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Work-related risk factors for asthenopia among employees: a 2024 study

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ABSTRACT

Asthenopia, or eye strain, is a common occupational health issue that can negatively impact employee productivity. This study aimed to analyze occupational factors associated with asthenopia among office-based employees in 2024. A cross-sectional analytical design was employed, involving 61 respondents. Data were collected using a structured questionnaire to assess variables such as age, sex, years of employment, eye rest habits, and duration of computer or laptop use. The distance between the eyes and the computer/laptop was measured with a measuring tape, and lighting intensity at workstations was assessed using a luxmeter. Statistical analysis was conducted using the chi-squared test and Fisher's exact test. The results showed that 70.5% of respondents experienced asthenopia. Significant associations were found between asthenopia and age ($p = 0.011$), eye rest ($p = 0.007$), duration of computer/laptop use ($p = 0.018$), screen distance ($p = 0.031$), and lighting intensity ($p = 0.006$). No significant association was found between asthenopia and sex or years of employment. Based on these findings, routine eye examinations and the implementation of eye rest techniques are recommended, particularly for employees over the age of 40. Employers are also encouraged to implement promotive measures, including the provision of visual aids, ergonomic workstations, standing desk options, and improved lighting using LED daylight lamps.

1. Introduction

Technological advancements in the 21st century, particularly in information technology, have led to the widespread use of computers across various occupational settings [1] to improve productivity and efficiency [2]. However, this shift has also introduced a range of occupational health risks, especially among office-based workers [3]. Prolonged computer use is increasingly linked to visual health issues, particularly asthenopia [4], or eye strain, resulting from exposure to ultraviolet and electromagnetic radiation emitted by computer monitors [5].

The increased reliance on Visual Display Terminals (VDTs), such as computer monitors, has contributed to a rise in asthenopia cases [6]. Also known as computer vision syndrome, asthenopia presents with external symptoms such as dry eyes, burning sensations, and irritation, as well as internal symptoms like fatigue, eye pain, and occipital headaches [7]. While the condition is often intermittent, if left unaddressed it can significantly impair visual comfort, concentration, and overall productivity [8].

Globally, visual impairment is a widespread issue. The 2021 *World Report on Vision* estimated that 2.2 billion people experience some form of vision impairment [9]. Similarly, *Universal Eye Health: A Global Action Plan* reported that approximately 285 million people (4.24% of the world's population) have low vision. Studies show a high prevalence of visual complaints, with 40–90% of individuals reporting symptoms [10]. According to a 2016 *Digital Eye Strain* report involving 10,000 U.S. adults, women are more likely than men to report asthenopia, with 69% of female respondents affected [11]. The 2015 *American Optometric Association Survey* further found that 58% of individuals who use computers for more than seven hours a day experience asthenopia [12]. In Indonesia, the 2017 Rapid Assessment of Avoidable Blindness survey recorded approximately 8 million people with vision impairment, 6.4 million of whom had moderate to severe impairment [13]. Low awareness of eye health often exacerbates these issues. According to the American Academy of Ophthalmology (2022), 14% of individuals were unaware they were experiencing asthenopia symptoms until diagnosed through a comprehensive eye exam [17].

Several occupational risk factors contribute to asthenopia, including poor lighting, screen glare, non-ergonomic viewing distances and postures, and uncorrected vision problems. The Occupational Safety and Health Administration (OSHA) identifies key contributing factors such as workstation design (e.g., monitor distance), work characteristics (e.g., frequency of eye rest), worker demographics (e.g., age, refractive errors), and environmental conditions (e.g., lighting intensity) [14]. However, existing research has yielded inconsistent findings—some studies report significant associations between screen time and asthenopia, while others do not [15]. In Indonesia, studies on asthenopia among office workers remain limited, often focusing on individual and computer use factors, while neglecting environmental contributors such as lighting conditions. Moreover, few studies adequately control for confounding variables like refractive errors, which increase the effort required for accommodation, leading to visual fatigue [16].

This study aims to identify occupational factors associated with asthenopia among office workers using the epidemiological triad model (host, agent, and environment). The novelty of this research lies in its comprehensive assessment of individual, behavioral, and environmental contributors to asthenopia in an office setting where similar studies have not yet been conducted. The study incorporates objective measurements using calibrated instruments and applies standardized categorization methods. Rigorous exclusion criteria based on medical screening data are used to control for confounding factors, improving the validity of the findings. The results are expected to contribute practical, evidence-based recommendations for workplace eye health promotion and prevention strategies, with the goal of reducing the prevalence of asthenopia and its impact on employee productivity.

