Jurnal Biologi Tropis

Original Research Paper

The Relationship Between Gadget Usage Patterns and The Incidence of Asthenopia Among Junior High School Students in Mataram City

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Article History
Received : June 11th, 2026
Revised : July 20th, 2026
Accepted : August 03th, 2026

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Abstract: Gadget use among junior high school students continues to rise, clearly contributing to asthenopia through extended exposure and inadequate self-regulation. This study directly assesses the impact of gadget use on asthenopia among junior high school students in Mataram City. Observational analytical research using a cross-sectional design enrolled 118 participants via simple random sampling. Data collected from gadget-use questionnaires and the Visual Fatigue Index (VFI) were analyzed with chi-square tests and binary logistic regression. Results confirmed that 57.6% of participants demonstrated poor usage habits, while 31.4% experienced asthenopia. No statistically significant relationship was found between overall gadget use and asthenopia ($p = 0.785$). Nonetheless, device use exceeding 2 hours emerged as the primary factor linked with asthenopia. In summary, poor gadget use is widespread, and prolonged use increases the risk of asthenopia, although this study did not find a significant overall link. Eye itching clearly dominated reported symptoms. To advance understanding and support student well-being, future research must employ objective measures of visual function and develop effective strategies for healthier use of devices.

Keywords: Asthenopia; Gadget usage pattern; Junior high school students.

Introduction

Eye health is one of the important components of human quality of life, since nearly all daily activities such as studying, working, and social interaction depend heavily on optimal visual function**.** The rapid pace of modern development has driven changes across many fields, one of which is technology in the form of gadget use. A gadget is defined as an electronic device with a practical function. The convenience offered by gadgets has led almost everyone to own such devices. Indonesia's population shows high ownership of digital devices: 96.7% own a smartphone, 5.8% own a tablet, 27.8% own a laptop/notebook, and 6.9% own a PC (Kementerian Komunikasi dan Informatika Republik Indonesia, 2024). Smartphone ownership in West Nusa Tenggara (NTB) reached 73.2%, an increase from 61.1% in 2022 (Badan Pusat Statistik, 2023). This increase reflects that dependence on digital devices is no longer merely a local phenomenon, but a continuously growing global pattern following digital transformation across various sectors of life, including education.

This widespread gadget use is particularly prevalent among adolescents, especially junior high school students. Adolescents fall within the 10–18 year age range and junior high school students (13–16 years) belong to this category (Azmi et al., 2023). A total of 95.40% of SMP students use a mobile phone/tablet, a need that continues to rise alongside online-based learning (Asosiasi Penyelenggara Jasa Internet Indonesia, 2024). The essential concept underlying this problem is asthenopia, a group of symptoms related to the visual and muscular system that arises as a compensatory response to continuous digital

DOI: http://doi.org/10.29303/jbt.v26i3.12369

device use, with clinical manifestations ranging from eye strain and soreness to headaches (Jaseem, 2021; Pratama et al., 2021). Etiologically, asthenopia is divided into two types: muscular asthenopia, caused by binocular vision disorders such as convergence insufficiency and refractive asthenopia, caused by ametropia, presbyopia, or uncorrected refractive errors (Rahmawinata, 2021). Pathophysiologically, exposure to digital screens causes the eyes to continuously accommodate toward the resting point of accommodation (RPA), reduces blink frequency, and exposes the eyes to blue light, which increases the sensitivity of retinal ganglion cells (Alemayehu, 2019; Bahkir & Grandee, 2020).

A problem arises when exposure to these asthenopia risk factors occurs at an age when visual development should still be at its optimal stage**.** Data on the prevalence of asthenopia in the city of Mataram itself remain limited, but data from other regions in Indonesia point to fairly concerning figures. In West Jakarta, 83.7% of adolescents aged 15–17 years were found to experience asthenopia (Fernanda & Amalia, 2018). If left untreated, asthenopia may progress into more serious visual impairment, which reported a refractive error prevalence of 18–20% among school-aged children (Direktorat Pencegahan dan Pengendalian Penyakit Tidak Menular Kementerian Kesehatan, 2022). This risk is further compounded by the psychological characteristics of junior high school students themselves. According to Piaget's theory, junior high school students are in the formal operational stage, characterized by growing independence that is not yet matched by adequate self-control, along with an egocentric belief that their behavior is protected from harm. This makes junior high school students more prone to excessive gadget use than elementary school students, while their self-control remains lower than that of senior high school students (Thahir, 2018). This is precisely the root of the problem, as the age group most exposed to this risk also has the weakest behavioral control over it.

