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Eye yoga exercises to reduce eye fatigue syndrome during online learning

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Original Article

ABSTRACT

Background: Eye fatigue syndrome increases as students use computers and smartphones during online learning. Interventions to reduce the eye fatigue syndrome and avoid the severity of its symptoms need to be performed with appropriate and easy-to-practice techniques.

Objective: This study aims to determine effects of eye yoga exercises on eye fatigue syndrome in students during online learning.

Methods: This study applied one group pretest-post-test design involving 30 students from Universitas 'Aisyiyah Bandung, West Java, Indonesia. Its samples were collected by using a proportional stratified random sampling. The eye yoga exercises were practiced four times for one week and had to begin 30 minutes after the end of online learning. The eye fatigue syndrome was measured using the Computer Vision Syndrome Questionnaire (CVS-Q). The difference in the intervention effect was calculated by using the Wilcoxon Signed-Rank Test.

Results: This study revealed that the yoga eye exercises significantly affected the eye fatigue syndrome ($Z = -4.636$; p-value < 0.05). The average eye fatigue score decreased; the eye fatigue score before the intervention was 14.40 ± 9.17, and it decreased to 9.17 ± 4.88 after the eye yoga exercise intervention was given.

Conclusion: Eye yoga exercises can reduce the level of eye fatigue syndrome in students who are learning by using electronic devices. The exercises can be performed independently to reduce this syndrome when working with a computer or smartphone. This intervention can be a standard for preventing the syndrome in educational institutions by incorporating eye yoga exercises after learning activities, particularly in online learning.

INTRODUCTION

Using a computer or smartphone for a long time during online learning has some potential to cause health problems, especially to the eyes. The potential for eye disorders is in line with technological developments, especially in online learning processes and distance learning. Apart from that, at the end of 2019, the emergence of the coronavirus disease (COVID-19) pandemic also encouraged an increase in the frequency of use of computers or other devices in the educational process and the development of various online learning application platforms.[1,2] This condition has been slowly changing learning habits to online learning and increasing the frequency of use of electronic devices. Thus, it cannot be denied that the intensity of using computers and easily accessible gadgets can potentially increase eye problems.

The optimum duration of computer use is at most four hours a day. If it is more than four hours, it can lead to experience refraction more quickly.[3] Using a laptop or smartphone for more than three hours daily may results in dry eyes and blurred vision.[4] During the pandemic, the duration of electronic media use, such as smartphones, tablets, and computers increased to 4-7 hours per day.[5] The most common use is for online learning. A frequent impact of using the

electronics for too long is eye fatigue syndrome.[6]

Eye fatigue syndrome is a collection of symptoms related to vision, eye, and musculoskeletal problems. This term is often replaced with computer vision syndrome (CVS), which means complaints triggered by long-term use of digital devices.[7,8] The syndrome experienced can be caused by three potential mechanisms: extraocular mechanism, accommodative mechanism, and ocular surface mechanism.[9] Postural disorders can cause the extraocular mechanism due to improper computer screen placement, inappropriate table or chair height, and incorrect distance between the eyes and the screen, which result in unnecessary stretching or bending forward, often causing muscle sprains.[10–12] Then the accommodative mechanism can also cause eye fatigue syndrome. This accommodative mechanism occurs when someone uses a digital device for an extended period so that accommodation, convergence and pupil size will experience changes or tension, causing the syndrome.[13,14] Next is the ocular surface mechanism, which causes symptoms such as dry eyes, redness, gritty sensation, and burning sensation after using a computer for a long time. The appearance of symptoms in this mechanism is due to increased exposure of the corneal surface during horizontal viewing of the eye to a computer screen, causing eye strain.[9]