2. Method

This study employed a quantitative analytical design with a cross-sectional approach, conducted at an office-based workplace in Bekasi, Indonesia, from October 2023 to June 2024. Due to the relatively small population at the study site, total population sampling was used, encompassing all 89 eligible individuals. After applying inclusion and exclusion criteria, a final sample of 61 respondents (68.54% of the population) was obtained, deemed representative of the overall workforce. Inclusion criteria consisted of employees who actively used computers or laptops for work, were present during the data collection period, and consented to participate. Exclusion criteria included individuals who were unwell at the time of data collection or had diagnosed refractive errors, as these could affect the assessment of asthenopia. Information on refractive errors was obtained from medical examination records to minimize potential bias.

Data collection involved both self-reported questionnaires and objective measurements. Demographic and behavioral variables were gathered through a structured questionnaire. Asthenopia was measured using the Computer Vision Syndrome Questionnaire (CVS-Q) developed by Seguí et al. (2015), which consists of 16 items [18]. A total score above 6 was classified as indicating asthenopia. The instrument demonstrated good reliability (Cronbach's alpha > 0.78) and validity, including Rasch analysis using WinSteps. It was adapted into Bahasa Indonesia through a forward-backward translation process to ensure linguistic and conceptual equivalence.

Objective measurements were conducted on two environmental variables. First, the viewing distance between the eyes and the computer monitor was measured using a tape measure. These measurements were then categorized based on the standards outlined in the Indonesian Ministry of Health Regulation No. 48 of 2016. Second, the workplace lighting intensity for each respondent was assessed using a calibrated luxmeter. The lighting data were classified according to the national standard SNI 03-6575-2001. All measurements were taken once during daytime work hours, with each assessment repeated twice to improve accuracy and reliability.

Data analysis included both univariate and bivariate approaches. Univariate data were presented as frequencies and percentages. Bivariate analysis was conducted using the chi-square test, or Fisher's exact test when expected cell frequencies were below five. Associations between independent variables and asthenopia were analyzed using prevalence ratios (PR) with 95% confidence intervals (CI). Variable categorization followed established literature and national regulatory standards. This study received ethical approval from the Health Research Ethics Committee of Universitas Muhammadiyah Prof. Dr. HAMKA (Approval No. 03/24.02/03160).

3. Results and Discussion

3.1. Results

Table 1 shows that the majority of respondents experienced asthenopia. In terms of respondent characteristics, most were male, over 40 years of age, had more than five years of work experience, took eye breaks lasting less than 10 minutes, and used computers or laptops for more than four hours per day. Regarding environmental factors, most respondents were found to be working in environments with lighting intensity below 300 lux. The results can be seen in Table 1 below.

Table 1. Distribution of Workers by Asthenopia and Determinant Factors among Workes

Variable	Category	Total	
		n	%
Sex	Female	17	27.9
	Male	44	72.1
Workers' Age	Old (> 40 years old)	40	65.6
	Young (≤ 40 years old)	21	34.4
Work Tenure	> 5 years	36	59
	≤ 5 years	25	41
Eye Rest	< 10 minutes	13	21.3
	≥ 10 minutes	48	78.7
Computer/laptop usage duration	> 4 hours/day	42	68.9
	≤ 4 hours/day	19	31.1
Computer/laptop usage distance	< 50 cm	41	67.2
	≥ 50 cm	20	32.8
Lighting Intensity	< 300 lux	53	86.9
	≥ 300 lux	8	13.1
Asthenopia	Total score ≥ 6 poin	43	70.5
	Total score < 6 poin	18	29.5

Bivariate analysis using Fisher's exact test in detailed refer to Table 2. It showed that the prevalence of asthenopia was highest among female respondents (82.4%). The prevalence ratio (PR) indicated that females were 1.249 times more likely to experience asthenopia than males (95% CI: 0.920–1.697); however, the association was not statistically significant (p = 0.348). In contrast, a chi-square test examining the association between age and asthenopia found that respondents aged >40 years had the highest prevalence (82.5%). Those in this age group were 1.733 times more likely to experience asthenopia compared to respondents aged ≤40 years (95% CI: 1.082–2.774), with a statistically significant association (p = 0.011).