Previous studies have confirmed the relationship between gadget usage patterns and the incidence of asthenopia among adolescents. A study by Tarigan and Kurniasari (2022) involving 210 students found that 172 students experienced eye fatigue due to prolonged gadget use and viewing distances that were too close, with 81.90% of students experiencing eye fatigue related to poor gadget-use behavior (distance <30 cm, duration >4 hours/day, frequency of 3 times a day, and use in dark rooms). However, these studies were conducted outside the West Nusa Tenggara region, and to date no study has specifically examined the relationship between gadget usage patterns and the incidence of asthenopia among junior high school students in the city of Mataram**.** This gap in local data constitutes the state of the art of this study, given that demographic characteristics, gadget usage patterns, and access to eye health services in Mataram may differ from previously studied regions. Therefore, this study aims to determine the relationship between gadget usage patterns and the incidence of asthenopia among junior high school students in the city of Mataram, with the urgency of providing empirical evidence that can serve as a basis for promotive and preventive efforts against asthenopia among adolescents in the region.

Materials and Methods

This study was conducted at SMPN 5 Mataram, with data collection carried out from July to October 2025. The research employed a quantitative approach with a cross-sectional design aimed at analyzing the relationship between gadget usage patterns and the occurrence of asthenopia among students. The study population consisted of all active students in grades VII and VIII at SMPN 5 Mataram who used gadgets. Inclusion criteria comprised active students who used gadgets and were willing to provide informed consent, while students who were absent or had incomplete questionnaires were excluded. The sampling technique applied was simple random sampling, performed with Microsoft Excel (Version 2016, Microsoft Corp., USA) following the sampling procedure described by Dahlan (2010), with a total of 118 respondents participating in this study. The independent variable was gadget usage pattern, measured using a structured questionnaire that had previously undergone validity and reliability

DOI: http://doi.org/10.29303/jbt.v26i3.12369

testing, while the dependent variable was the occurrence of asthenopia, assessed using the Visual Fatigue Index (VFI), with a VFI score ≥ 0.4 indicating the presence of asthenopia. Gadget usage pattern was categorized on an ordinal scale (good, poor), whereas the occurrence of asthenopia was classified on a nominal scale (yes/no). Data collection was carried out through direct administration of a self-administered questionnaire to respondents, covering respondent characteristics, gadget usage patterns, and asthenopia symptoms.

The study began with obtaining ethical approval and preparing the research instruments. Respondents were identified according to the inclusion criteria, followed by an explanation of the study objectives, procedures, benefits, and potential risks, after which respondents who agreed to participate provided written informed consent. Respondents then independently completed the questionnaire under the researcher's supervision. The collected data were subsequently processed through five stages: editing, coding, data entry, cleaning, and tabulating using IBM SPSS Statistics version 29, prior to further analysis.

Univariate analysis was performed to describe the demographic characteristics and gadget usage habits using frequency distribution. Numerical data on gadget usage were tested for normality using the Kolmogorov-Smirnov test to determine the cut-off point (mean for normally distributed data, median for non-normally distributed data), in order to classify them into "Good" and "Poor" categories. Bivariate analysis using the Chi-square test was performed to examine the association between gadget usage habits and asthenopia status. Multivariate analysis using binary logistic regression was applied to identify habits that significantly influenced the occurrence of asthenopia ($p < 0.05$), with the strength of association evaluated through the Odds Ratio (OR) and 95% confidence interval (CI); a variable was considered a significant risk factor if its 95% CI did not include the value 1.

