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Risk Factors for Eye Fatigue among Students during the Covid-19 Pandemic: A Scoping Review

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Abstract

Background: The use of electronic devices (e-devices/ED) in online classrooms by students during the COVID-19 pandemic has been reported as one of the factors contributing to eye fatigue. The aim of this scoping review was to identify the risk factors (ergonomics and environmental conditions) for eye fatigue among students.

Materials and Methods: A scoping review was conducted on databases such as PubMed, Scopus, Google Scholar, etc. with keywords including eye strain, students, online learning, ergonomics, and environmental factors along the COVID-19 pandemic during the years 2020-2022. Initially, 106 articles were identified. Then, 29 articles were assessed by applying inclusion and exclusion criteria. Finally, 18 articles were selected.

Results: Students used e-devices for ≥4-6 hours/day, so the mean score of Computer Vision Syndrome (CVS) was determined to be 30, and the range of eye strain was reported 13.0-94.5%. The review results indicated that use of e-devices due to improper ergonomics (wrong posture, duration of screens usage, screen distance<50 cm computer and<12-inch mobile phone, no breaks, viewing angle, number and duration of online classes/day, diminished blinking rate) and environmental conditions (fatigue 1.728 times in low lighting, relative humidity<40%, air quality/conditioner, high temperature) had significant effects on the eye fatigue of students during the COVID-19 pandemic.

Conclusion: Raising awareness of DES among parents and students, proper postures, reducing duration on a screen (<6 hours/day online class), a suitable distance to screen, adjusting the workplace/screen lighting, viewing angle≤15°, usage of software screen time limit, frequent blinking, eyes' examination, using wetting drops, 15-minute breaks after 2 hours work, and eye exercises can be effective in reducing eye fatigue in students.

Keywords: COVID-19, Education, Fatigue, Students, Virtual.

Introduction

The pandemic of COVID-19 has influenced daily life [1]. Worldwide, governments needed to impose restrictions such as social distancing, restricting entertainment, distance working, closing schools, etc. to prevent the spread of COVID-19 [2, 3].

The closure of schools and universities due to the COVID-19 pandemic has affected the educational life of many students [4] and as a result distance education increased the usage of digital devices (DDs) [5-7].

Extensive viewing and little and near distance in long-term work to e-devices screen can lead to eye discomfort, fatigue, blurred vision and headaches, dry eyes, and other symptoms of eyestrain [8, 9].
Risk factors such as large number of classes/day, long classes, no break between classes [8], workload, and environmental conditions affect eye strain among students [9, 10]. Choudhary et al. also reported that increasing the use of e-devices resulted in students' asthenopia since they were not knowledgeable of ergonomics [11].
Environmental factors, as one of the ergonomic approaches [10], can have an impact on physical well-being, academic performance of students, and eye complications in users. Excessive gadget usage, incorrect posture, inadequate blinking while viewing digital screens [12] and improper environmental conditions such as lighting, noise, and temperature/air-conditioning can all contribute to these effects [8, 10, 12, 13]. Consequently, the prevalence of Digital Eye Strain (DES) is estimated to vary from 25% to 93% [12, 14, 15]. Therefore, it is necessary to develop innovative strategies and the right ways for using e-devices. It is also important to teach appropriate ergonomic measures to minimize the risk of eye strain.
Objectives of this review: Objective 1. Investigation of the eye strain; fatigue; syndrome due to using e-devices among school/college students during the COVID-19 pandemic. **Objective 2.** Recognition of the risk factors of improper ergonomics and environmental conditions; factors impacting eye strain; fatigue; syndrome among school/college students. **Objective 3.** Recommending corrective measures regarding observation of ergonomics work with e-devices and improvingenvironmental conditions/factors to decrease eye strain; fatigue; syndrome among school/college students.

