Sriwijaya Journal of Ophthalmology
Journal Homepage: https://sriwijayaopthalmology.com/index.php/sjo

The Relationship between Eyestrain and the Occurrence of Floaters in Kalam Kudus Senior High School

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ARTICLE INFO

Keywords:
Computer vision syndrome
Eye health
Eyestrain
Floaters

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All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.37275/sjo.v6i2.112

A B S T R A C T

Introduction: Floaters, or particles that appear to float in the visual field, are often subjective complaints that cause disruptive sensations in vision. Eye strain, which is a common symptom associated with prolonged use of digital screens, can lead to other visual disorders. However, there is limited research examining the relationship between eye strain and floaters. This study aimed to evaluate the relationship between eyestrain and the occurrence of floaters in Kalam Kudus Senior High School. **Methods:** The study was conducted using a cross-sectional method with 62 respondents who extensively use electronic devices. Data on eye strain symptoms and the occurrence of floaters were collected using a standard questionnaire. Statistical analysis was performed to evaluate the relationship between eye strain and floaters. **Results:** The results of the study showed a significant relationship between eyestrain and the occurrence of floaters (p-value = 0.022). Students who reported eyestrain had a higher risk of experiencing floaters. **Conclusion:** Excessive use of digital screens and eye strain can contribute to the development of floaters in the high school student population.

1. Introduction

Floaters are small dots, dark or transparent spots that appear to float in the visual field. Floaters arise from molecular changes within the vitreous body and at the vitreoretinal interface that occur progressively with age.[1] They are more noticeable while looking at something bright, like the blue sky or a white piece of paper. The shapes and sizes of floaters vary. Some appear as black silk threads, while others may look larger, resembling spider webs. Floaters can cause complaints of intermittent blurry vision, glare, haze, and discomfort in daily activities such as reading, driving, and working.[2] Furthermore, floaters have been reported to affect contrast sensitivity in patients' vision.[3] If left untreated and continue to increase, floaters can significantly impact a child's quality of life. In a study by Wagle and colleagues (2011), it was found that younger patients were even willing to take surgical intervention with the risk of blindness to eliminate the floaters' symptoms compared to older patients.[2]

Although floaters can occur at any age, they are rarely found in teenagers and young adults. Floaters in teenagers can be attributed to several risk factors, including high myopia. Those with high myopia tend to have elongated eyeballs, leading to increased tension on the retina and a higher risk of posterior vitreous detachment (PVD). Further research is needed to explore this mechanism. Based on Asian data, 80% of the population has myopia.[4] According to

Wong et al. (2020), the prevalence of myopia will increase by 1.4 to 3 times in 2020 compared to the previous 5 years.[5] The incidence of myopia among adolescents increased by 10.40% from 2019 to 2020, with reduced outdoor playtime being the major cause in China (P<0.0001).[6]

The development of online learning has increased children's screen time and reduced outdoor activities. This has also led to the occurrence of computer vision syndrome (CVS), also known as digital eyestrain. Currently, an estimated 60 million people worldwide experience CVS, and this number is predicted to increase each year. Studies show that the prevalence of eye disorders related to computer use varies between 25-93%.[7] This study aimed to assess the relationship between eyestrain in adolescents and the occurrence of floaters. This is essential because untreated floaters can lead to learning difficulties and a diminished quality of life for these children.

2. Methods

This study is a quantitative observational research with a cross-sectional design. It was conducted in June 2023 at SMA Kalam Kudus II Jakarta. The population of this study includes all high school students at SMA Kalam Kudus II. The sample for this study is a part of the population that meets the inclusion criteria. The inclusion criteria for this study are all students from X and XII grades at SMA Kalam Kudus II Jakarta. The exclusion criteria are respondents with a history of eye infections within the last 3 months, eye trauma within the last 6 months, eye surgery, eye bleeding, retinal tears, and other eye organ disorders. The sampling technique used in this study is total sampling.

The research process includes study design, obtaining research permits, data collection, data analysis, and report writing. All respondents in this study have provided informed consent. The variables in this study include age, gender, floater symptoms, screen time, history of eyeglass use, and occurrence of eye fatigue. The measurement of the floater variable is done through a questionnaire, followed by showing images representing floater characteristics during the anamnesis to confirm the responses. The measurement of the eyestrain variable is also done through a questionnaire and confirmed during the anamnesis with complaints of heavy eyes and blurred vision after using digital devices. The measurement of screen time is done through a questionnaire, with responses in hours.

All collected data will be analysed descriptively and analytically. Descriptive data presentation will include proportions (%) for qualitative data and measures of central tendency for quantitative data. Hypothesis testing in this study will use the Pearson Chi-square with Yates correction test with Fisher exact as an alternative test. The significance level expected for this study is 5%.