Results and Discussion

This study involved 118 students from the 7th and 8th grades of SMP Negeri 5 Mataram, with data collected between July to October 2025. The characteristics of the respondents are presented in Table 1. The majority of respondents were 13 years old (55.9%), with a relatively balanced gender distribution between males (49.2%) and females (50.8%).

Table 1. Respondent Characteristics

Category	n	%
Age		
12 years old	33	28
13 years old	66	55,9
14 years old	19	16,1
Gender		
Male	58	49,2
Female	60	50,8
Class		
VII B	37	31,4
VII D	36	30,5
VIII C	45	38,1
Medical History		
Yes (Refractive Error)	5	4,24
None	113	95,76
Most Frequently Used Device Types		
Smartphone	118	100

Based on class distribution, the largest group of respondents came from class VIII C (38.1%). Most respondents had no specific medical history (95.76%), and all respondents (100%) used smartphones as their primary device.

Table 2. Frequency Distribution of Respondent Characteristics Based on Gadget Usage Patterns

Category	n	%	Good		Poor	
			n	%	n	%
Age						
12 years old	33	28	12	36,4	21	63,6
13 years old	66	55,9	31	47	35	53
14 years old	19	16,1	7	36,8	12	63,2
Gender						
Male	58	49,2	27	46,6	31	53,4
Female	60	50,8	23	38,3	37	61,7
Medical History						
Yes (Refractive Error)	5	4,24	3	60	2	40
None	113	95,76	47	41,6	66	58,4

The distribution of respondent characteristics based on gadget use patterns is presented in Table 2. Generally, poor gadget use patterns were found in more than half of the respondents across all age groups, including those aged 12 (63.6%) and 14 (63.2%).

By gender, female respondents showed a higher tendency toward poor gadget use patterns (61.7%) compared to males (53.4%). Interestingly, within the group with refractive errors, the majority of respondents actually exhibited good gadget use patterns (60%).

Table 3. Frequency Distribution of Respondent Characteristics Based on the Incidence of Asthenopia

Category	n	%	Astenopia		Non Astenopia	
			n	%	n	%
Age						
12 years old	33	28	6	18,2	27	81,8
13 years old	66	55,9	20	30,3	46	69,7
14 years old	19	16,1	11	57,9	8	42,1
Gender						
Male	58	49,2	15	25,9	43	74,1
Female	60	50,8	22	36,7	38	63,3
Medical History						
Yes (Refractive Error)	5	4,24	3	60	2	40
None	113	95,76	34	30,1	79	69,9

The distribution of asthenopia incidence based on respondent characteristics is shown in **Table 3**. Proportionally, the 14-year-old age group showed the highest prevalence of asthenopia (57.9%), although the absolute number was dominated by the 13-year-old group.

Based on gender, the incidence of asthenopia was more prevalent in females (36.7%) than in males (25.9%). Furthermore, respondents with refractive errors showed a higher proportion of asthenopia incidence (60%) compared to those without a medical history (30.1%).

The analysis results in **Table 4**. indicate that the majority of respondents had poor gadget usage patterns (57.6%) defined as failing to meet recommended behavioral or ergonomic practices, while 42.4% fell into the good category, characterized by adherence to these recommended patterns. Building on these findings, further examination of specific behavioral components provides deeper insight.

Table 4. Gadget Usage Pattern Analysis

Category	n	%
Good	50	42,4
Poor	68	57,6
Total	118	100

Table 5. Comparison of Frequency Distribution of Gadget Use Behaviors Between Poor and Good Pattern Groups

Gadget Usage Patterns	Poor Pattern Group		Good Pattern Group	
	n	%	n	%
Using gadgets in a sitting position	29	42,6	8	16
Position the gadget at eye level	60	88,2	36	72
The distance between the eyes and the gadget screen is not less than 30 cm	38	55,9	23	46
The length of time spent staring at a gadget screen should not be more than 2 hours.	54	79,4	39	78
Rest your eyes for 20 minutes	40	66,7	14	28
The room lighting is bright	61	89,7	20	40
The gadget screen brightness setting is brighter than the ambient lighting.	67	98,5	48	96
Use eye protection	67	98,5	48	96

DOI: http://doi.org/10.29303/jbt.v26i3.12369

Further analysis of behavioral components **Table 5.** revealed that the most frequently neglected aspects in the poor pattern group were screen brightness settings and the use of eye protection (98.5% each). Additionally, the behavior of resting the eyes for 20 minutes remained low in the poor pattern group (66.7%) compared to the good pattern group (28%).