Materials and Methods

The present study is a scoping review. Key concepts and theories in a specific research topic and finding the types of available evidence can be considered a scoping review. Scoping review can be implemented especially around topics that have not been comprehensively reviewed so far or remained understudied. In cases where the aim is to identify knowledge gaps, to scope a body of literature, to clarify concepts, or investigate research conduct, scoping reviews are performed instead of systematic reviews. Besides, scoping reviews may also be helpful precursors to systematic reviews and can be used to confirm the relevance of inclusion criteria and potential questions [16].
Inclusion criteria: The inclusion criteria included: studies undertaken on school or college students, those having eye strain, digital eye strain, computer visual syndrome (CVS), associated with working with e-devices, online learning, distance education, or online classes, and written in English during lockdown of the COVID-19 pandemic with available full text.
Exclusion criteria: The exclusion criteria included: studies that did not assess ergonomics and environmental factors, and did not fulfill the inclusion criteria.
Search Strategy: Databases were searched using a combination of the following keywords in the section of the title of the articles :(1) digital eye strain; eye health; digital ocular health; computer vision syndrome(CVS); eye strain syndrome; dry eye; eye strain symptoms; eye fatigue; eye boredom; eye risk factor AND (2) school student; university student AND (3) virtual learning; virtual education; distance education; online learning; online classes; online teaching AND (4) electronic devices AND (5) COVID-19; Coronavirus (6) awkward ergonomics; poor ergonomics; incorrect ergonomics; wrong ergonomics; ergonomics factors AND (7) environmental factors; condition factors. The considered studies had reported inappropriate ergonomics, environmental factors, and eye fatigue from using e-devices and virtual learning in students during the epidemic of Coronavirus. To determine the objectives of the study, the abstract, results, methods, and discussion sections of the articles were thoroughly examined to extract the relevant information. Accordingly, given the objectives of the study including the prevalence of eye strain, risk factors, and corrective measures, from among the results of each article, only the finding related to the aims of this study were used. The search was conducted on articles published in 2020-2022 databases: PubMed, Scopus, Google Scholar, Medline, Web of Science, Willey online library, BMJ learning, Springer, and ProQuest.
Data presentation: The steps of identification, screening, and the results review of articles are presented in Figure 1 and Table 1 respectively.
Quality appraisal: The quality of included studies was assessed using the Joanna Briggs Institute (JBI) appraisal tools for cross-sectional studies [17]. Two reviewers independently assessed the quality of the studies. Studies with more than three unmet appraisal items were excluded from the review. Any disagreement about the quality of studies or appraisal items was resolved through discussion among the reviewers.