3. Results

This study included 62 research respondents who met the inclusion criteria with an age range of 15-17 years. The basic characteristics of the respondents are presented in Table 1. Further hypothesis testing revealed a significant association between eyestrain and the occurrence of floaters (p-value: 0.022). Clinically, it was found that eyestrain has a 2.543 times higher risk of experiencing floaters. On the other hand, the Pearson Chi-square with Yates correction test showed no significant association between the use of glasses and the occurrence of floaters (p-value: 0.540). However, clinically, it was found that the use of glasses has a 1.385 times higher risk of experiencing floaters (Table 2).

4. Discussion

Vitreous

The vitreous is a gel-like substance that fills approximately 80% of the eye's volume, providing shape and stability to the eye. It mainly consists of about 98-99% water, with the remainder being collagen, hyaluronic acid, and soluble proteins.[8] Collagen provides structure and strength to the vitreous, and it comprises three types: type II, IX, and V/XI collagen.

Table 1. Characteristics of respondents.

Parameter	N (%)	Mean (SD)	Med (Min-Max)
Gender			
Male	24 (38,7%)		
Female	38 (61,3%)		
Wearing glasses			
Yes	26 (41,9%)		
No	36 (58,1%)		
Screen time durations, hours per day		7,18 (2,83)	7 (1 – 12)
Floaters			
Yes	20 (32,3%)		
No	42 (67,7%)		
Eyestrain			
Yes	23 (37,1%)		
No	39 (62,9%)		
Headache			
Yes	7 (11,3%)		
No	55 (88,7%)		

Table 2. Relationship between eyestrain and the use of glasses on the occurrence of floaters.

Parameter		Floaters				PR	Confidence interval 95%		p-value
		Positive		Negative					
		N	%	N	%		Lower	Upper	
Eyestrain	Yes	12	52,2	11	47,8	2,543	1,224	5,285	0,022
	No	8	20,5	31	79,5				
Glasses	Yes	10	38,5	16	61,5	1,385	0,676	2,836	0,540
	No	10	27,8	26	72,2				

Vitreous collagen resembles hyaline cartilage collagen, differing from scar tissue and other tissues like dermis, cornea, and sclera. The adhesion of the vitreous cortex to the internal limiting membrane (ILM) is mediated by laminin, fibronectin, proteoglycan, and chondroitin sulfate. Cortical vitreous adhesion to ILM is relatively weaker at the posterior pole compared to the region near the vitreous base, where fibres are firmly embedded in the peripheral retina and pars plana.[8]

During the normal aging process, the vitreous undergoes structural changes known as "vitreous syneresis," where it starts to liquefy and even clump together. Thin collagen fibrils (12-15nm) break into smaller fragments due to the loss of collagen type IX, a protector of collagen type II, with advancing age. These fragments clump and become thicker or cloudy fibres, visible under a slit lamp.[9] As the softening process continues, adhesion between the vitreoretinal surfaces, located between the cortical vitreous gel and ILM, decreases. This combined process eventually results in Posterior Vitreous Detachment (PVD) in about 50% of individuals over 50 years old.[1]

PVD can be accelerated by other conditions such as inflammation, vitreoretinal dystrophy, myopia, and systemic diseases like diabetes. Studies have found a higher incidence of PVD in older women due to biochemical composition changes in the vitreous related to hormonal changes during menopause. Risk factors for early PVD include myopia and collagen disorders like Marfan and Stickler syndrome. PVD in young individuals not only induces floater phenomena but can also lead to retinal tears and rhegmatogenous retinal detachment.[1]

Floaters

Vitreous floaters can be divided into primary and secondary floaters. Primary floaters originate from endogenous vitreous structures and occur due to aging processes and vitreoretinal disturbances, such

as Stickler syndrome and Wagner's disease. Secondary floaters result from exogenous materials and are usually composed of proteins, amyloid, or cells.[1] The most common cause of secondary floaters is pre-retinal and vitreous hemorrhage, leading to sudden floaters and blurred vision. Vitreous hemorrhage can occur due to acute rhegmatogenous PVD, retinal tears with their blood vessels, ischemic conditions causing neovascularization, retinovascular abnormalities, trauma, and neoplasms. Intraocular inflammation and injections can also trigger secondary floaters.[1]

Floaters are generally classified into three main groups: transparent floaters, opaque floaters, and ring-shaped. Transparent floaters are described as smooth and translucent structures, yet they have distinct shapes. They can be classified as cell-like (C), thread-like (S), or membrane-like (M). Opaque floaters are solid and cloudy structures distinguished by various levels of contrast. These floaters may have sharp or blurred edges.[10] Computer Vision Syndrome (CVS) is a set of symptoms that arise from excessive use of digital devices like computers, smartphones, television, and tablets. One common symptom of CVS is asthenopia or eye fatigue, which can occur after prolonged near-work activities, such as computer use.[7] Asthenopia is caused by fatigue in the ciliary and extraocular muscles responsible for the accommodation and convergence of the eyes during near-vision tasks.

