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Research Article

Relationship Between Lighting Intensity and Eye Fatigue in Workers of the Weaving Industry Central in Dalangan Tawangsari Village, Sukoharjo

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Abstract: Eye fatigue is a common condition often experienced by workers in the textile industry when their eyes feel very tired due to prolonged and continuous use in low light conditions. Among textile workers in Dalangan Village, Tawangsari, Sukoharjo, 100% of the 10 respondents experienced eye fatigue due to insufficient lighting intensity that did not meet the standard (300 Lux). This study aims to investigate the relationship between lighting intensity and eye fatigue among textile workers in the central textile industry in Dalangan Village, Tawangsari, Sukoharjo. This is a quantitative study using observational analysis with a cross-sectional approach. Lighting intensity was measured using a lighting measurement observation sheet with a Lux Meter, while eye fatigue was measured using a questionnaire. The study population consisted of 35 workers, and the sample was selected using total sampling. Based on the results of the chi-square test analysis, a significant relationship was found between lighting and eye fatigue among textile workers, with a p-value of <0.05 and a p-value of 0.039. The analysis yielded a PR value of 0.727, meaning that respondents with inadequate lighting have a 0.727 times higher risk of experiencing eye fatigue compared to respondents with adequate lighting. We recommend that weaving workers pay more attention to eye health and ensure that the lighting levels used comply with standards.

Keywords: Lighting Intensity; Eye Fatigue; Weavers

1. Introduction

The traditional weaving industry center in Dalangan Village, Tawangsari, Sukoharjo is a weaving industry that uses wooden looms [1]. One of the weaving industry centers that is classified as an informal industry that is still lacking in terms of Occupational Safety and Health (OSH) for workers. This can lead to workers facing risks of workplace accidents or work-related illnesses, one of which is eye fatigue [2]. Informal sector businesses have not taken the issue of occupational safety and health seriously, such as work posture, work equipment, and the adaptation of work equipment to the physical condition of workers [3].

Occupational Safety and Health, hereinafter referred to as OSH, refers to all activities aimed at ensuring and protecting the safety and health of workers through efforts to prevent workplace accidents and occupational diseases [4]. One of the common workplace accidents among workers is eye fatigue. Eye fatigue is the excessive effort of the visual system to achieve sharp vision despite inadequate visual conditions [5]. Symptoms of eye fatigue include red eyes, a burning or itching sensation in the eyes, watery eyes, drowsiness, blurred vision, and headaches, neck, and shoulder pain. This can also increase workloads, lead to easier fatigue, frequent breaks, lost work hours, reduced job satisfaction, increased likelihood of errors, decreased productivity, and impaired concentration while working [6].

According to the Indonesian Labor Regulation No. 5 concerning Occupational Safety and Health in the Workplace, Article 17 paragraph 2 states that "Workplaces shall use natural lighting, and building designs must ensure that light intensity meets standards," and paragraph 4 states that "artificial lighting

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shall not cause excessive heat or interfere with KUDR." Occupational Safety and Health in the Workplace for workers involved in the weaving of cotton materials with a lighting standard of 300 Lux Metter [7]. Eye fatigue is a common condition that often occurs when the eyes feel extremely tired due to prolonged continuous use over an extended period. The fatigue experienced is typically not an emergency condition but often results in disrupted productivity or discomfort [8].

Maximum performance needs to be supported by a safe, healthy, and comfortable work environment, with one of the influential factors being lighting intensity [9]. Insufficient lighting intensity can lead to workplace accidents and reduce precision in weaving, which affects the quality of the woven fabric produced. On the other hand, excessive lighting intensity can cause glare, reflections, shadows, and eye fatigue [10] [11].

The National Institute for Occupational Safety and Health (NIOSH) estimates that nearly 90% of computer users who spend three or more hours per day on a computer will experience vision problems. The United States reports nearly one million new cases of eye fatigue in the workplace each year [12]. According to the World Health Organization (WHO), the incidence of eye fatigue (asthenopia) ranges from 40% to 90%. WHO also notes that 285 million people, or 4.24% of the global population, experience vision impairments such as low vision or reduced visual acuity and blindness, with 246 million people, or 65%, affected [2].

