

RESEARCH ARTICLES

The Effect of *Blue Light Filter* on *Smartphones* on Levels Eye Fatigue of Faculty of Medicine Students University of Muhammadiyah North Sumatra

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Abstract: The use of *smartphones* in the digital era like today is increasingly intense in daily life. Not only teenagers and adults, *smartphones* are also widely used by children, toddlers, and even babies. *Blue light filters* on *smartphones* are believed to reduce visual disturbances that occur due to long-term smartphone use. The purpose of this study is to analyze the effect of a *blue light filter* on the level of eye fatigue of students of the Faculty of Medicine, University of Muhammadiyah North Sumatra (FK UMSU). This research is *quasi-experimental* with a *pre-posttest design*. A total of 154 FK UMSU students were divided into 2 groups, the Blue Light Filter Group (BLF) and the Non-Blue Light Filter Group (Non-BLF) with the same number ($n_1 = n_2 = 77$). Each group filled out a VFS (*Visual Fatigue Scale*) questionnaire before and after working on *the visual task*. The data were analyzed using the Mann-Whitney and Wilcoxon tests. The results showed that the post-test score of the level of eye fatigue in the Non-BLF group was significantly higher than that of the BLF group ($P < 0.001$). There was a significant difference between the pre-test and post-test results of the Non-BLF Group ($P < 0.001$), while the pre-test and post-test results of the BLF Group showed a difference but not significant ($P = 0.860$). This study shows that the use of *blue light filters* affects the level of eye fatigue.

Keywords: *blue light filter, smartphone, visual fatigue*

INTRODUCTION

Eye fatigue is a condition in the eyes that results in a decrease in vitality and productivity due to eye health problems. Eye fatigue can occur when the eye muscles are forced to work hard, especially when looking at close objects for a long time. The

symptoms in people who experience tired eyes include headaches, pain around the eyes, blurred vision, red eyes, and watery eyes.^{1,2}

Eye fatigue is a symptom that is often found due to continuous eye interaction with electronic devices. The results of the

research were conducted at the corporate customer care centre of PT. In 2009, there was a 90.2% prevalence of eye fatigue due to continuous interaction with computer screens.³

The use of gadgets in the digital era like today is increasingly intense in daily life. The use of *smartphones* is not only in adolescents and adults, but the use of smartphones is also known to be 29% in children, 3.5% in infants < 1 year old, 25.9% in children under 1-4 years old, and 47.7% in preschool children 5-6 years old. This percentage increased in line with the COVID-19 pandemic.⁴

Computers or other digital devices such as televisions and smartphones have a blue light beam which is classified as high-energy visible light (HEV light), which is visible light with a short wavelength, around 415 to 455 nm, and has a high level of energy. Blue light is found in the spectrum that is still acceptable to the eye, but the nature of *HEV Light* or *High-Energy Vision Light* has an impact on the retina if exposed for a long time.^{5,6}

Naturally, the eye cannot filter light as strong as blue light so that the light penetrates directly on the retina, this causes the lens of the eye to focus less optimally on the shadow. This condition results in tension in the ciliary muscles that are responsible for controlling the change in the shape of the lens to focus light.⁷

Tension in the ciliary muscles occurs because the muscles work harder to always tilt the lens (maximally accommodating) to focus the light. The close viewing distance also forces the lens to always accommodate optimally. In addition to the ciliary muscles, the *sphincter pupillae* muscle, which is

responsible for controlling pupil contractions, also needs to work harder so that the light entering the eye is reduced. The continuous work of these muscles will cause fatigue in the eyes.^{8,9}

The blue light filter on smartphones is designed to block the blue light emitted by the LED backlight screen and thus reduce the amount of blue light that enters the eyes while viewing the screen. Blue light filters can reduce blue light emissions from smartphones by adding additional physical filters and changing the screen display from white mode to sepia mode.^{10,11}

The purpose of this study is to analyze the effect of the *blue light filter* on the level of eye fatigue of students of the Faculty of Medicine, University of Muhammadiyah North Sumatra (FK UMSU)

METHOD

This research is quasi-experimental with a pretest-posttest design. The research was carried out at the Faculty of Medicine, University of Muhammadiyah North Sumatra and has received Ethical Approval from the Health Research Ethics Commission, Faculty of Medicine, University of Muhammadiyah North Sumatra, No: 994/KEPK/FKUMSU/2023.

