Innovations

Influence of Six Weeks Eye Exercise Program on the Severity of Digital Eye Strain Among Primary School Students

Madhanagopal Jagannathan[1], Hani Jameel Mohammad Hamad[1], Zaher Al-bashabsheh[1], Stephen Yong[2],Christina Gellknight[3], Fuad A Abdulla[1]

[1]Faculty of Allied Medical Sciences, Philadelphia University, Amman, Jordan

[2]School of Physiotherapy, AIMST University, Kedah, Malaysia

[3]Faculty of Medicine, AIMST University, Kedah, Malaysia

Corresponding Author: Dr. Madhanagopal Jagannathan,

Email: mjagannathan@philadelphia.edu.jo.

Abstract

Problem: *Literature suggest that treatment of digital eye strain (DES) prescribed by health professionals is not highly effective in reducing the symptoms of it. This demands an additional management to be prescribed along with the current treatment for DES. Exercise is one of the potential emerging additional strategies in the conservative management of DES. Therefore, the purpose of this study was to estimate the influence of eye exercise (EE)among primary school students with DES.* ***Methodology:*** *A Computer Vision Syndrome Questionnaire (CVS-Q) score of 6 was used to identify the subjects with DES, followed by ophthalmologist examination. Then, the subjects were allocated into two groups. Group A (n = 15) received conventional therapy (CT) (artificial tears and the 20-20-20 rule) and EE (pencil push-ups, eye-rolling, and palming). Group B (n = 11) received CT. Both groups underwent treatment for a period of six weeks. Before and after treatment, CVS-Q was administered to all participants. Treatment outcome was analyzed using the Wilcoxon signed rank test and the Mann-Whitney U test.* ***Findings:*** *The results revealedtatistical significance within group A (p = 0.001), and across groups (p = 0.006), and statistical non-significant within group B (p = 0.104).These results suggest that exercise is beneficial in lessening the severity of DES among school students.* ***Conclusion:*** *The EE may be prescribed along with the CT to reduce the severity of DES among primary school students.*

Keywords: *Digital eye strain, eye exercise, computer vision syndrome, primary school students, severity of eye strain*

Introduction:

The digital eye strain (DES), an emerging public health concern, is characterized by ocular discomfort and/or visual disturbance caused by the use of electronic devices. It is caused by a variety of ocular system stresses, including dryness, glare, eye strain, headache, fatigue, defocus, disparity, accommodation dysfunction, fixation, and discomfort (Coles-Brennan et al., 2019; Tawil et al., 2020). Despite the fact that DES is easily preventable, it affects over 60 million people worldwide, with 1 million new cases reported each year (Roy et al., 2022). The prevalence of DES among post-secondary students was found to be 68.16% in Bangladesh, and in primary school students, it was found to be 50.23 percent in India and 35.4 percent in Saudi Arabia(Ranasinghe et al., 2016; Mohan et al., 2012; Abuallut et al., 2022).

Many studies have recommended the following treatments for DES: i) ergonomic practices such as ergonomic awareness, careful positioning of the digital device, appropriate lighting (antiglare screen filter and radiation screen filter), adjusting image parameters (text size, contrast, resolution, luminance), and taking breaks (Jones et al., 2016), ii) the use of lubricating eye drops, and iii) blinking exercises (Cardona et al., 2014). However, the literature suggests that the efficacy of these treatments in reducing DES symptoms is conflicting. For instance, taking breaks between tasks, such as the 20-20-20 strategy (after 20 minutes of electronic device unit use, look at any objects more than 20 feet away for a duration of 20 seconds), antiglare filters, and ergonomic awareness, are not supported by sufficient evidence to reduce DES symptoms (Roy et al., 2022).Additionally, although artificial tears lessen DES symptoms like fatigue, dryness, and difficulty concentrating, they do not completely cure it(Coles-Brennan et al., 2019). This suggests that researchers need to look into new, better DES management techniques. To the best of our knowledge, there is no research evaluated the effect of eye exercise (EE) on the severity of DES among students. Therefore, the purpose of this study was to evaluate the influence of therapeutic benefits of EE (pencil push-up, eye-rolling, and palming) among primary school students diagnosed with DES and its comparison with CT.