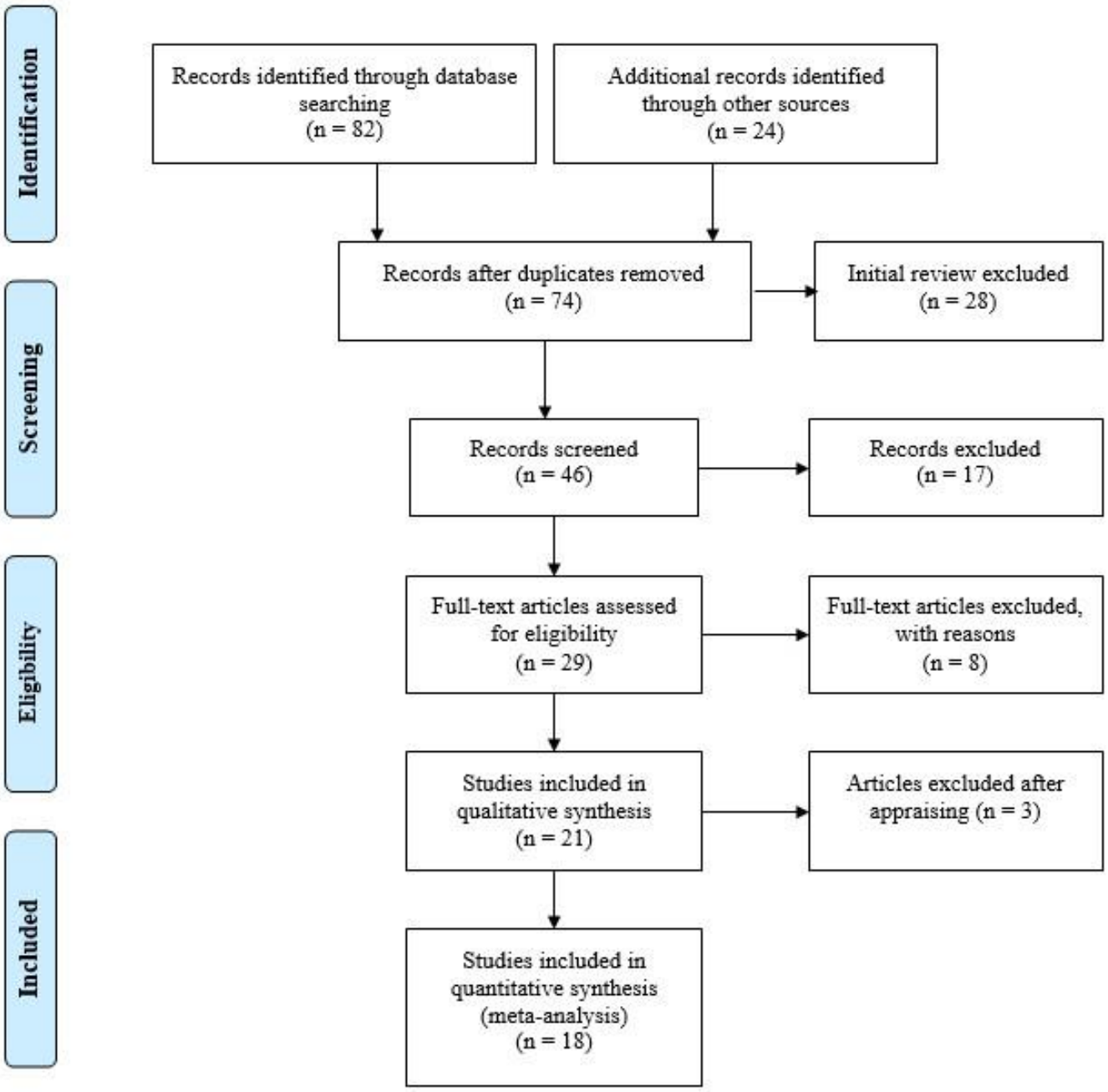

Fig. 1. Flowchart showing search strategy

Results

Search strategy: Initially, 106 articles were identified. Next, 32 articles were excluded from the review due to duplication, thus remaining 74 articles. The initial review of the titles of the included articles revealed that 46 articles had addressed the review questions. After reading the abstract of retrieved articles, 17 were irrelevant to the review's aims and were discarded leaving 29 studies. After reading the full texts, 8 studies were excluded as they were irrelevant to the review objectives. A total of 21 studies were quality appraised. Following the quality appraisal, 3 studies were excluded from the review due to methodological issues related to poor sampling and measurement. A total of 18 studies were finally included in the review (Figure 1).

Data from all studies were collected using online questionnaires of the computer vision syndrome (CVS), eye fatigue, eye health scale or self-developed questionnaires. Evidence from 18 studies showed that the effects of using e-devices during the COVID-19 pandemic on students can be categorized as the following: Risk factors (including improper ergonomics and environmental factors), and eye fatigue (Table 1).