Central Java data consists of many industries and companies that require intense lighting, and the majority of lighting intensity in Central Java is in the low category. This can be seen from survey data conducted by the Indonesian Ministry, which shows a prevalence of vision loss or eye fatigue in Central Java of 1.5%, with 0.14% of cases caused by prolonged computer use [13].

This study has several advantages, including the use of a cross-sectional design, which allows for efficient data collection in a single time frame, thereby saving time. It also uses the appropriate Chi-square test to analyze the relationship between two categorical variables, such as lighting intensity and eye fatigue [14]. It employs a quantitative approach that generates objective, measurable, and generalizable data if the sample represents the population, and provides practical benefits in the field of ergonomics by providing a scientific basis for decision-making regarding lighting arrangements in the workplace to prevent eye fatigue [15]. The use of primary data collected directly through measurements and questionnaires makes the results of this study more relevant, contextual, and aligned with real-world conditions in the field [16].

Based on the results of a preliminary survey conducted on November 25, 2024, at the Dalangan Tawangsari Sukoharjo village textile industry center, using a brief interview method with several textile workers at the Dalangan Tawangsari Sukoharjo village textile industry center, it was found that all of the textile workers were over 40 years old and 100% of the 10 respondents all experienced eye fatigue such as watery or red eyes while working, felt tiredness in their eyes while working, experienced blurred vision when looking, and the majority of workers frequently felt pain in their eyes. According to the Ministry of Manpower Regulation of the Republic of Indonesia No. 5 of 2018 on Occupational Safety and Health in the Workplace, the lighting standard for cotton weaving workers is 300 Lux Meters. Based on observations in the weaving room, the average lighting intensity in the weaving room is 192 Lux Meters, which is insufficient because each weaving machine has its own lighting, and the intensity of that lighting naturally varies.

Based on the above background, the researcher was interested in conducting research on the relationship between lighting intensity and eye fatigue among workers in the textile industry in the village of Dalangan Tawangsari, Sukoharjo.

2. Literature Review

Lighting Intensity

Light intensity is the strength of light emitted by a light source to a specific place or point [17]. The standard used in measuring lighting intensity in the work environment in the cotton weaving section is 300 Lux Meter [7]. A lux meter is an electronic device used to measure illuminance, which is the intensity of light falling on a surface [18]. Lighting, often referred to as a lighting factor, is a very important factor in achieving a sense of safety and comfort, which is closely related to human productivity in performing their work [19]. Lighting is one of the important factors in designing a space to support worker comfort. Insufficient lighting in a room can disrupt activities. Good lighting can create a comfortable work environment, while inadequate lighting can cause eye fatigue and even lead to eye damage [20]. Whether insufficient or excessive, lighting can affect eye function, so optimal lighting is crucial for reducing eye fatigue, improving accuracy, and maintaining work productivity [21].

Eye Fatigue

Eye fatigue is an excessive effort by the visual system to achieve sharpness in vision [5]. Eye fatigue is caused by stress on the visual function. Stress on the accommodative muscles can occur when a person looks at small objects at close range for an extended period of time. In such conditions, the

eye muscles work continuously and are overworked. The tension in the accommodation muscles (ciliary muscles) increases, leading to an increase in lactic acid and, as a result, eye fatigue [22]. This can ultimately cause workers to become easily fatigued, lose work hours, reduce performance, and potentially make mistakes or decrease work productivity [23]. In this study, a questionnaire was developed or designed. The purpose of creating the questionnaire was to ensure it was relevant to the local context and easy for respondents to understand. Researchers identified key indicators, such as knowledge, attitude, and practice (KAP), and selected the most relevant questions [24]. Sentences were simplified and made clear, and the measurement scale was determined according to needs. The questionnaire consists of 12 questions across three domains: knowledge, attitude, and practice. Finally, the questionnaire was validated on 30 respondents to ensure the clarity, consistency, and effectiveness of the questions [25].