Materials and Methods:

***Study participants*:** The study population was recruited from two private schools in Pulau Pinang and one in Kedah, Malaysia. The research was carried out between October 2019 and March 2020. Prior to participating in the study, all participants completed the CVS-Q, which was followed by a comprehensive eye examination by an ophthalmologist. Participants with a CVS-Q score of 6 and no ocular disease were eligible, as were participants of both genders and three races (Malay, Chinese, and Indians).Participants with uncorrected refractive errors, including presbyopia, manifest strabismus, accommodative and vergence anomalies, altered blinking patterns, ptosis, cataract, amblyopia, and corneal scars, as well as contact lens wearers, were excluded from the study. The study was approved by the AIMST University Human Ethics Committee (Ref No: AUHEC/FAHP/2019/29) and carried out in accordance with AIMST University's ethical standards in Kedah, Malaysia, as well as the tenets of the Helsinki Declaration. All study participants parents provided written informed consent.

***Study procedure*:** The study criteria were met by a total of 26 participants. Then, the participants were allocated into groups A (n = 15) and B (n = 11) using convenience sampling technique. CVS-Q was administered to participants before and after treatment was prescribed to assess the severity of DES. Group A received artificial tears, 20-20-20 strategy, and EE (pencil push-ups, palming, and eye-rolling). while group B received only artificial tears and the 20-20-20 strategy. Both groups received artificial tears by instilling 1-2 drops into both eyes three times per day for two weeks and were instructed to follow the 20-20-20 strategy while using electronic devices. Both groups underwent treatment for a period of six weeks.

The EE protocol and its implementation*:** A physiotherapist taught the EE and ensured that the participants could perform it independently and without supervision. ***Pencil push up: Hold a pencil/pen with a 20/60 size letter at arm's length in front of their eyes and gradually bring it closer to their eyes while maintaining bifoveal fixation. The participants were instructed to look at the pencil/pen against a white background. ***Palming*:** Participants were instructed to rub their hands together for 15 seconds, or until they felt a tolerable warmth in their hands. Then, for 30 seconds, they were instructed to gently place their palm over their eyes, with the index finger resting on the brow and the heel of the hand resting on the chin ***.Eye rolling:*** Participants were told to complete this exercise while sitting or standing upright by holding a target (pencil/pen) with a 20/60 size letter at an arm's length in front of their eyes and gently moving the target in a slow pace circular movement in both clockwise and anticlockwise directions. During the study period, all participants were instructed to follow the exercise protocol (5 days per week, 4 sets per day, each set consisting of 10 repetitions, 1 minute of rest between each set). The daily exercise sessions lasted approximately 30 minutes. The researcher followed up with the participants three times per week to ensure exercise compliance.

***Outcome measure*:** Before administering CVS-Q to the study population, five participants who were chosen at random and were not part of the study population were tested for understanding of CVS-Q. All participants' feedback on their ability to understand CVS-Q was also recorded. The CVS-Q was easily comprehended by the participants. The CVS-Q is a reliable and valid assessment tool that includes the frequency and intensity of 16 DES symptoms. According to Segui et al., 2015,the CVS-Q score was calculated from study participants.

***Statistical analysis*:** The statistical analysis was conducted with SPSS version 23 (SPSS, Chicago, IL). The normality distribution of the data was analyzed using the Shapiro–Wilk (S–W) test. The effect of EE on DES symptoms was analyzed using the Wilcoxon signed ranks test and the Mann-Whitney U test, respectively, within and between groups A and B as the data were not normally distributed.

Results:

Table 1 shows the characteristics of all study participants. The mean (M) **±**standard deviation (SD) of age, time spent in digital devices daily, corrected refractive error, time spent on-screen brightness of digital devices per day, and baseline CVS-Q score of group A (9 males and 6 females) and group B (3 males and 8 females) participants are given in table 1. It also shows that there is no statistically significant difference between groups in their baseline CVS-Q score, with $p > 0.05$.