Table 1: Study design categories and reported effects of electronic devices used among school/college students during COVID-19 pandemic

Reference number- Author(s) and Year of publication	Data collection Tools	Sample size, participants and Country	Aims of study	Findings	Outcome	
					Risk factor (Ergonomics and environmental conditions)	Eye Fatigue
33- Noreen et al. (2020)	Self-designed questionnaire	326 Undergraduate Medical Students, Pakistan	Determining the frequency of computer vision syndrome and its associated risk factors among undergraduate medical students	- Among 98.7% of students that used a laptop or desktop, the lower forearm length was found computer vision syndrome. - 71% of students reported ocular symptoms and 29% of students had extraocular complaints. - Use of a mobile phone at a distance <12 inches is statistically significantly related to neck and shoulder pain and eye irritation. - Frequency of break of > 60 minutes was statistically significant with light sensitivity, eye irritation, and enhance blinking, -Ergonomic workstations had an important role in the reduction of students' CVS symptoms than those using poor ergonomics workstations.	*	*
8-Huseyin (2020)	Complete of eye health scale and eye fatigue questionnaire by an e-mail	402 university students, Turkey	Evaluating the impact of online learning on eye health during the COVID-19 pandemic	- Eye health scale related to online education during the COVID-19 period was developed by Kaya. - A negative relationship was found between the eye's health of university students and online education . - Eye fatigue was significantly predicted by the eye health scale during the COVID-19 pandemic.		*
9- Realyvásquez et al. (2020)	Self-Designed Questionnaire	206University Students,Mexico	Investigating the effects of the noise lighting, and temperature levels on the performance of students during the COVID-19 pandemic	- In the study of ambient conditions during online classes, a percentage of students (28.6% for lighting, 9.2% for sound level, 30.6% for temperature, and 35% for air quality) reported that these environmental factors were consistently appropriate. These findings indicate that environmental conditions significantly directly impact the academic performance of university students. - The ergonomic design of the study environment, such as a quiet space, suitable temperature and light, and controlled air conditioning, can help improve the education of students.	*	

24-Ganne et al. (2020)	Pre-validated Computer Vision Syndrome questionnaire	941 responses from 688 students, 45 teachers, and 208 general population, India	Estimating the prevalence of digital eye strain (DES), describe the pattern of gadget usage, and analyze the risk factors for DES	- The prevalence of eye strain was higher among students taking online classes compared to the general public (50.6% vs. 33.2%). - There was an increase in screen time during the pandemic compared to pre-pandemic time. - The digital eye strain score was highest among students attending online classes, in those with eye diseases, greater screen time, screen distance <20 cm, those who used gadgets in dark, and those who took infrequently/no breaks. - The DES scores were proportional to the increase in the number of hours of gadget usage during the pandemic.		*
23-Dey et al (2020)	Self-Designed Questionnaire	234 College students, India	Studying the physical and psychological health problems among adults during the lockdown.	-46.6% of the student used a mobile phone for >6h/day and about 13% used computers (laptop and PC) for >6h. - Appetite problems, eye problems, and sleep disorders were reported among most of the students. - 46.6% of participants that included three-fourths of the study subjects reported eye problems such as eye strain (33.8%), irritation, and itching (23.1%).		*
10-Choudhary et al. (2020)	Self-Designed Questionnaire	186Children, India	Evaluating the impacts of compliance with ergonomic principles among children who use more time on e-devices	- Children use gadgets for 5-7 hours a day to study in a sitting position. - Children use e-devices for longer hours including laptops (58%), android/apple phones (20%), desktops (12%), and tablets (10%). - The content on devices was curriculum (45%), games (35%), and others (20%). - The parents were not aware of ergonomics and its impacts on their children. - Very few parents understood the importance of breaks (38%), correct sitting posture (6%), laptop ergonomics (3%), and eye-monitor ergonomics (1%). - The children suffered from eye strain (13%), headache (11%), irregular sleep (6%), and behavioral changes (6%). - Awkward posture during work and repetition are probable causes for pain.	*	*
18-Gammoh (2021)	Computer Vision Syndrome Questionnaire	382 students, Jordan	Determining the prevalence and severity of digital vision syndrome among university students in Jordan.	- Prevalence of CVS was 94.5%, with tearing being the most prevalent symptom (59%). - Digital device use for more than six hours per day was reported by 55.5% of the sample size. - (36.1%, n=138) reported using digital devices continuously. - Slightly more than half of the students (53.7%, n=205) reported using digital devices mostly during the night. - 93.9% (n=199) of the students who used DD for more than six hours in total during the day suffered from CVS.		*