Table 2. Association between Determinant Factors and Asthenopia among Workers

Determinant Factors		Asthenopia				Total		PR (95% CI lower-upper)	P-Value
		Experiencing		Not Experiencing					
		N	%	n	%	n	%		
Sex	Female	14	82.4	3	17.6	17	100	1.249 (0.920 – 1.697)	0.348
	Male	29	65.9	15	34.1	44	100		
Workers' age	Old (> 40 years old)	33	82.5	7	17.5	40	100	1.733(1.082-2.774)	0.011*
	Young (≤ 40 years old)	10	47.6	11	52.4	21	100		
Work Tenure	> 5 years	22	61.1	14	38.9	36	100	0.728(0.533 – 0.994)	0.086
	≤ 5 years	21	84	4	16	25	100		
Eye Rest	< 10 minutes	13	100	0	0	13	100	1.600 (1.285 – 1.992)	0.007*
	≥ 10 minutes	30	62.5	18	37.5	48	100		
Computer/laptop usage duration	> 4 hours/day	34	81	8	19	42	100	1.709 (1.041 – 2.807)	0.018*
	≤ 4 hours/day	9	47.4	10	52.6	19	100		
Computer/laptop usage distance	< 50 cm	33	80.5	8	19.5	41	100	1.610 (1.013 – 2.559)	0.031*
	≥ 50 cm	10	50	10	50	20	100		
Lighting Intensity	< 300 lux	41	77.4	12	22.6	53	100	3.094 (0.924 – 10.367)	0.006*
	≥ 300 lux	2	25	6	75	8	100		

** p-value<0.05*

Analysis of work experience using Fisher's exact test revealed that the highest prevalence of asthenopia occurred among respondents with ≤5 years of experience (84%). However, the PR of 0.782 (95% CI: 0.533–0.994) and a p-value of 0.086 indicated no statistically significant association. Regarding eye rest duration, all respondents who took breaks of less than 10 minutes reported asthenopia (100%). These respondents were 1.600 times more likely to experience asthenopia compared to those who took breaks of ≥10 minutes (95% CI: 1.285–1.992), with a significant association (p = 0.007).

The duration of computer/laptop use also showed a significant association. Respondents using computers for more than 4 hours per day had the highest prevalence of asthenopia (81%) and were 1.709 times more likely to be affected compared to those using computers for ≤4 hours per day (95% CI: 1.041–2.807, p = 0.018). The distance between the eyes and the computer screen was another significant factor. Respondents who used computers at a distance of <50 cm had a higher prevalence of asthenopia (80.5%) and were 1.610 times more likely to develop asthenopia compared to those who maintained a distance of ≥50 cm (95% CI: 1.013–2.559, p = 0.031). Lastly, analysis of lighting intensity using Fisher's exact test revealed that respondents working in environments with lighting <300 lux had a higher prevalence of asthenopia (77.4%) compared to those in better-lit conditions. These respondents were 3.094 times more likely to experience asthenopia (95% CI: 0.924–10.367), with a statistically significant association (p = 0.006).

3.2. Discussion

Asthenopia was assessed using the Computer Vision Syndrome Questionnaire (CVS-Q), a validated instrument developed by Seguí et al. (2015), which, despite relying on subjective perception, has demonstrated strong reliability (Cronbach's alpha > 0.78) and construct validity through Rasch analysis [18]. Strict exclusion criteria were applied to control for potential confounding factors, such as refractive errors, to improve the accuracy of findings. Results showed that the majority of respondents experienced asthenopia, which can be attributed to a combination of host (individual), agent (device use), and environmental factors. These include age, duration and distance of computer/laptop use, insufficient eye rest, and suboptimal lighting conditions.

This finding aligns with previous studies. Research on office workers at the Communication and Information Office in Semarang reported common asthenopia symptoms such as blurred vision, dry and irritated eyes, and headaches [19]. Similarly, a study on employees at another company found asthenopia to be associated with sex, job tenure, and prolonged computer use [20].

Sex and Asthenopia

Although the present study found no statistically significant association between sex and asthenopia, the prevalence was higher among female respondents [19]. This is consistent with prior research suggesting that hormonal differences, particularly estrogen and anti-androgen levels, may disrupt the function of the meibomian glands [21], resulting in reduced tear secretion and a thinner tear film, which contributes to eye fatigue [22]. Nonetheless, male respondents also experienced asthenopia, likely due to extended screen time and inadequate lighting. These findings support the notion that prolonged visual tasks increase the risk of asthenopia for all employees, regardless of sex [2]. However, the study's unbalanced sex distribution may have influenced these results.

Age and Asthenopia

Age was significantly associated with asthenopia. Respondents over 40 years of age were more likely to experience symptoms [23], which may be attributed to age-related declines in retinal sensitivity, lens elasticity, and ciliary muscle strength, all of which affect visual accommodation [24]. Importantly, job assignments in the study setting were not age-dependent, meaning older workers faced similar visual demands as their younger counterparts. These findings suggest the need for targeted visual ergonomics interventions for employees aged over 40, even in age-neutral work environments.

Tenure and Asthenopia

The study found no significant association between job tenure and asthenopia, consistent with previous research at the Riau Regional Office of the Ministry of Religion [25]. While some literature suggests that longer tenure increases risk due to cumulative fatigue [26], this study observed that respondents with ≤5 years of experience also reported high levels of asthenopia. This may be due to inadequate adaptation to new tasks and work environments, leading to extended screen use and reduced efficiency [27]. Thus, screen time appears to be a more influential factor than tenure itself.