Research on the relationship between lighting intensity and eye fatigue has been extensively conducted by previous researchers, one of which was conducted by Khoiriyah in 2019 at PT Textile X, which showed that the majority of workers, with a total of 74 respondents, as indicated by the Spearman correlation results, demonstrated a significant relationship between lighting intensity and eye fatigue with a p-value of 0.001 < 0.05, a significant relationship between eye fatigue and visual acuity impairment with a p-value of 0.043 < 0. 05, and a significant correlation between lighting intensity and visual acuity impairment with a ϱ value of 0.001<0.05. Companies need to conduct regular eye examinations and increase lighting intensity by adding more lights, while workers must maintain their health and prevent eye fatigue [26].

A similar study on eye fatigue measurement was conducted by Fatmayanti in 2020 at PT Sawargi Karya Utama on sewing department workers, with a total of 45 respondents. Based on the results of this study, a P-value of 0 was obtained. Since the P-value is greater than 0.5, this indicates that, statistically, there is no significant relationship between lighting intensity and eye fatigue. The absence of a significant relationship between lighting intensity and eye fatigue in this study may be due to the fact that the lighting in the workplace has caused workers to become accustomed to lighting that does not comply with the NAB standards set by regulations, which specify 750 Lux [27].

The study conducted by Jehung in 2021 at the Respati Yogyakarta University campus used a quantitative descriptive method with a cross-sectional design and employed purposeful sampling techniques with a total of 46 respondents. The study found a p-value of 0.103 (>0.05), indicating no significant relationship between lighting intensity and eye fatigue among employees at Universitas Respati Yogyakarta. The conclusion is that employees work daily using computers for more than two hours without breaks, with a viewing distance from the monitor of less than 50 cm, and an average general lighting level in the workplace of less than 300 lux. This is what causes many employees to experience eye fatigue [28].

3. Method

This type of research is quantitative research using observational analysis methods with a cross-sectional approach. The research was conducted at the Dalangan Village Weaving Industry Center in Tawangsari District, Sukoharjo Regency. The independent variables in this study are age and lighting intensity, which will be measured using questionnaires and a Lux Meter. The dependent variable in this study is eye fatigue, which will be measured using questionnaires. The population in this study consists of 35 workers, selected from the total number of workers at weaving industry centers 1, 2, 3, and 4. The sample in this study uses total sampling, consisting of 35 workers. Primary data in this study was obtained by distributing questionnaires and measuring lighting intensity using a Lux Meter. Data collection in this study was conducted using an eye fatigue questionnaire containing 12 questions and a Lux Meter that had been activated. Measurements were taken at a height of 0.8 meters, and the results were read on layer [29]. The analysis in this study used the chi-square test, which will be presented in the form of tables and narratives.

Validity and reliability tests were conducted on 30 weavers at the Sarung Goyor Pojok Industrial Center in February 2025. The validity test used Person's test, and the reliability test used Cronbach's Alpha. The results of the validity test indicated that the instrument was valid with a value of $r > 0.576$ and reliable with $r > 0.60$ (eye fatigue (0.922) with 12 questions). Therefore, it can be used as a reliable research measurement tool, and this instrument will be used to collect research data.