11-Khan et al (2021)	Database searching	415 records were identified through data-based searching and other sources, India	Identifying and synthesizing evidence about the prevalence of digital eye strain (DES) before and after the lockdown	- 93.6% of respondents reported an increase in their screen time since the lockdown was declared. - Average increase in digital device usage was calculated at about 4.8 ± 2.8 h per day. - The total usage per day was found to be 8.65 ± 3.74 hours. - Prevalence of digital eye strain was 64.3% in pre-lockdown periods.		*
19-Agarwal et al. (2021)	Online questionnaire	840 Parents of students, India	Investigating the ocular problems of school children during COVID-19 pandemic	- The most common ocular symptoms were reported among children including headache (n = 328) and rubbing of eyes (n = 320) due to digital device use. - Ocular symptoms reported among 55.23% of children were related to COVID-19 lockdown. - Mobile devices were the top preference for children, with 96% choosing them, and they also accounted for the majority of screen usage time. - 59.04% of students reported a rate of usage>6h/day. - Based on reports from parents of students, 34% of children had awkward posture while working with digital devices.	*	*
7-Singh et al (2021)	Self-Designed Questionnaire	1541 and 684 students of medical nursing, India	Surveying health issues from online classes among students during the COVID-19 pandemic	- The long duration of each class and pre-existing health predicted headache, eyestrain, sleep disturbance, etc. were reported. -Health issues due to prolonged screen time were reported among 37–58% of the students. -The most common problem reported was eye strain (54%). - Increased symptoms of digital eye strain, such as dry eyes, blurred vision, and headaches, have been shown due to the prolonged usage of screens (all e-devices put together) for>4 hours a day. - Long classes of >40 min and classes for >4 h a day were the most reasons for health issues among students. - Students proposed: Interactive education sessions, 3–6 classes/day, and each class <40 min, 10–20 min break between classes.	*	*
22-Gupta et al. (2021)	Self-administered Computer-Vision Symptom Scale	645 students, India	Assessing digital eye strain (DES) among schoolchildren during lockdown	- The average per day digital device exposure was 5.2 ± 2.2 h with the mean CVS score of 30.1±8.1. - 507 (92.8%) children reported experiencing at least one asthenopia/dry eye symptom (AS/DS) - The most prevalent symptoms were eye redness (69.1%) and heaviness of eyelids (79.7%). - CVS score was found to correlate significantly with age and duration of digital device exposure.		*

25-Mohan et al. (2021)	Online electronic survey (Computer Vision Syndrome Questionnaire)	217 Parents of students completed the questionnaire, India	Determining prevalence, symptoms frequency and associated risk factors of digital eye strain (DES) among children attending online classes during the COVID‑19 pandemic	- An increased prevalence of DES among children was found in the COVID era. - Mean duration of digital devices used during the COVID era was 3.9 ± 1.9 h which is more than the pre-COVID era (1.9 ± 1.1 h). - 36.9% (n = 80) reported using digital devices >5 h in COVID era. - Prevalence of DES was reported 50.23%, of these 26.3% were mild, 12.9% moderate, and 11.1% of the severe grade. - 53.9% of symptoms were itching and headache.		*
31-Demirayak et al. (2022)	online electronic survey (using Google Forms)	692 Parents of student's completed forms, Turkey	Identifying the prevalence of digital eye strain created by display devices and its associating factors among children in distance learning during the COVID‑19 pandemic.	- The most common display devices used were personal computers (61.7%) for online classes and smartphones (57.8%) for nonacademic purposes. - The mean duration of display device use was 71.1 ± 36.02 min without a break and 7.02 ± 4.55 h per day. - The most common reported symptom was headache (52.2%).		*
26-Seresirikachorn et al. (2022)	online questionnaire	2476 high school students, Thailand	Assessing the risk factors and the prevalence of students CVS during the lockdown COVID-19 pandemic	- The average number of hours using digital devices by students increased per day (10.53±2.99 hours) during the COVID-19 era compared to pre-pandemic (6.13±2.8 hours). - On average students had 7.03±2.06 hours of online learning during the pandemic. - 70.1% of students reported CVS. -CVS is very dependent on hours of digital device usage, hours of online learning, refractive errors, use of multiple digital devices, and ergonomics.		*
27-Munsamy et al. (2022)	Online questionnaires of screen time and computer vision syndrome (CVS-Q)	290 university students, Africa	Investigating the prevalence of digital eye strain (DES) among university students during COVID-19 lockdown	- 82.41% of participants reported smartphone device usage. - 55.52% of the students did not use any optical correction. - 64.24% of university students reported prevalence of DES during the COVID-19 vacation. - Students had on average 13 hours/day of screen time used during the lockdown.		*

