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Covid-19 After Effect: School-Age Visual Acuity Analysis with Secondary Data

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Abstract

Students' ability to see is crucial for learning and helps them achieve more. Normal visual acuity enables students to read the writing on the blackboard clearly, which improves their comprehension of the information the teacher is providing. With the online learning system, students spend more time using a computer or phone, which impairs their visual acuity, hinders their understanding of the material, and lowers their academic performance. The purpose of this study was to ascertain how online learning affected elementary school students' visual acuity. A Snellen chart and a questionnaire are used in this observational analytic research study with a cross-sectional design. 728 students from 7 elementary schools in Surabaya's Jeruk and Lakarsantri Districts made up the sample size. The results of the study showed that 184 of the 728 students who took part had deteriorated visual acuity during the observation period. These were divided into three categories: mild (166 cases), moderate (4 cases), and severe (14 cases). 79 pupils had recently seen a level increase in their eyesight, 27 had recently experienced a level increase in their vision, and 4 had experienced an additional level gain in their vision. There is a substantial difference in visual acuity between the pre-and post-online learning periods, according to the Wilcoxon signed-rank test results. The results of this study can support the responsible use of computers and mobile devices by parents, educators, and students.

Introduction

Despite the potential for COVID-19 infection control-related events to affect child well-being, comprehensive assessments of post-lockdown changes and persistent outcomes are lacking (Sum *et al*., 2022). On March 11, 2020, the World Health Organization (WHO) declared that the Corona Virus Disease (COVID-19) pandemic was underway. On Saturday, March 14, 2020, the Indonesian government issued a Presidential Decree of the Republic of Indonesia Number 12, 2020, concerning the Stipulation of Non-Natural Disasters of the Spread of COVID-19, designating Covid-19 as a national disaster. Since April 17th, 2020, the government has implemented extensive social restrictions (PSBB) to prevent the coronavirus from spreading to a wider population. The Government implemented Restricting Community Activities from January 11 to January 25, 2021. The government's implementation of abrupt and specific restrictions in response to Covid-19 could potentially result in an undesirable situation (Hermahayu, Faizah, & Candra, 2022). The government has implemented an online learning system starting on March 16th, 2020, where students can begin studying from their homes instead of attending school to prevent the coronavirus from spreading in schools. Students are required to use electronic devices, such as computers and mobile phones, in the online learning system. An online learning system takes one to three hours per day on average.

During the coronavirus disease 2019 (COVID-19) self-quarantine period, the transition to online courses has profoundly

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changed the learning modes of millions of school-aged children (Li *et al*., 2021). Students also receive school assignments that they complete on computers or mobile devices, in addition to online meetings using the programs Zoom, Meet, or Microsoft Teams. The process of working on school assignments involves using a web search engine to find information on a website, and then using a computer to analyze the data that is returned. Due to this condition, more eyes are exposed to computers and mobile devices. After prolonged exposure, radiation from a computer or laptop screen, according to Kumar (2020), may harm people. The radiations enter the body, and the cells and tissues of the human body absorb electromagnetic energy (Kumar *et al.,* 2020).

Students frequently use computers and mobile devices to play online games and are active users of social media websites to get rid of their boredom. Students use it to continue playing online games during downtime or school breaks. Games frequently involve a team of friends or other students playing on a computer or a mobile device. This may go on for hours, allowing students to indirectly spend more than three hours per day staring at computer or mobile phone screens. This increases the chance that students will experience decreased vision acuity, as noted by Santosa (2018) that school children who have a habit of playing online games for an extended period are susceptible to visual acuity impairment. Without taking breaks, playing online games for an extended period can lead to eye fatigue and decreased visual acuity (Santosa & Sundari, 2018).

It has been reported that myopia prevalence is high in Southeast Asia, and refractive errors if not corrected properly may lead to amblyopia. Therefore, a regular eye screening is important (Darusman, 2021). School closures during the COVID-19 pandemic increased the risk of myopia in Chinese children and adolescents due to the accumulation of poor eyesight habits, unhealthy lifestyles, and excessive screen time (Dong *et al*., 2022). Children's visual acuity is impacted by technological advancements that encourage school-aged kids to spend more time watching television, reading comic books or other reading material, and playing games on laptops or other frequently used devices. Consider implementing health education and discussions to improve the eye health of school-age children as early detection of decreased visual acuity is necessary for providing an overview of the condition of visual acuity in elementary school-age children (Birch *et al.,* 2021). Concerns have been raised about whether home confinement may have worsened the burden of myopia owing to substantially decreased time spent outdoors and increased screen time at home (Wang *et al*., 2021). Decreased time spent outdoors and increased sustained near work and digital screen time due to the lockdown and quarantine measurements could have visual repercussions for children (Alvarez-Peregrina *et al*., 2021). During this last year of the pandemic outbreak, the study habits of children have been modified, increasing the use of digital technology and online e-learning. Based on the foregoing, the goal of this study is to ascertain whether schoolchildren's visual acuity has been impacted by the pandemic's online learning environment.