Table-1. Characteristics of study participants and variables

Variables	**Group A (n=15) M ± SD**	**Group B (n=11) M ± SD**	***p*-value (>0.05)**
Age (years)	10.40 ±1.12	10.72 ± 1.34	0.52
Time Spent in Digital devices (hrs)	1.86 ± 1.40	1.45 ± 0.82	0.35
Screen brightness (%)	47.33 ± 30.17	39.54 ± 21.84	0.53
Corrected Refractive error (%)	53.33	54.54	0.95
Pre-test CVS-Q score	10.42 ± 5.87	7.81 ± 2.96	0.14

CVS-Q = Computer vision syndrome questionnaire

Table 2 shows the pretest and posttest median (Mdn) and interquartile range (IQR) of the CVS-Q score were within group A (Mdn = 8.00, IQR = 6-13, and Mdn = 4.00, IQR = 2-5, with $p = 0.001$) and group B (Mdn = 6.00, IQR = 6-9, and Mdn = 6.00, IQR = 3-9, with $p = 0.104$). The Wilcoxon signed rank test analysis revealed that participants in Group A have statistical significance in reducing the severity of DES ($p = 0.001$). On the other hand, it revealed that the participants in Group B are not statistically significant in reducing the severity of DES, with $p = 0.104$.

Table-2. Comparison of CVS-Q scores within and between Group A and B before and after treatment

Groups	Median	Minimum	Maximum	IQR Percentile		Z/U	p
				25th	75th		
Within Group							
Group A (n=15)	8.00	6.00	28.00	6.00	13.00		
Pre-test						-3.30	0.001
Post-test	4.00	0.00	9.00	2.00	5.00		
Group B (n=11)	6.00	6.00	15.00	6.00	9.00		
Pre-test						-1.62	0.104
Post-test	6.00	2.00	11.00	3.00	9.00		
Between Group							
Group A	16.90						
		-3.00	9.00	0.00	7.25	31.50	0.006
Group B	8.86						

Note: IQR- Interquartile range, Z- Wilcoxon signed-rank test, U-Mann-Whitney U test

The Mann-Whitney U test was then used to compare the pretest and posttest CVS-Q scores between groups. Groups A and B had median ranks of 16.90 and 8.86, respectively. With a *p*-value of 0.006, the obtained IQR between groups was 0.00–7.25. These findings indicated that group A's treatment (artificial tears, 20-20-20 strategy, and EE) was statistically significantly more effective in reducing DES symptoms than group B's treatment (artificial tears, 20-20-20 strategy).

Discussion:

The influence of EE on DES among school primary studentswas investigated in this study. The results suggested that the EE combined with CT was significantly betterat reducing the severity of DES than CT alone (p=0.006).

The following is a possible mechanism for the reduction of DES severity among study participants in group A in our study. The EE training may have improved intra-orbital blood circulation, promoted a vasodilatory effect on episcleral veins, stimulated aqueous humour flow, and facilitated better contraction and relaxation of extraocular muscles (EOMs). EMOs undergo concentric and eccentric contraction during EE, which may increase intraorbital blood circulation and act as a pump for efficient intraorbital venous outflow. Especially during palming, because of the transfer of heat from the hand to the eye, it may cause a vasodilatory effect on episcleral veins, resulting in triggering of blood circulation and outflow of aqueous humour, which aids in the nourishment of ocular structures (vitreous humour, cornea, iris, ciliary body, and lens) in the anterior segment of the eyeas proposed in previous studies (Gupta et al., 2020; Kim 2016).This study has a few limitations that should be mentioned. A small sample size was used to estimate treatment outcome from CVS-Q score. Further studies are in progress with a larger sample size and randomization to generalise the findings of this study.

Conclusion:
In general, this study demonstrated that EE could be effective in reducing the severity ofDES among study participants. This study proposes that EE may be prescribed along with the medical treatment to minimize the severity of DES among primary school students.

Conflict Of Interest:
The authors declare no conflict of interest.

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