29-Lu et al. (2022)	Self-reported eye strain scale in different environments	20 undergraduates Students, China	Determining the role of different environments on eye strain recovery	- Eye strain significantly decreased among students after 15 min e-learning with 10 min rest in green space compared to indoor space. - Restoration of eye strain was related to the type of landscape. - Recovery of eye strain was positively dependent on temperature, view of the sky, tree density, Intensity of sunlight, and wind speed. - Recovery of eye strain was negatively associated with relative humidity.	*	*
34-Uwimana et al. (2022)	Computer Vision Syndrome Questionnaire (CVS-Q) and Dry Eye Questionnaire (DEQ-5) via the social media platform	452 international students, China	Determining the prevalence of dry eye disease (DED) based on the severity of Digital eye strain (DES) and its symptom correlation	- Eye allergy, tired eyes, conjunctivitis, glares, neck pain, and back pain were predictors of DES and DED symptoms. - Ph.D. and daily students used more than 9h from the screen. - Increase in DES scores would lead to exponentially enhanced DED scores, and a positive significant association between those was found. - 26.5% and 8.2% of students with DES symptoms reported mild to moderate and severe DED symptoms respectively.		*
				Sum	**6**	**16**

Summary of examined studies: 70% of the articles that were selected based on the inclusion criteria are related to digital eye strain, fatigue, and the remaining 30% are associated with ergonomics (environmental factors and posture). Among the surveyed articles, 15 articles had been written in Asia, 1 article in America, 1 article in Europe, and 1 article in Africa.

Discussion

Online education could involve increasing use of gadgets [11], as well as improper ergonomics and environmental conditions that can in turn lead to eye fatigue [18].

Objective 1: Examining prevalence of eye strain, and its relationship with the COVID-19 pandemic: According to the results of included studies, the duration of screen exposure was high in many students so mobile usage increased by 3 hours among students during the outbreak [6, 8, 19-21]. This has been due to the lockdown and stay-at-home, whereby online teaching has been the only way for student education; as a result, usage of electronic devices to connect online increased the screen time [22].Most students experienced at least one symptom of dry or asthenopia [23]. Prevalence of eye strain, CVS, or DES has been reported 13% to 94.5% among students during the pandemic [8, 11, 12, 19, 24-28]. The high prevalence of eye stains can be due to the lack of awareness of ergonomic guidelines such as the distance and proper height of the device as well as lighting level [11, 29]. More than half of the students used digital devices at night, and most students with eye discomfort utilized e-devices for more than 6 hours per day [19, 20, 27]. Also, Gupta's study indicated that students who employed e-device for more than 6 h had a mean CVS score of 30 and higher [23]. In addition, Bahkir reported a slow deterioration of ocular health among students and other people [30]. Munsamy et al. noted that the high prevalence of DES may be linked to a decline in student performance [28].