From an ergonomic perspective, many respondents did not keep the screen at eye level (88.2%) and did not maintain a minimum viewing distance of 30 cm (55.9%). Meanwhile, a screen time duration of more than 2 hours per day was found to be almost equally distributed across both groups: 79.4% in the poor group and 78% in the good group.

Table 6. Analysis of Asthenopia Occurrence

Category	n	%
asthenopia	37	31,4
Non asthenopia	81	68,6
Total	118	100

The distribution of asthenopia incidence among respondents is presented in **Table 6.** Most respondents (68.6%) did not experience asthenopia, while 31.4% did. According to the symptom analysis, the most frequently reported complaints were itchy eyes (70.3%), followed by glare when looking at bright light (51.4%), watery eyes (51.4%), and headaches (48.6%). Meanwhile, symptoms such as eyelid twitching and pain on eye movement were found in very low proportions (2.7%).

Table 7. Analysis of the Relationship between Gadget Usage Patterns and the Incidence of Asthenopia

Gadget Usage Pattern	Asthenopia Incidence				*p-value*
	Asthenopia		Non Asthenopia		
	n	%	n	%	
Good	15	30,0	35	70,0	p=0,785
Poor	22	32,4	46	67,6	
Total	37	31,4	81	68,6	

Chi-square test results in Table 7. indicate that there was no statistically significant association between gadget use patterns and asthenopia incidence (p=0.785). Binary logistic regression analysis Table 8. reveals that using gadgets for more than 2 hours per day significantly increases the risk of asthenopia (p=0.003; OR=4.755; 95% CI=1.720–13.145). This duration is identified as the most influential factor among usage pattern components.

Table 8. Binary Logistic Regression Test

Gadget Usage Pattern	Sig.	OR CI95%
Using gadgets in a sitting position	0,789	0,725 (0,068 – 7,690)
Position the gadget at eye level	0,853	0,915 (0,356-2,352)
The distance between the eyes and the gadget screen is not less than 30 cm	1,000	1,000 (0,309-3,241)
The length of time spent staring at a gadget screen should not be more than 2 hours.	0,003	4,755 (1,720-13.145)
Rest your eyes for 20 minutes	0,979	0,984 (0,306-3,162)
The room lighting is bright	0,440	0,687 (0,265-1.780)
The gadget screen brightness setting is brighter than the ambient lighting.	0,084	0,373 (0,122-1,141)
Use eye protection	0,204	0,389 (0,091-1,669)

Discussion

Characteristics of respondents with asthenopia and gadget usage patterns

This study, conducted at SMP Negeri 5 Mataram with 118 respondents, outlines student characteristics related to asthenopia based on age, gender, gadget type, and medical history. The majority of respondents were 13 years old (55.9%), representing early adolescence, a phase characterized by high curiosity but suboptimal self-control regarding gadget usage (Thahir, 2018). However, the highest incidence of asthenopia was observed in 14-year-olds (57.9%). This finding aligns with the theory that increased age is associated with decreased lens elasticity and ciliary muscle fatigue, which reduce accommodation capacity and make the

DOI: http://doi.org/10.29303/jbt.v26i3.12369

eyes more susceptible to asthenopia (Manik & Wahyuningsih, 2022).

Gender distribution was relatively balanced between females (50.8%) and males (49.2%). Consistent with the higher rate of poor gadget usage among female students (61.7%), the incidence of asthenopia was also found to be higher among females (36.7%) than males (25.9%). This finding aligns with Manik and Wahyuningsih (2022), who reported that females tend to be more prone to eye fatigue due to more meticulous visual behavior that involves prolonged near-distance focus. Hormonal factors may also play a role: declining estrogen levels with age affect tear secretion, resulting in a thinner tear film among females and, consequently, greater susceptibility to dry-eye symptoms and asthenopia.