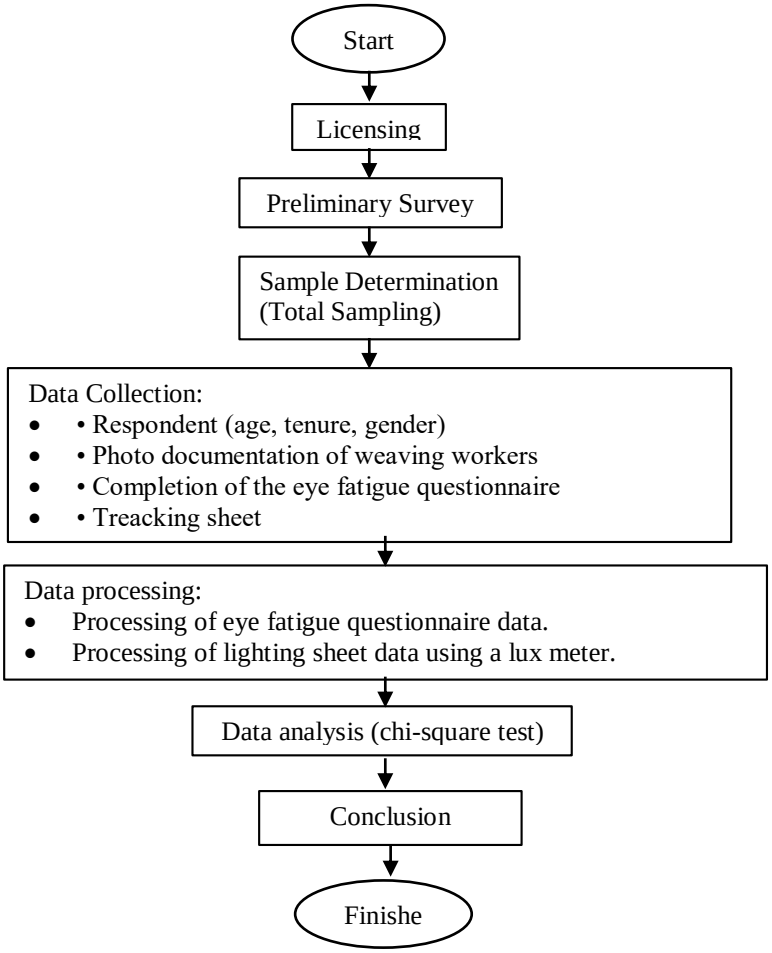

Figure 1 Research Flowchart

4. Results and Duscussion

Based on research conducted on workers in the weaving industry in Dalangan Village, Tawangsari, Sukoharjo, the characteristics of respondents based on gender, age, and length of service are as follows:

Table 1 Gender Characteristics of Respondents

No	Gender	Frequency (n)	Percentage (%)
1.	Male	14	40
2.	Female	21	60
Total (N)		35	100

Source: Primary data, 2025

Based on Table 1, it can be seen that there are 14 male weavers (40%) and 21 female weavers (60%).

Table 2 Age Characteristics of Respondents

No	Age	Frequency (n)	Percentage (%)
1.	31-40 years	1	2,9
2.	41-50 years	7	20,0
3.	51-60 years	3	8,6
4.	61-70 years	18	51,4
5.	> 71 years	6	17,1
Total (N)		35	100,0

Source: Primary data, 2025

The data from Table 2 shows that there is one worker aged 31-40 years old (2.9%). There are seven workers aged 41-50 years old (20%), and three workers aged 51-60 years old (8.6%). There are 18 weavers (51.4%) in the age group 61-70 years old, and 6 weavers (17.1%) over 71 years old.

Table 3 Characteristics of Respondents Working Period

No	Length of Service	Frequencyi (n)	Percentage (%)
1.	< 3 years	3	8,6
2.	≥3 years	32	91,4
	Total (N)	35	100,0

Source: Primary data, 2025

Based on the results of the analysis of Table 3, it can be seen that the majority of weavers have worked for more than three years, totaling 32 people (91.4%). Three weavers (8.6%) have worked for less than three years.

Table 4 Univariate analysis of lighting intensity

No	Lighting Measurement	Frequency (n)	Percentage (%)
1.	Eligible ≥300 Lux	22	62,9
2.	Not Eligible <300 Lux	13	37,1
	Total (N)	35	100,0

Source: Primary data, 2025

After conducting measurements using the required standard of 300 Lux Metter, it was found that the lighting that met the requirements for weavers was 22 frequencies with a percentage of 62.9%, while the lighting that did not meet the requirements for weavers was 13 frequencies with a percentage of 37.1%.