Method

This study has a cross-sectional design and is an observational analysis. In this study, samples were collected from seven schools in Surabaya City's Jeruk and Lakarsantri subdistricts. The 728 students who make up the entire student body are in the Elementary School's grades 4, 5, and 6. Grades 4, 5, and 6 elementary school students were chosen as samples because this study tracked how students' visual understanding changed over the previous three years (the year 2019 to the year 2022). Students who had previously undergone an acuity check in March 2019 or before the online learning period and were observed once more in March 2022 or following the online learning period made up the sample in this study. To ascertain the following: 1. The number of additional new decreased vision in the right and left eye; 2. The severity of reduced vision in the right and left eye; and 3. Correlation of duration of computer/mobile phone use with the severity of decreased visual acuity. The secondary data from the visual acuity examination in March 2019 will be compared

with the primary data taken in March 2022.

Seven elementary schools were visited, and visual acuity physical exams were conducted on students using a Snellen chart and a questionnaire. Normal visual acuity is defined as 20/20 feet, or 6/6 meters, on the Snellen chart. This means that within 20 feet, or six meters, normal eyes can see the alphabet. An alphabet that is large enough to read can only be seen by a patient at a distance of 30 feet (9 meters) or 20 feet (6 meters) if the visual acuity results are 20/30 (Azzam & Ronquillo, 2023). The independent variable in this study is the number of hours spent using a computer or a mobile device. The primary data from the visual acuity examination in March 2022 or the value of visual acuity from the results of the visual acuity examination after the online learning period serve as the dependent variable. The visual acuity value obtained from the visual acuity test results obtained before the online learning period or secondary data obtained from the visual acuity test in March 2019 and March 2020 serves as the control variable. Based on the outcomes of the visual acuity test, univariate analysis data count respondent characteristics, frequency, distribution, and visual acuity values. Using the Wilcoxon signed rank test with continuity correction in a bivariate analysis, the relationship between the independent and dependent variables will be determined.

Results and Discussion

Table 1 lists the characteristics of this research sample. The total number of respondents is 728 students, with male students accounting for 377 of them (51.8%), the average age of respondents being nine (31.9%), the majority of respondents attending grade 4 elementary schools (286, or 39.3 percent), and the least number attending grade 5 elementary schools (206, or 28.3 percent), respectively. The majority of respondents, or 715 students, reported using mobile phones (98.2 percent).

Visual acuity may be impacted by prolonged computer/mobile phone use. Based on the findings of that study, it can be deduced that increasing the amount of time students spend using computers or mobile devices for online learning can increase the risk of their visual acuity deteriorating. The study observed an increase in students experiencing significant visual acuity deterioration when comparing test results from 2019 to 2020 and 2022. In 2021, due to the adoption of online learning at home as per Circular Letter No. 15 of 2020 from the Ministry of Education and Culture, there were no physical visual acuity assessments for pupils, so no data is available for that year. Visual acuity was classified by the WHO into four categories: normal, mild vision decrease, moderate vision decrease, and severe visual impairment. The study analyzed data for both left and right-eye visual acuity declines, starting with the right eye, comparing data from 2019-2020 (pre-online learning) and 2022 (post-online learning). Additional data points related to students experiencing new vision loss in their eyes were also examined.

Table 1. Respondents' Characteristics

Characteristics	n	%
Gender		
Male	377	51,8
Female	351	48,2
Age (years)		
9	232	31,9
10	183	25,1
11	225	30,9
12	88	12,1
Grade Elementary School		
4	286	39,3
5	206	28,3
6	236	32,4
Electronic Devices Used		
Computer	13	1,8
Mobile phone	715	98,2
Total	728	100

Source: Primary data, 2023

As shown in Table 3, some additional students have a new vision decrease, including up to 15 students (2.1%) at mild level severity 20/30, 23 students (3.2%) at mild level severity 20/40, 5 students (0.7%) at mild level severity 20/50, 11 students (1.5%) at mild level severity 20/70, and 14 students (1.9%) at severe level severity 20/200. According to severity level categories, the enhancement amount of students who develop new vision experience decreases as follows: As many as 54 additional

students (7.5%) had a recent mild level severity decrease in vision; however, no student had a recent moderate level severity decrease in vision. However, an additional 14 students (1.9 percent) of the total research population had a recent severe level severity vision decrease.