The symptoms of computer vision syndrome are related to a lot of factors. These factors include low contrast level of letters compared to the background of digital screens, reflection and screen glare, low room lighting conditions, inappropriate distance and viewing angle of digital screens, low flashing intensity, and unstable body posture when using the electronic devices. The eye fatigue syndrome can be severe for people of any age. It is caused by improper vision correction, visual overload and dry eyes.[15] Symptoms of eye fatigue that are felt can include complaints of dry eyes, difficulty in focusing on objects, eye strain, tired eyes, and headaches.[8] If left untreated, its symptoms can develop into refractive disorders that cannot be cured (myopia, presbyopia and astigmatism) and persistent dry eye syndrome up to blindness.[16]

Efforts to reduce this syndrome need to be addressed early on, which is one of duties of nurses or other health workers. American Optometric Association (AOA) states that complaints of visual disturbances such as eye fatigue in computer users can be reduced by using the rule of 20:20:20.[17] In this method, the computer user takes a break for 20 minutes by looking at an object 20 feet or 6 meters away for 20 seconds. However, using the rule of 20:20:20 has not wholly reduced complaints of it. It can also be reduced by wearing glasses with blue light filters to reduce light exposure to the eyes from computer screens.[18] However, using these glasses has many disadvantages, such as the cost of the lenses, which are expensive, we must pay attention to the maintenance of the glasses, and they can only reduce light exposure.

An eye exercise program can also be an option because they can reduce stress and eye fatigue. As in Kim's study, eye yoga exercises for 60 minutes every two days for eight weeks can reduce eye fatigue in nursing students.[19] Likewise, a study on yoga ocular exercise conducted on 30 undergraduate optometry students significantly reduced eye fatigue.[20] Eye yoga exercises are thought to increase the sensitivity of visual perception and the ability to stimulate blinking by increasing the frequency of blinks, which reduces the magnitude of the optical illusion.[19] Eye yoga exercises also have physical benefits and health down-regulation of the action of the hypothalamus-pituitary-adrenal and sympathetic nervous system. Yoga eye exercises are non-pharmacological and can be a therapeutic therapy to reduce the eye fatigue syndrome.[20] These exercises are easy to do and do not require a special place for training because they can be done alone at your work desk, and these do not require a long time and do not cost money.[21] Based on the study above, using a computer or mobile phone can increase risks of eye fatigue or computer vision syndrome. Interventions to reduce eye fatigue and avoid the severity of its symptoms need to be performed with appropriate and easy-to-practice techniques. Thus, this study aims to identify effects of eye yoga exercises on eye fatigue syndrome in students in online education.

METHODS

Research design

This study used a pre-experimental approach with one group pre-test and post-test design.

Its subjects involved in this study were students from Universitas 'Aisyiyah Bandung, West Java.

Population and sample

The sample size of this study was calculated based on the paired numerical comparative diagnostic formula with a confidence level of 95% and a power level of 0.8 to obtain 30 people for the study [$n = ((z\alpha+z\beta)^2 \pi) / (P_1-P_2)^2 \approx ((1.96+0.84)^2 \times 0.35) / (0.95-0.65)^2 = 30$]. The estimated proportion of P1 (65%) was taken from the study of Maisa *et al*., and the proportion of P2 from the literature is 30% if eye fatigue decreases after therapy and is considered significant with a difference in that value.[22]

The sample selection technique applied a proportionate stratified random sampling. This sample recruitment was conducted out based on students' educational levels and measured based on proportion allocation. The students' education level was divided into undergraduate and vocational levels, specifically for first-year students. After determining the sample size for each group based on the allocation proportion, names were drawn based on the attendance list of students undertaking online learning.

Each participant who participated in this study must meet the inclusion criteria as they had to be enrolled as an active student, participated in online learning for at least three hours per day, did not wearing glasses, did not use eye drops, did not use contact lenses, did not use an anti-radiation screen protector on the device, and did not have eye disease (glaucoma, eye infection, or eye injury). Meanwhile, the exclusion criteria in this study were students who experienced illness or dropped out of school during the study and students who changed classes to face-to-face learning.

Eye yoga exercises

The intervention in this study was eye yoga exercises. Yoga eye exercises are a non-pharmacological therapy to reduce complaints of eye fatigue. We developed eye yoga exercises from several studies that had focused on eye yoga exercise interventions.[23,24] These exercises could be practiced four times a week consecutively every day and conducted after online learning. Then these exercises must begin at maximum of 30 minutes after the end of online learning.