Psychosocial factors likely contribute to the longer gadget-use duration observed among female students, whose usage is predominantly driven by communication and social media activities (Taywade & Khubalkar, 2019). Although the dynamic shifts in visual focus typical of social media use are generally less straining than sustained near-point tasks such as online gaming, the cumulative duration combined with poor usage habits still elevates the risk of visual fatigue in this group.

Furthermore, although 95.76% of respondents had no history of systemic or ocular disease, 60% of students with refractive errors (4.24% of the total sample) experienced asthenopia. Refractive errors cause blurred vision and impair accommodation, leading to increased contraction of the ciliary and orbicularis oculi muscles, often resulting in squinting. This heightened accommodative effort significantly increases vulnerability to eye fatigue compared to having normal vision (Ciputra, 2022).

Gadget Usage Patterns

Most respondents in this study demonstrated poor gadget usage, particularly in adjusting screen brightness and protecting their eyes. This finding indicates inadequate awareness of healthy visual habits and blue light mitigation among adolescents, as excessive exposure to unadjusted screen brightness and blue light significantly increases ocular strain during prolonged near work. Similar findings were reported by Irmawati et al. (2024), who found that most teenagers fail to match screen brightness to ambient light, Ultimately, this finding highlight the critical need for visual ergonomics education to reduce preventable eye fatigue among students.

Furthermore, a prominent behavioral contrast was observed in the eye-rest indicator, with a low frequency of resting eyes being highly prevalent in the poor usage group. Violating structured eye-resting protocols, such as the 20-20-20 rule, forces the ciliary muscles to accommodate continuously, leading to persistent ocular fatigue. This is highly consistent with Kumar and Pandey (2024), who found that the absence of structured eye-rest reminders significantly worsens asthenopia symptoms. Therefore, structured visual breaks during academic or recreational gadget use are vital to prevent cumulative muscle strain among adolescents.

From an ergonomic perspective, non-ergonomic habits were highly prevalent: 88.2% of respondents rarely kept screens at eye level, and 55.9% failed to maintain a safe 30 cm viewing distance, though 57.4% still preferred sitting over lying down. Sub-optimal viewing angles and close-range screen placement accelerate ocular tension by forcing the eye lenses to thicken continuously through ciliary contractions. This aligns with Kurnia et al. (2024), who found that 96.5% of adolescents positioned devices below the eye line.

A crucial baseline factor identified in this study concerns the duration of gadget use: exceeding the 2-hour daily screen time limit was universally ignored, affecting approximately 79.4% of the poor pattern group and 78% of the good pattern group. This negligible gap reveals that excessive screen time has become a deep-seated, universal lifestyle habit among students at SMP Negeri 5 Mataram. Because excessive duration is pervasive across all behavioral groups, it acts as a primary, unavoidable risk factor that requires structural screen-time interventions at both school and home environments.

Incidence of Asthenopia

Regarding clinical manifestations, the most common asthenopia symptoms reported were itchy eyes (70.3%), followed by glare (51.4%)

and watery eyes (51.4%). This symptomatic profile reflects severe tear film instability and dry ocular surfaces, which typically stem from a reduced blink rate while staring intensely at digital screens. This pathophysiological response is strongly corroborated by Kaur et al. (2022), who established that screen-induced dry eyes sensitize corneal nerves, causing itching, and trigger compensatory reflex tearing. Consequently, future interventions must prioritize awareness of blinking and ocular lubrication strategies to mitigate tear film evaporation during prolonged gadget use.

