of screens should be avoided 1 hour before bedtime.

Encourage outdoor activity over screen time.

8. Conclusion

Although the use of computer and other electronic devices are an inevitable part of modern life, every user should have sufficient knowledge about causes, prevention, and treatment of the visual and nonvisual side effects of long-term use of these devices. Otherwise, we have to wait for a big epidemic of visual problems, especially in children and young people, in the not-so-distant future.

Conflict of interest

The authors declare no conflict of interest.

Acronyms and Abbreviations

CVS Computer vision syndrome
VDT video display terminals

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