In detail, the eye yoga exercise consisted of eight movements. The first movement was palming; the participants were asked to close both eyes, to rub their palms together until warm and to place the palms gently on their eyelids. After that, they were asked to exhale slowly and to maintain their position until the warmth of their hands ultimately reached their eyes. These movements were repeated three times. The second movement was blinking; they were asked to blink their eyes 10-15 times quickly, then to close their eyes, and to relax for 20 seconds. These movements were repeated five times. The third movement was sideways viewing; this technique involved moving the eyes to the left and right and holding them for 20 seconds each. All participants must repeat these movements five times. The fourth movement was front and sideways viewing; they were asked to move their eyes to the left or right and then to look back to the front. These movements were repeated five times. The fifth movement was rotational viewing; they were asked to rotate the eyeballs clockwise and then to close the eyes for 10 seconds. These movements were repeated five times. The sixth movement was up-and-down viewing; this technique was to move the eyeballs upwards for 20 seconds and then to move the eyeballs downwards for 20 seconds. These movements were carried out alternately five times. After that, they were asked to close their eyes for 20 seconds. The seventh movement was preliminary nose-tip gazing; they were asked to focus their eyes by looking at the tip of their nose, holding them to concentrate for 20 seconds, and then closing their eyes for 20 seconds. These movements were repeated five times. The last movement was the eye focusing vision on distant and near objects; they were focused on their thumbs to look at close objects at ± 50 cm distance, and then they were asked to look at distant objects at 4-6 meters. The technique was performed to focus the eyes on the near object and then the far object for 10 minutes alternately. These movements were done ten times and ended with closing eyes for 20 seconds.

Before the eye yoga exercise intervention was performed, the participants were given

training on the eye yoga exercise procedures from the instructor and assisted with eye yoga exercise videos to better understand the movements. Before and after the intervention, each participant was asked to complete a questionnaire assessing the eye fatigue by using the CVS-Q. This assessment using CVS-Q from Segui *et al*.[25] was translated into Indonesian by Safaryna *et al*.[26] The questionnaire is publicly accessible and does not require written permission. The CVS-Q assesses eye fatigue and extraocular symptoms, with 18 questions items on a 3-point Likert scale, and with response options including no symptoms, sometimes, often. The CVS-Q has good validity (0.500–0.847) and reliability indices (Cronbach α: 0.946).[26]

Data analysis

Descriptive analysis of this study utilized proportion and percentage values to describe demographic data such as age, gender, level of education, length of study, type of device used, and eye distance to electronic devices. The Spearman-rank test was conducted to assess the relationship between respondent characteristics and the eye fatigue indices, and Wilcoxon Signed-rank Test was applied to assess the effects of eye yoga exercise intervention on the eye fatigue syndrome and/or its symptoms.

Ethics

This study has been ethically approved by Research Ethics Committee, Universitas 'Aisyiyah Bandung with a number 135/KEP.01/UNISA-Bandung/VI/2022. Writtent informed consent was obtained from all the participants included in the study.

RESULTS

Table 1 demonstrates that most students were 19 years old (56.7%); were predominantly female (80%) and from undergraduate education (76.7%). Most of them studied more than three hours daily (86.7%) and used a combination of laptop or smartphone devices (63.3%). In addition, the distance between most students' eyes and the electronic device screen was less than 50 cm (56.7%).