Eye rest and Asthenopia

A significant association was found between insufficient eye rest (<10 minutes) and asthenopia, reinforcing prior findings [19]. Reduced blinking frequency during screen use leads to symptoms [28], such as dry eyes, irritation, and visual discomfort [29]. Preventive strategies—such as implementing 10-minute breaks every hour and applying the 20-20-20 rule (looking 20 feet away for 20 seconds every 20 minutes)—are recommended [30]. Interestingly, some respondents who reported ≥10 minutes of rest still experienced asthenopia, which may be due to the quality or timing of the break, or environmental conditions [31].

Duration of computer/laptop use and Asthenopia

This study confirmed a significant relationship between prolonged computer use (>4 hours/day) and asthenopia, consistent with studies among university students in Pakistan [1]. The integration of digital systems in many workplaces, including the study setting, requires continuous computer use, placing strain on the ciliary muscles and leading to visual fatigue [12]. Blue light exposure from screens may also impair cognitive function and productivity [32]. These findings highlight the need to balance digital workloads with eye health protection measures.

Viewing distance and Asthenopia

Screen distance was also significantly associated with asthenopia. [20]. Most respondents worked at distances <50 cm from the screen, below the ergonomic recommendation of 50–101 cm outlined in the Indonesian Ministry of Health Regulation No. 48 of 2016 [32]. Improper viewing distances can strain the eye's accommodation system, increasing the risk of fatigue [33]. Many respondents lacked awareness of ergonomic viewing distances and did not use adjustable laptop stands, forcing them to adopt close viewing postures. Such practices contribute to visual strain and physical discomfort, reducing both focus and motivation [34].

Lighting intensity and Asthenopia

A significant association was observed between inadequate lighting (<300 lux) and asthenopia, consistent with findings from a 2022 study at Jambi Ekspres [35]. Poor lighting forces the eyes to exert more effort to focus [36], increasing the risk of fatigue [37]. The Indonesian light intensity standard for office work is 300 lux [38]. Lighting that is too dim or too bright, causing glare or visual distortion [39], can contribute to asthenopia [40]. Observations revealed that many workspaces used soft white downlights and lacked natural light due to design limitations, such as closed blinds or absence of windows. These factors, along with measurement limitations (e.g., single time-point measurement, reflective surfaces), may have affected results.

This study also suggests potential interactions between variables. For instance, older workers may require higher lighting levels due to reduced retinal sensitivity [23], and the combination of prolonged screen use with inadequate rest increases the likelihood of asthenopia [31]. These findings support the use of the epidemiological triad framework, which considers host (individual), agent (devices), and environment factors in the onset of asthenopia. This study contributes to the fields of occupational health and ophthalmology by identifying key work-related factors associated with asthenopia. The results support the need for targeted promotive and preventive interventions, including ergonomic education, regular eye health monitoring, and workplace design improvements [4].

This study has limitations, such as unbalanced sex distribution and lack of data on psychosocial factors or sleep quality, which may also influence visual fatigue. While this study provides valuable insights, it has several limitations. Its cross-sectional design limits the ability to establish causal relationships, and the absence of multivariate analysis restricts the measurement of the strength of associations between variables. Furthermore, potentially influential factors such as psychosocial stressors and sleep quality were not assessed. Future studies should incorporate multivariate statistical analyses and explore a broader range of contributing factors to better inform evidence-based interventions aimed at preventing asthenopia in the workplace.

4. Conclusion

This study found that 70.5% of respondents experienced asthenopia, with significant associations identified for factors including age, insufficient eye rest, duration and distance of computer/laptop use, and inadequate lighting intensity in the workplace. To reduce the risk of asthenopia among workers, several measures are recommended. First, employees should undergo annual eye examinations, and if vision abnormalities are detected, appropriate corrective aids should be used. Second, workers are advised to take regular eye breaks, ideally every hour, using the 20-20-20 rule—looking at an object 20 feet away for 20 seconds every 20 minutes of screen use. Third, effective time management strategies should be promoted to balance screen time and rest.

At the organizational level, it is recommended that agencies implement promotive health education programs focusing on visual health, conduct routine annual health screenings, and review workload management practices. Environmental improvements should include the use of LED daylight lighting, flicker-free and low blue light monitors, and provision of ergonomic aids such as standing laptop supports. Additionally, office layouts should be redesigned to comply with ergonomic standards, enhancing both comfort and visual health.

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Author contributions

T.P.P played a role in conceptualizing and designing the research, conducting literature reviews, and collecting and analyzing data. Meanwhile, O.L and H.M contributed to the drafting and revision of the manuscript.

Conflict of Interest

This study declares that there is no conflict of interest.

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