Respondents as many as 154 FK UMSU students who have met the inclusion criteria are divided into two groups, the Blue Light Filter Group (BLF) and the Non-Blue Light Filter Group (Non-BLF) with the same number ($n_1 = n_2 = 77$). Data was collected with the help of a Visual Fatigue Scale (VFS) questionnaire which contained 9 complaints of eye fatigue with a scale of 0-100 on each complaint. The total scale

obtained is recorded as the value of eye fatigue.¹²

The day before the treatment, respondents were asked to reduce the use of smartphones, get enough rest, and not stay up late to prevent eye fatigue before the treatment.³

On the day of treatment, each group was placed in a room with the same level of lighting between room 1 and room 2. The following preparations were made: the distance *between the smartphone* and the respondent's eyes was set between 25-30 cm; the brightness level of the smartphone screen was set at 50%; the level of *blue light filter* in the BLF Group was 50%; the level of *blue light filter* in the Non-BLF Group was 0% (without using a filter); downloading the *game* application "*Find The Differences 750+ levels*" as a visual task.¹³

Respondents then fill out the Visual Fatigue Scale (VFS) questionnaire (pretest) that has been given. After filling out the pretest questionnaire, respondents simultaneously carried out *visual tasks* for 30 minutes. After completion, respondents were again asked to fill out the VFS (*postest*) questionnaire which was given at the same time without a time gap.

The collected data were analyzed using the Kolmogorov-Smirnov normality test, followed by the Mann-Whitney test for posttest data and the Wilcoxon test for pretest-posttest data. The significance value will be achieved if $P < 0.05$.

RESULT

Of the 154 respondents, 104 of them were women (67.5%) and the remaining 50 were men (32.5%). Meanwhile, in terms of

age, the most respondents were 20 years old (44.2%). Table 1 shows the data on the characteristics of respondents by age and gender.

Table 1. Respondent Characteristics.

Variable	Category	Frequency	Percentage
Gender	Man	50	32,5 %
	Woman	104	67,5 %
Age	19 Yo	23	14,9 %
	20 Yo	68	44,2 %
	21 Yo	63	40,9 %

Table 2 shows the statistical distribution of eye fatigue levels based on the Visual Fatigue Scale in the BLF group and the Non-BLF group.

Table 2. Statistical Distribution of Mann Whitney Test.

Variable	Group	N	Mean Rank	Sum of Rank
Eye Fatigue Level	Post-test Non-BLF	77	112.63	8672.50
	Post-test BLF	77	42.37	3262.50
Total		154		

BLF = Blue Light Filter

The results of the Mann-Whitney statistical distribution showed that the average value of eye fatigue in the group that did not use *the blue light filter* (Non BLF) was higher than the group that used *the blue light filter* (BLF). The average value of the Non-BLF group was 112.63 while the average value of the BLF group was 42.37.

Table 3. Mann Whitney Test Results.

	Eye Fatigue Level
Mann-Whitney U	259.500

Wilcoxon W	3262.500
Z	-9.905
Asymp. Sig. (2-tailed)	<,001

Table 3 shows that the Asymp. Sig. (2-tailed) value is less than 0.001 ($p < 0.05$) which means that there is a significant difference between the group that does not use *the blue light filter* and the group that uses *the blue light filter*.

Table 4. Statistical Distribution of Wilcoxon Test.

		N	Mean Rank	Sum of Rank
Posttest – pretest Non BLF	Negative Ranks	0 ^a	.00	.00
	Positive Ranks	77 ^b	39.00	3003.00
	Ties	0 ^c		
	Total	77		
Posttest- pretest BLF	Negative Ranks	25 ^d	19.50	487.50
	Positive Ranks	18 ^e	25.47	458.50
	Ties	34 ^f		
	Total	77		

The results of the statistical distribution of the Wilcoxon test in Table 4 showed that in the group that did not use *the blue light filter* (Non-BLF), there were no *negative ranks* (pretest > posttest values)^a and *ties* (pretest = posttest values)^c in the respondents, while positive *ranks* (pretest < posttest values)^b were found in all respondents (N=77).

In the group that used *the blue light filter* (BLF), it was seen that 25 respondents showed *negative ranks* (pretest > posttest values)^d, 18 respondents showed *positive ranks* (pretest < posttest values)^e, and 34 respondents showed *ties* (pretest = posttest)^f values.