Table 1. Student characteristics and their relationship to the final eye fatigue index

Variables	n (%)	Correlation with eye fatigue index (p-value)
Age		0.075
18 years	9 (30.0%)	
19 years	17 (56.7%)	
20 years	3 (10.0%)	
21 years	0 (0.0%)	
22 years	1 (3.3%)	
Gender		0.026*
Male	6 (20.0%)	
Female	24 (80.0%)	
Educational level		0.904
Diploma level	7 (23.3%)	
Bachelor level	23 (76.7%)	
Length of online learning activity		0.277
3 hours/day	4 (13.3%)	
More than 3 hour/day	26 (86.7%)	
Type of device used		0.039*
Mobile phone	9 (30.0%)	
Computer or laptop	2 (6.7%)	
Combination (computer/laptop/ mobile phone)	19 (63.3%)	
Eye distance to electronic devices		0.000*
Less than 50 cm	17 (56.7%)	
More than 50 cm	13 (43.3%)	

*p-value < 0.05 (significant)

Table 1 also illustrates the test results of the relationship between the eye fatigue and the student characteristics. We found gender, type of electronic device used, and distance to electronic devices had a significant relationship with eyestrain (p-value < 0.05). Meanwhile, age, level of education, and length of study had no relationship to the student fatigue (p-value > 0.05). Table 2 points out changes in eye fatigue symptom index in the pre-test and post-test. The findings reveal that 13 symptoms had significant differences (p-value < 0.05) in each symptom after the intervention. These symptoms include tired eyes, eye strain, painful eyes, lots of blinking, headaches, watery eyes, irritated eyes, red eyes, itchy eyes, double vision, eyes that are more sensitive to light, and pain in the back. Meanwhile, five symptoms of eye fatigue had no difference in the index after the intervention (p-value > 0.05). These symptoms are dry eyes, blurred vision, difficulty focusing on distant objects, difficulty focusing on close things, shoulder pain, and neck pain.

Table 2. Distribution of decreases and differences in symptoms of eye fatigue syndrome

Symptoms	Pre-test n (%)			Post-test n (%)			Wilcoxon test (p-value)
	No symptom	Sometimes	Often	No symptom	Sometimes	Often	
Eyes strain	3 (10.0)	21 (70.0)	6 (20.0)	11 (36.7)	18 (60.0)	1 (3.3)	0.001*
Eyes tense	12 (40.0)	16 (53.3)	2 (6.7)	18 (60.0)	12 (40.0)	0 (0.0)	0.021*
Eyes hurt	3 (10.0)	23 (76.7)	4 (13.3)	8 (26.7)	22 (73.7)	0 (0.0)	0.007*
Dry eyes	18 (60.0)	11 (36.7)	1 (3.3)	21 (70.0)	8 (26.7)	1 (3.3)	0.405
Blink a lot	13 (43.3)	16 (53.3)	1 (3.3)	21 (70.0)	9 (30.0)	0 (0.0)	0.020*
Headache	2 (6.7)	19 (63.3)	9 (30.0)	8 (26.7)	21 (70.0)	1 (3.3)	0.001*
Watery eyes	11 (36.7)	18 (60.0)	1 (3.3)	23 (76.7)	6 (20.0)	1 (3.3)	0.001*
Irritated eyes	13 (43.3)	15 (50.0)	2 (6.7)	21 (70.0)	9 (30.0)	0 (0.0)	0.002*
Reddish eyes	7 (23.3)	20 (66.7)	3 (10.0)	21 (70.0)	8 (26.7)	1 (3.3)	0.001*
Itchy eyes	8 (26.7)	16 (53.3)	6 (20.0)	10 (33.3)	19 (63.3)	1 (3.3)	0.035*
Blurred vision	12 (40.0)	13 (43.3)	5 (16.7)	14 (46.7)	13 (43.3)	3 (10.0)	0.102
Double vision	16 (53.3)	10 (33.3)	4 (13.3)	22 (73.3)	6 (20.0)	2 (6.7)	0.011*
Far-objects focusing difficulty	15 (50.0)	5 (16.7)	10 (33.3)	15 (50.0)	12 (40.0)	3 (10.0)	0.106
Near-objects focusing difficulty	19 (63.3)	11 (36.7)	0 (0.0)	20 (66.7)	10 (33.3)	0 (0.0)	0.564
Light-sensitive eyes	8 (26.7)	19 (63.3)	3 (10.0)	17 (56.7)	12 (40.0)	1 (3.3)	0.001*
Shoulder pain	11 (36.7)	14 (46.7)	5 (16.7)	14 (46.7)	16 (53.3)	0 (0.0)	0.033*
Neck pain	8 (26.7)	18 (60.0)	4 (13.3)	8 (26.7)	22 (73.3)	0 (0.0)	0.206
Back pain	4 (13.3)	17 (56.7)	9 (30.0)	8 (26.7)	22 (73.3)	0 (0.0)	0.003*