Table 2. Duration of Computer/Mobile Phone Usage Before and During Online Learning

Duration (hours)	Before online learning		During online learning	
	n	%	n	%
0-2	485	66,6	1	0,1
2,1-4	184	25,3	170	23,4
4,1-6	44	6	244	33,5
6,1-8	15	2,1	166	22,8
8,1-10	0	0	103	14,1
>10	0	0	44	6
Total	728	100.0	728	100
Total respondents' daily use (hours)	1.455,54		4.562,80	
Mean	1,9		6	
Minimum	0		1,5	
Maximum	8		18	

Source: Primary data, 2023

According to Table 4, some additional students have new vision loss. There are eight students (1.1%) at mild level severity 20/30, 24 students (3.3%) at mild level severity 20/40, seven students (1.0%) at mild level severity 20/50, five students (0.7%) at mild level severity 20/7, and fourteen students (1.9%) at severe level severity 20/200. According to severity level categories, the number of students who experience new vision decreases as follows: Up to 44 additional students (6.0%) had recent mild level severity vision declines; however, no students had recent moderate level severity declines in vision. However, there were additional students—up to 14 students, or 1.9% of the total research population—who had recent, severe vision decline.

Data analysis reveals a significant increase in students experiencing reduced visual acuity before and after online learning. This suggests that prolonged computer and mobile device use may contribute to declining vision. One contributing factor is the emission of radiation from screens, confirming Sayekti's theory that computer screens can transmit harmful

Table 3. Right Eyes Vision Decrease

Vision Decrease	Category	2019		2020		2022	
		n	%	n	%	n	%
Normal	Best corrected	663	91,1	634	87,1	544	74,7
20/30	Mild	32	4,4	53	7,3	89	12,2
20/40		13	1,8	15	2,1	40	5,5
20/50		11	1,5	13	1,8	20	2,7
20/70		4	0,5	5	0,7	17	2,3
20/100	Moderate	5	0,7	8	1,1	4	0,5
20/200	Severe	0	0	0	0	14	1,9
Total		728	100	728	100	728	100

Source: Primary data, 2020

Table 4. Left Eyes Vision Decrease

Vision Decrease	Category	2019		2020		2022	
		n	%	n	%	n	%
Normal	Best corrected	665	91,3	634	87,1	552	75,8
20/30	Mild	29	4	52	7,1	83	11,4
20/40		14	1,9	17	2,3	44	6
20/50		10	1,4	9	1,2	15	2,1
20/70		5	0,7	6	0,8	12	1,6
20/100	Moderate	5	0,7	10	1,4	8	1,1
20/200	Severe	0	0	0	0	14	1,9
Total		728	100	728	100	728	100

radiation to the eyes. Monitors emit various waves and radiation, including electromagnetic microwaves, shallow frequencies, X-rays, and ultraviolet rays, which can strain the eyes and affect their health due to screen brightness and sharpness. Continued exposure may lead to eye fatigue and potential harm (Sayekti *et al.,* 2016). Prolonged use of computer or mobile phone screens can cause eyestrain and potential visual acuity decline, leading to Computer Vision Syndrome (CVS). Santoso's study demonstrates a direct correlation between extended online gaming and visual acuity impairment. The percentage of students experiencing decreased visual acuity rises as they spend more time playing online games without breaks each day (Santosa & Sundari, 2018). Visual impairment levels were assessed through data coding. The vision decrease code categories are: Normal (code 0), 20/30 (code 1), 20/40 (code 2), 20/50 (code 3), 20/70 (code 4), 20/100 (code 5), and 20/200 (code 6). To calculate the increased severity of visual acuity decline, the difference in codes between pre-online learning (2019–2020) and during online learning (2020–2022) was analyzed for both right and left eyes.

Before the online learning period in 2019–2020, there was an increasing severity of right eye visual acuity decrease, as indicated by the number of respondents who reported experiencing this decline: 683 respondents (93.8%) had normal vision; 40 respondents (5.5%) had one level of vision impairment; and five respondents had two levels of impairment (7 percent of whole population samples). During the online learning period in 2020–2022, the increasing severity of right eye visual acuity decreased. It was discovered that the number of respondents who experienced right eye visual acuity decreased as follows: respondents with normal vision in the right eye were 560 respondents (76.9 percent); 130 respondents (17.9 percent); 34 respondents (4.7 percent); and four respondents (three levels of vision decreased) (0.5 percent of whole population sample).

The number of respondents with a new level of decreased vision was calculated using the difference between data on the rate of decline in right eye vision in 2019–2020 and data on the rate of decline in right eye vision in 2020–2022. There was an increase in the number of new respondents who increased to one level, totaling 90 respondents (12.4%); an increase in the number of new respondents who increased two levels, totaling 29 respondents (4.0%); an increase in the number of new respondents who increased three levels, totaling four respondents (0.5%); and there was no increase in the number of new respondents who increased three levels.