Table 5. Wilcoxon Test Results.

	Posttest – pretest Non BLF	Posttest-pretest BLF
Z	-7.634 ^b	-.176 ^c
Asymp. Sig. (2-tailed)	<,001	.860

Based on the results of the Wilcoxon test, the Asymp. Sig. (2-tailed) value was less than 0.001 (<0.05) in the group that did not use *the blue light filter* (Non-BLF), which showed that there was a significant difference between the pretest value and the posttest value of the group that did not use *the blue light filter*. Meanwhile, in the group that used *the blue light filter* (BLF), the Asymp. Sig. (2-tailed) the value obtained was 0.860 (>0.05), which means that there was no significant difference between the pretest and posttest values of the group that used *the blue light filter*.

DISCUSSION

In the Mann-Whitney test, there was a significant difference between the group that used the blue light filter and those who did not use the blue light filter. Table 2 shows that the average value of eye fatigue in the group that does not use the blue light filter (Non-BLF) is higher than the group that uses the blue light filter (BLF). The average value of the Non-BLF group was 112.63 while the average value of the BLF group was 42.37. This is in line with Ida Ayu Indah Udiantari's research in 2018 entitled "Eye Protection Feature on Smartphone Screens Can Reduce Eye Fatigue and Extend the Duration of Use in Junior High School Students 1 Seririt".⁷

The study was conducted by calculating the duration of smartphone use

with a blue light filter and without a blue light filter, in the study there was a significant difference between the duration of using a smartphone without a blue light filter and those using a blue light filter. The average duration of using a smartphone without a blue light filter was 684.77 seconds and that using a blue light filter was 1070.35 seconds. The percentage increase in duration with a blue light filter is 56.30%, which shows that the use of a blue light filter during activities in front of the smartphone screen can increase the duration of smartphone use.^{14,15}

The same thing was also found in Sofia Apriyanti's 2021 research entitled "Smartphone Use Affects the Symptoms of *Computer Vision Syndrome*". This study was conducted to find out the relationship between the duration and distance of smartphone use and *computer vision syndrome*. The duration of smartphone use has a significant relationship with the symptoms of *Computer Vision Syndrome* with an OR value of 6.673. This means that a person who uses a smartphone with a usage duration of ≥ 4 hours/day has a 6,673 times greater risk of experiencing CVS symptoms than someone who uses a smartphone with a usage duration of < 4 hours/day.¹⁶

In the Wilcoxon test, there was a significant difference between the pretest and post-test scores in the group that did not use the blue light filter, whereas from the research carried out, the results showed that a higher level of eye fatigue occurred in the group that did not use the blue light filter while there was no significant difference between the pretest and posttest values. In the group that used *the blue light filter*

(BLF), it was seen that there were as many as 25 respondents who showed *negative ranks* (pretest $>$ posttest) ^{values}, 18 responden yang menunjukkan nilai *positive ranks* (nilai pretest $<$ posttest)^e, dan 34 responden yang menunjukkan nilai *ties* (pretest = posttest)^f.

The use of blue light filters can prevent eye fatigue because the addition of a screen protector on the smartphone screen can reduce the negative impact caused by blue light. Screen protectors are made of plastic or glass materials that can polarize light. Penggunaan blue light filter pada layar smartphone dapat mengurangi kelelahan mata penggunanya dibandingkan yang tidak menggunakan fitur blue light filter. The intensity of blue light that passes through a medium such as plastic or glass will be reduced, so the use of a screen protector can protect the eyes from damage and reduce eye fatigue due to the blue light emitted by the smartphone screen. From this statement, it can be concluded that the use of a blue light filter in the form of a screen protector on the smartphone screen can extend the duration of use because the occurrence of eye fatigue can be delayed.^{17,18}

Several other studies report that the use of eye protection or blue light filter features can extend the duration of smartphone use. Blue and UV-blocking lenses allow 30% to 40% of light transmission with wavelengths exceeding 625 nanometers. The combination filter with polarize blocks at least 80% of harmful blue light and UV radiation. Increased visual comfort will have an impact on reducing the incidence of eye fatigue so that

the use of digital devices becomes longer.^{19,20}

CONCLUSION

Based on the description of the discussion above, it is known that smartphone users who use blue light filters and those who do not use blue light filters have significant differences in the level of eye fatigue, so it can be concluded that there is an effect of using blue light filters on the level of eye fatigue.

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