*p-value < 0.05 (significant)

The results of the Wilcoxon test in Table 3 indicate that there was an influence of eye yoga exercises on the level of eye fatigue in the students (Z = -4.636; p-value < 0.05). The average eye fatigue score decreased; meanwhile, the eye fatigue score before the intervention was 14.40 ± 9.17 and decreased to 9.17 ± 4.88 after the intervention. This infers that eye yoga exercises could effectively reduce the eye fatigue syndrome in students.

Table 3. Wilcoxon test results and mean changes in eye fatigue syndrome index after eye yoga exercises

	Eye fatigue syndrome (Mean ± SD)	Z	p-value
Before eye yoga exercises	14.40 ± 9.17	-4.636	0.000*
After eye yoga exercises	9.17 ± 4.88		

*p-value < 0.05 (significant)

DISCUSSION

The findings of this study reveal that eye yoga exercise intervention can reduce eye fatigue syndrome in students undergoing online learning. This study also noted that all students experienced decreased symptoms of the syndrome after practicing eye yoga exercises. Thus,

these exercises can reduce the syndrome in students when online learning. These exercises are one method used to train the strength of the eye muscles to reduce the symptoms of eye fatigue.[27] The exercises can effectively and efficiently mitigate the syndrome because eye yoga movements can restore the elasticity of the eyes' accommodation muscles and reduce stress on the eyes.[22] The exercises are non-pharmacological and can be considered a therapeutic therapy to reduce symptoms of eye fatigue.[20]

Eyestrain is a collection of symptoms related to asthenopia, ocular surface, visual and musculoskeletal.[8] Symptoms of eye fatigue are associated with asthenopia are tired eyes, eye strain, sore eyes, dry eyes, lots of blinking and headaches. Symptoms of eye fatigue related to the ocular surface are watery eyes, irritated eyes, red eyes, and itchy complaints due to contact lenses. Visual symptoms of eye fatigue include blurred vision, double vision, difficulty focusing on objects at close and far distances, and presbyopia. Meanwhile, symptoms of eye fatigue related to musculoskeletal problems are neck, shoulder, and back pain.[26,28]

This finding aligns with a study by Dewi and Novia, stating that eye yoga exercises can reduce eye fatigue by increasing eye muscle efficiency.[21] These exercises can reduce eye fatigue and sharpen vision.[22] The exercises in this study used video tutorials made by researchers that consist of eight movements: palming, blinking, sideways viewing, front and sideways viewing, rotational viewing, up and down viewing, preliminary nose-tip gazing, and eye focusing. The process of providing the exercises in this study was conducted four consecutive days a week, with each session lasting 30 minutes.

The level of eye fatigue syndrome in students is on different indices. Various influencing factors of the syndrome include demographic characteristics such as age, gender, status of education, length of online learning, eye distance from electronic devices, and types of devices used when learning online. The eye function decreases as age increases, especially in old age. The strength of the eye's ciliary muscles decreases so that the ability of the eye lens decreases when looking at objects, causing discomfort in the eyes and accelerating the occurrence of the syndrome. Computer users aged more than 40 years are 5.4 times more likely to experience it than computer users under 40 years.[29] However, visual abnormalities can occur at any age in types of work that require focusing on close objects and are carried out continuously for extended periods.[30]

Meanwhile, gender also determines how fast or slow the eyes will get tired. Women are more likely to experience eye fatigue syndrome than men.[31] This tendency is because as women ages, her oestrogen and antiandrogen hormones will increase. These two hormones will suppress the secretion of tears so that the tear layer in women tends to be thinner than in men. This thinning of tears will result in the eyes watching to experience the syndrome when using a smartphone or computer.[4]