Objective 2: Exploring risk factors (ergonomics and environmental condition) of eye strain among students: The included studies have shown that eye strain is directly related to the duration of using screens (more than 4hours per day) [8, 23, 25, 31]. Indeed, Mohan et al. and Demirayak et al reported that the use of e-device >5 h or more is an independent risk factor for DES in students [26, 31]. Excessive usage of digital gadget screens is harmful to visual health, including symptoms such as blurred vision, eye fatigue, dryness, and stinging. Prolonged exposure to glare, microwave radiation, and poor ergonomics of the eye monitor contributes to eye discomfort, irritation, itching, and issues like digital eye strain (DES) and headaches [11, 12, 20, 26, 31]. Focusing on a task for long time durations without blinking or reducing the blinking rate can leave one's eyes feeling dry and tired [12]. Kaya's study showed that as a result of worsening eye health due to online education, eye fatigue has increased [9].

Poor ergonomics like improper lighting, glare, distance (less than 50 cm for computer), and air conditioner causes dry eyes, thus increasing the risk of CVS complaints [12, 27]. Also, CVS among the academic community during the COVID-19 pandemic showed that lightning is one of the most important environmental factors when using computers. Low light levels had an eye fatigue risk 1.728 times greater compared to good lightening levels. The distance of VDT to the eye affects accommodation capacity, so if the eye's accommodation power works to an extreme it can cause the eye muscles to tire quickly and cause headaches. Moreover, low relative humidity (below 40%) and high temperature increase the evaporation of the tear film, resulting in hyperosmolarity and eye dryness [32]. Also, sitting near a vent that is blowing hot or cold air in your face can quickly dry out one's eyes [12]. Lu's study suggested that relief of eye strain is significantly related to the type of landscape, temperature, relative humidity, wind speed, visibility sky, solar radiation intensity, tree density, and canopy density [29].

Other risk factors for eye discomfort and CVS include looking at an e-device monitor for a long time, use of multiple digital devices, fast-moving screens, focusing on small fonts on the screen, glare, distance less than 12 inches from a mobile phone, and less frequent break intervals [11, 27, 33]. These risk factors cause symptoms of CVS and severe strains on the oblique and rectus muscles of the eyeball. In addition, the DES score was highest among the students taking online classes owing to the increased screen time/day [12], the numbers of online classes/day, the duration of each class, plus the duration of breaks between the classes [8], diminished screen distance, increased gadget usage in the dark, presence of pre-existing eye disease (uncorrected refractive errors and no ocular treatment illnesses), as well as the habit of not taking/infrequently taking breaks (every 2–3 hours) during screen viewing [12, 27].

Watching TV, the type of mobile phones available, and text size in smartphones compared to computers and laptops, together with the burden of

educational activities among students of different levels can be the various causes of eye fatigue reported.

Objective 3: Investigating ccorrective measures to reduce eye fatigue among students: This review showed that upright sitting, back resting, and feet on the floor are proper postures that provide the best comfort, both visually and physically [12].

Maintaining a suitable posture while using a digital device, using the device in a good orientation, and shortening the long focus on a digital screen can dramatically reduce the likelihood of visual symptoms [12, 20]. Previous studies have suggested that the total weekly time spent by adolescents working on computers ranges from 1.5-14 hours per week [19]. Mohan et al. and Demirayak et al. studies reported that parents should be watchful of the duration, type, and distance of the digital devices to prevent DES symptoms in students as a side effect of online learning [26, 31].

Some of the proven methods of decreasing eye strain included: adjusting the ambient light to avoid glare and reflections, using anti-glare screen filters to improve contrast, placing the screen lower than the eye level, using computer glasses (blue-light filtering glasses with anti-reflective coating), limiting the duration of screen time to <4 hours/day as well as duration of online classes <6 hours/day, and employing night mode during evening hours [25, 34].

Setyowati's study also mentioned that the American Optometric Association recommends a viewing distance of 20-28 inches away from a computer [32]. Also, Noreen et al. recommended distance more than the forearm length while using a laptop or desktop and >12 inches for a mobile phone, which are significantly effective on reducing CVS, shoulder and neck pain, as well as eye irritation [33]. Adjusting text size, font, and color - black text on a white background is best for the eyes [19]. Uwimana et al. pointed out that a viewing angle ≤15° is better since only the inferior surface of the eyes is exposed to the air, so evaporation and dryness of the eyes are reduced [34].