Table 5. Right and Left Eye Vision Decrease Level

Vision Decrease Level	Before Online Learning 2019-2020 (1)		During Online Learning 2020-2022 (2)		New Increase of Right Eye Vision Decrease (Compare 1 and 2)	
	n	%	n	%	n	%
Right Eye Vision Decrease Level						
0 (No increase)	683	93,8	560	76,9	-123	-16,9
1	40	5,5	130	17,9	90	12,4
2	5	0,7	34	4,7	29	4
3	0	0	4	0,5	4	0,5
4	0	0	0	0	0	0
Total	728	100	728	100	123	16,9
Left Eye Vision Decrease Level						
0 (No increase)	680	93,4	570	78,3	-110	-15,1
1	41	5,6	120	16,5	79	10,9
2	7	1	34	4,7	27	3,7
3	0	0	4	0,5	4	0,5
4	0	0	0	0	0	0
Total	728	100	728	100	110	15,1

Source: Primary data, 2020

Before online learning in 2019–2020, left-eye visual acuity changes were as follows: 93.4% had normal vision, 5.6% experienced a one-level decrease, and 1.0% had a two-level decrease. Specifically, for left-eye visual acuity: 78.3% had normal vision, 16.5% had a one-level decrease, 4.7% had a two-level decrease, and 0.5% had a three-level decrease. Comparing left-eye vision data between 2019–2020 and 2020–2022, there were: 10.9% with a one-level increase, 3.7% with a two-level increase, and 0.5% with a three-level increase. No new respondents experienced a three-level decrease. Extended computer and mobile device use can expose eyes to harmful radiation, leading to eye strain. Poor monitor contrast and viewing distance worsen the issue, influenced by factors like lighting, object shape, contrast, viewing duration, and distance. A Chinese study during COVID-19 found increased myopia among Wuhan students due to online learning, with genetics and habits playing a role. Another study in Argentina showed higher myopia progression rates during pandemic confinement (Hu *et al*., 2021; Picotti *et al.*, 2021). Myopia is rising among students globally, driven by increased visual demands. Homebound children during the COVID-19 pandemic experienced significant myopic shifts (Markova *et al.,* 2021). Egyptian schoolchildren also saw increased myopia rates due to pandemic-induced screen time (Sallam *et al.,* 2022). To combat this trend, a stricter visual regimen with regular breaks and at least 2 hours of outdoor time during daylight is recommended (Frolova & Bezditko, 2022). In a previous study, a connection was observed between a family history of myopia and visual acuity, whereas no correlation was found between visual acuity and factors such as knowledge, attitude, behavior, screen time, reading position, and reading distance. The primary factor contributing to myopia appears to be the elongated anteroposterior axis of the eye, which is inherited from parents to their offspring (Asiyanto *et al.,* 2020).

The Shapiro-Wilk Test for Normality was used before the correlation test, yielding W = 0.95477 and a p-value of 3.632e-14. Data is considered non-normally distributed if the p-value is below 0.05. A Wilcoxon signed-rank test with continuity correction was used for right-eye vision decrease data before and after online learning, resulting in V = 94 and p-value 2.2e-16, where p exists = 0.05. A significant difference in vision loss before and after online learning is indicated when the p-value is below 0.05. These results highlight the significant impact of online learning on vision, a crucial aspect of education and overall life, especially in school-age children, as it directly affects their learning capacity and cognitive development. During the COVID-19 pandemic, myopia increased in children, particularly among younger ones, due to higher screen time and less outdoor activity. Recommendations include more outdoor time and reduced digital device usage post-pandemic (Yang *et al*., 2022). Increased reliance on digital devices for remote learning led to visual problems like myopia progression, dry eye symptoms, visual fatigue, and accommodation issues in children (Masihuzzaman *et al.*, 2023). Implementing post-pandemic ophthalmological surveillance programs based on individual factors is crucial for better disease control (Pellegrini *et al.,* 2020). To maintain good eye health while studying online, the Indonesian Ministry of Health's P2PTM advises limiting computer or mobile device use to two hours, maintaining a 40-50 cm screen distance, reducing brightness, and taking 20-second breaks for every 20 minutes of screen time (Kemenkes RI, 2020). These practices relax eye muscles and promote eye health.

Conclusions

The study's findings demonstrated a statistically significant difference between the visual acuity scores of schoolchildren before and after the online learning period. The value of school students' visual acuity is impacted by online learning. To track the development of eye health, it is advised that the Public Health Center conduct screening health exams for schoolchildren regularly. It is advised that schools advise parents to closely monitor their children's use of computers and mobile devices at home and advise students to limit their use of these devices outside of class to preserve their visual acuity and raise their academic performance.

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