Using a laptop or smartphone for over three hours daily can cause dry eyes and blurred vision. The maximum duration of using electronic media is 4 hours a day. Using gadgets for an extended period can cause a decrease in eye sharpness and make the eye muscles stiff, usually characterized by eyes feeling tired, blurred vision, double vision, headaches and discomfort in the eyes when looking at objects far and near.[21]

Besides, the distance between the eyes and the screen is related to the incidence of eye fatigue syndrome.[32] The viewing distance from a computer or smartphone screen has a high risk of the syndrome if the space is over 50 cm.[33] The closer the eyes are to the screen, the higher the possibility of the syndrome. Eyes that see objects at close range will contract and increase the load on the ciliary muscles to focus the image on the retina.[34] Apart from that, the position of the eyes on the laptop screen can affect eye health. Efforts to position the eyes higher than the laptop screen can reduce the decrease in blinking frequency so that the eyes do not dry out quickly. Meanwhile, setting the eyes lower than the laptop screen can lessen the blinking frequency so the eyes dry more rapidly.[35,36]

Eyestrain can also occur in several conditions. Another condition that affects eyestrain is room lighting.[37] Using a computer in a bright or dark room can cause vision problems. Lighting that is too bright or dim will force the pupils to adjust to the more excellent light they receive,

causing the eyes to tire quickly. Meanwhile, a laptop or smartphone screen display can affect eye fatigue syndrome. A laptop or smartphone screen's "dark mode" display can provide comfort and sharpen vision, especially in dim environmental lighting. However, in bright ecological lighting, the "dark mode" display on a laptop or smartphone screen can cause the text to fade so that the eyes need to focus more, which can cause the syndrome.[38] Screen resolution can be a factor in the syndrome. Higher screen resolution can improve perceived image quality and comfort when reading text. Contrasting colour combinations were preferred when viewing a monitor screen.[35,36] Thus, adjusting the laptop screen display will affect the symptoms of eye fatigue that are felt.

Various factors also influence eye fatigue syndrome caused by electronic devices in online learning. Although this study did not examine the factors, there may be confounding factors. These confounding factors include physiological characteristics of the eye (refraction and muscles) and psychological and environmental factors.[7] Eye refraction disorders can be caused by excessive or insufficient light radiation received by the eye, causing the muscles for accommodation in the eye to work hard, leading the eyes to tire quickly.[39] Likewise, insufficient lighting can cause eye nerve fatigue due to constant eye strain.[39] The room used by individuals when using electronic devices is also a factor in the eye fatigue. This factor is related to room humidity, which may affect the eyes. Low room humidity allows evaporation and thinning of the tear film, while high humidity allows the growth of microorganisms.[40]

Based on these studies, a lot of factors can influence the changes in the eye fatigue levels during the implementation of the eye yoga exercises. However, the magnitude of the impacts caused by these factors on the intervention requires further study, which is the limitation of this study. In addition, another limitation is that this study is only conducted on one group of students in one site, so its results cannot be generalized to wider groups with more diverse characteristics.

CONCLUSION

The eye yoga exercises is considered effective in reducing symptoms of eye fatigue in students during online learning. They are an easy intervention and can be done independently. To reduce the eye fatigue syndrome, every computer or electronic user can practice the exercises four times a week within 30 minutes after using electronic devices. Furthermore, future study can analyse the exercises in a larger sample with a control group and randomization.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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AUTHOR CONTRIBUTION

AW and FNP were responsible for the study design. AW and AF were supervising the study. FNP and AW were responsible for data, statistical analysis, and providing the data. EL and MA reviewed the article. AW wrote the initial draft of the manuscript. All authors reviewed and agreed upon the final version of the manuscript.

LIST OF ABBREVIATIONS

COVID-19: Coronavirus Disease 2019; CVS: Computer Vision Syndrome; AOA: American Optometric Association; CVS-Q: Computer Vision Syndrome Questionnaire; SD: standard of deviation.

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