Modifying the ergonomic placement of screens, improving the workplace lighting, adjusting the adequate lighting of digital screens (reducing exposure to the amount of blue light from smartphones or other digital screens), avoiding direct light falling on the screen, improving the air with a humidifier, and taking illumination intensity of 500 lux can reduce visual symptoms [12, 19, 34].

It may also be helpful to use software to set the screen time limit on a student's mobile phone to limit and monitor extra academic browsing [23].

Other recommendations are raising awareness of DES among students via lectures on ergonomic use of e-devices [25, 30], using less than numerous digital devices, proper visual hygiene examination by an ophthalmologist and optical correction, getting regular eye exams, correcting refractive errors as part of universities health services for students, taking frequent breaks, frequent blinking, and artificial eye drops/using rewetting drops in excessive use of digital gadgets [12, 19, 28, 34]. In this regard, Munsamy et al. in their study noted that 15-minute breaks should be taken for every 2 hours of work with e-devices [28]. In addition, Uwimana et al. recommended that harmful ocular surface conditions should not be underestimated among students and it is necessary that students be taught about appropriate e-device usage practices [34].

As eye exercises such, the following instructions can be recommended: (1) Heat palms by rubbing and then cup them over closed eyes, fingers overlapping at the forehead, for two minutes; (2) keep thumb or pencil fifteen centimeters from the nose. Focus on a tip of the pencil for short time then change the focus to an object three meters away, repeat 10-20 times; (3) shut your eyes tightly for a few seconds in between works; (4) using the tip of the ring finger, do circular motions over the eyes with mild pressure for few minutes, especially artificial tears usage provides good relaxation to the eyes; (5) perform simultaneous movement of the pupils of the eyes toward or away from one another during focusing; and (6) apply 20-20-20" rule which can be effective on relieving eye fatigue [12, 19]. Based on Sheikh et al. study, a significant reduction was seen in eye fatigue with self-relaxing yogic eye exercises [8].

In conclusion, the findings of this review suggest that the duration of using digital devices has significant correlations with eye strain among students during quarantine. Eye syndrome is significantly related to awkward posture and environmental factors, the distance from electronic devices, the number and duration of online classes, infrequent blinking, and less frequent break intervals.

One of the limitations of this study can be the lack of access to some databases, which can lead to not receiving the full text of some articles, as well as the lack of access to articles conducted in several countries. Since few studies have been conducted on the level of awareness of parents and students regarding the observance of

ergonomic principles, further studies are required in this regard.

Conclusion

Staying at home and holding online classes for school/college students have increased the time students use digital devices, and in turn has intensified eye strain. The findings revealed that lighting, noise, etc. have an important role in students' position, eye strain, performance, concentration, and comfort in online classes during COVID-19. Various educational programs are needed to raise awareness of using smartphones among parents to prevent smartphone dependency from early childhood. Lack of awareness among students about ergonomics caused significant problems and increased the risk of painful syndromes including eye complaints, so, the inclusion of ergonomic management of the workstation in the educational curriculum of students can be a basis for reducing the mentioned problems. Also, increasing the ergonomics guidelines of students and parents on reducing the duration of using digital devices, lowering the number of devices used per day, and appropriate eye distance from digital devices (20-28 inches for a computer and >12 for a mobile phone), proper viewing angle, increasing break intervals, 15-minute breaks for every 2 hours of work, frequent blinking, using software to set the screen time limit, suitable environmental factors such as light, temperature, humidity, air-condition, avoid glare and reflections, eye exercises, doing outdoor recreational activities, using moisturizing eye drops, and regular eye examination by an ophthalmologist and correcting refractive errors can play an effective role in managing and reducing related symptoms of eye problems.

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