In addition to ocular surface complaints, extraocular manifestations were prominently reported, specifically headaches (48.6%) and neck pain (27%). Headaches indicate fatigue of the ciliary and extraocular muscles due to prolonged, excessive accommodation, whereas neck pain stems directly from maintaining static, non-ergonomic body postures. This matches the findings of Wartiningsih (2023), which linked sub-optimal body alignment during device usage to sustained skeletal muscle tension. These results imply that asthenopia management programs for adolescents cannot focus solely on eye health; they must also comprehensively incorporate musculoskeletal and ergonomic adjustments.

On the other hand, symptoms such as eyelid twitching and pain during eyeball movement yielded the lowest prevalence (2.7% each). This indicates that while visual fatigue is widespread, the current visual workload among students at SMP Negeri 5 Mataram has not yet escalated to severe neuromuscular disorders or chronic extraocular muscle inflammation. This is supported by Gunes (2024), who noted that symptoms such as twitching are generally secondary markers of greater systemic exhaustion or extreme stress. This low percentage represents a critical therapeutic window, suggesting that early-stage ergonomic interventions can effectively block the progression of asthenopia into severe neuromuscular complications.

Association between Gadget Usage Patterns and Asthenopia Incidence

This study found no significant association between gadget usage patterns and asthenopia incidence. This finding indicates that asthenopia in adolescents is largely driven by multifactorial compensatory mechanisms rather than by general usage habits alone. Physiologically, adolescents exhibit high accommodation amplitude and ciliary muscle flexibility, enabling them to tolerate screen exposure without severe ocular complaints. Furthermore, symptoms in this age group are often mild and subclinical, while parental supervision may serve as an additional protective factor. Unassessed individual factors, such as undetected refractive errors, might also confound these results. Similar non-significant associations between general gadget usage and asthenopia have been reported by Reza et al. (2024).

Despite the overall non-significant relationship, binary logistic regression identified screen time exceeding 2 hours per day as the most influential risk factor for asthenopia. Prolonged near-work without breaks forces continuous ciliary muscle contraction and significantly reduces blink frequency, which leads to tear film instability and ocular strain. This specific finding aligns with previous studies (Putri et al., 2023; Tarigan & Kurniasari, 2022), confirming that duration is the primary trigger for eye fatigue. These findings highlight that while adolescent eyes can compensate for general gadget use, targeted interventions focused on limiting screen time and encouraging regular visual breaks remain crucial for preventing asthenopia in students.

Research Limitations

Despite its insights, several limitations of this study should be considered. Reliance on the self-reported Visual Fatigue Index (VFI) introduces subjectivity and recall bias, as it captures perceived discomfort rather than objective physiological metrics such as blink frequency or accommodative changes (Kim et al., 2017). Aggregating gadget usage patterns into a total score may create a "masking effect," potentially obscuring the specific impact of individual behavioral indicators.

Conversely, this study possesses distinct strengths. Rather than relying on a single, generalized metric, it comprehensively evaluates gadget-use behavior across eight distinct indicators. Furthermore, by using binary logistic regression, the analysis successfully identified a precise, actionable risk threshold for screen time

DOI: http://doi.org/10.29303/jbt.v26i3.12369

exceeding 2 hours per day, rather than merely reporting general correlations. This provides a clear target for visual-ergonomic interventions specifically tailored to adolescents, a demographic whose unique physiological compensation and parental dynamics are often overlooked in digital eye strain literature.

Conclusions

This study found no statistically significant relationship between overall gadget usage patterns and the incidence of asthenopia among students at SMP Negeri 5 Mataram. However, logistic regression analysis identified gadget use duration exceeding 2 hours per day as the most dominant risk factor contributing to asthenopia, compared to other usage-related behaviors. The prevalence of asthenopia among students was 31.4%, with itchy eyes as the most frequently reported symptom, followed by glare and watery eyes, along with extraocular symptoms such as headache and neck pain. Asthenopia was also more prevalent among female students and those aged 14 years. These findings suggest that although the overall usage pattern category showed no significant association, specific behaviors, particularly prolonged screen duration, play a critical role in the development of visual fatigue.

Acknowledgments

The author would like to extend her deepest gratitude to the supervisors for their invaluable guidance throughout this research, to friends who have provided continuous support, and to her parents for their unwavering support and prayers.

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