The normal blink rate for humans is around 16-20 times per minute. However, when focusing on a computer screen, this rate can decrease to only 6-8 times per minute. Uncorrected refractive errors can also contribute to CVS.[7] Exposure to blue light from screens can cause tension and discomfort in the eyes, as this short-wavelength light scatters more easily and is harder to focus. Computer screens, along with other digital displays, especially those emitting light, contain little ultraviolet (UV) light. However, the potentially harmful light emitted by these screens is blue light. Blue light is a type of high-energy visible light with shorter wavelengths (400-500nm) and higher energy compared to other types of light.[11] The harmful wavelength range of blue light lies between 415 and 455 nm.[12] Direct penetration from the lens to the retina can cause phototoxic damage to the retina. Poor posture when using devices can also lead to increased strain on the neck and shoulders.

According to the Indonesian Pediatric Association, the screen time guidelines for adolescents aged 12-18 years are no more than 2 hours per day. Exceeding 7 hours of computer use per day increases the risk of computer vision syndrome (CVS). During the pandemic, the school curriculum led to high screen time habits found in high school students, with an average of 7 hours and 21 minutes per day.

This study found a positive correlation between eyestrain and the occurrence of floaters in adolescents ($p=0.022$). Floaters were described by the students as fine, moving threads that cause glare after prolonged digital screen exposure. They also frequently complained of symptoms such as headaches and eye fatigue after using digital screens, which are characteristic of CVS. A study conducted in Malang found that the prevalence of floaters in the age group of 15-80 years was 67%. However, the prevalence significantly increased to 36.7% in the age group of 51-60 years.[13] Although our study only involved subjects aged 16-18 years, 32.3% of them experienced floaters. From this data, it can be concluded that the prevalence of floaters increases in younger age groups. Out of the 62 respondents in this study, 40% who wore glasses had refractive myopia. Additionally, 45% of respondents who wore glasses reported experiencing floaters. Another study indicated that individuals with myopia had a 3.5 times higher risk of developing floaters ($p=0.0004$).[2] This finding is supported by the fact that myopia can accelerate the degeneration of the vitreous, thus leading to early Posterior Vitreous Detachment (PVD).

This finding is also supported by a study in India, which found a positive correlation between floaters and myopia ($p<0.05$) in medical faculty students. Apart from myopia, the habit of rubbing the eyes was found to increase the prevalence of floaters by 5.23 times.[14] Prolonged screen use can cause eye strain and

dry eyes, prompting individuals to rub their eyes, which may increase the risk of floaters.

Eyestrain experienced by our respondents was categorized as a CVS symptom, as complaints were reported after prolonged use of digital screens. One of the main symptoms frequently reported by respondents in our study was headaches due to eye fatigue after prolonged digital screen exposure. Another study also showed that headaches were the main symptom associated with prolonged screen use.[15] Understanding CVS and its management are crucial to prevent negative impacts on eye health in individuals who frequently use electronic devices.

In addition to eye health, socializing and playing outdoors are highly recommended for a child's development. Insufficient social interaction can lead to feelings of loneliness, depression, anxiety, and other mental health issues.[16] Adolescence is a critical developmental stage where social interaction plays a significant role. Missing opportunities for interaction can have long-term effects on a child's mental health, especially after the pandemic.

Our study provides new insights into the relationship between eyestrain and floaters, a hypothesis that has not been extensively explored in the literature before. Although this study found an association between these two conditions, further research is needed to fully understand this relationship. Moreover, it is essential to consider that eyestrain and floaters are complex conditions that may be influenced by various other factors. We need to understand that this hypothesis may not be supported by other studies due to differences in methodology, sample demographics, or other factors.

We acknowledge that our study has some limitations, such as a relatively small sample size and a lack of longitudinal data that could clarify the cause-effect relationship between eyestrain and floaters. Therefore, we recommend further research to examine this hypothesis more comprehensively, using a larger sample size and deeper examination with fundoscopy.

5. Conclusion

This study found that eyestrain in adolescents is positively associated with the occurrence of floaters, which are fine threads that move and cause glare after prolonged use of digital screens. The main reported symptom is headaches due to eyestrain from prolonged digital screen exposure, which is a symptom of Computer Vision Syndrome (CVS). Additionally, the importance of socializing and outdoor activities is emphasized, as insufficient social interaction can have negative impacts on children's mental health in the future.

Although the results of this study indicate an association between eyestrain and floaters, further research is needed to confirm and understand the significance of this relationship. Through more research, we hope to gain a better understanding of both conditions and how they can affect our vision. This conclusion expands our understanding of adolescent eye health conditions and assists in the development of intervention strategies and management in the future.

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