Table 5 Univariate analysis of eye fatigue

No	Eye Fatigue	Frequency (n)	Persentase (%)
1.	No Tired 0-6	6	17,1
2.	Tired 7-12	29	82,9
	Total (N)	35	100,0

Source: Primary data, 2025

Based on the data in the table, it can be seen that 6 weavers (17.1%) did not experience eye fatigue, while 29 weavers (82.9%) did experience eye fatigue.

Table 6 Bivariate analysis of the relationship between lighting intensity and eye fatigue

Lighting	Worker Eye Fatigue Weaving						P-value	PR (CI 95%)
	Not Experienced Fatigue		Experienced Fatigue		Total			
	n	%	n	%	n	%		
Eligible	6	27,3	16	72,7	22	100		
Not Eligible	0	0,0	13	100	13	100	**0,039**	0.727 (0.563 - 0 0.939)
Total (N)	6	17,1	29	82,9	35	100		

Source: Primary data, 2025

Based on the results of the analysis of the relationship between lighting intensity and eye fatigue, it was found that 6 (27.3%) of the workers did not experience eye fatigue under lighting that met the requirements. while 16 (72.7%) of workers experienced eye fatigue under adequate lighting conditions. Among workers exposed to inadequate lighting conditions, 0 (0%) did not experience eye fatigue, while 13 (100%) did experience eye fatigue. Based on the table of results from the analysis of the relationship between lighting intensity and eye fatigue among workers in the central textile industry in Dalangan Village, Tawangsari, Sukoharjo, it can be concluded that the chi-square test yielded a p-value of 0.039, which is less than 0.05. Therefore, it can be concluded that there is a significant relationship between lighting intensity and eye fatigue. The analysis also yielded a PR value of 0.727, meaning that respondents with inadequate lighting have a 0.727 times higher risk of experiencing eye fatigue compared to respondents with adequate lighting.

Based on research conducted on central textile industry workers in Dalangan Village, Tawangsari, Sukoharjo, it was found that the characteristics of respondents based on gender among textile workers showed that female workers outnumbered male workers because the work involved requires precision

and patience. These traits are generally possessed by women [30]. An increase in complaints of eye fatigue occurs in the age group of 40 years or older, and as age increases, complaints of eye fatigue may also increase, potentially leading to accommodation issues in the eye lens. Prolonged and continuous close-up work can cause vision abnormalities at any age [31]. Work tenure refers to the total amount of time a worker has been employed [32]. Long work tenure can make someone more experienced in performing their job, but it can also lead to fatigue and boredom while working, and increase the risks posed by the work environment [33].

The results of the univariate analysis of light intensity that meets the standard, which is 62.9%, show that many meet the standard. However, workers may experience discomfort if the light intensity is too dim or too bright, which can cause eye damage. Work that is frequently or continuously performed in poor lighting conditions (insufficient light) can cause short-term eye discomfort (eye fatigue) in the form of eye pain or fatigue, headaches, drowsiness, and fatigue, as well as long-term myopia or nearsightedness, or accelerate the onset of presbyopia at a younger age [27].

Although the lighting intensity meets the standard, there is a significant relationship between lighting intensity and eye fatigue, as it can be caused by other factors such as the large number of workers aged over 40 who have begun to experience eye fatigue or presbyopia, and their length of service of over three years as weavers [34]. The observation results show that some weavers have a viewing distance between their eyes and the weaving machine that is too close, which can cause eye fatigue, working hours exceeding 8 hours, and some weavers working from home with uncontrolled working hours. Many workers experience eye fatigue complaints despite lighting meeting the standard of 300 Lux Metter, such as frequent tearing of the eyes, feeling of glare while working, decreased visual acuity, blurred vision, vision disturbances, the distance between the eyes and the weaving machine being too close, work processes that require greater precision, and repetitive and continuous work processes over a long period of time [35].

This study is in line with research conducted by Tianto in 2020, regarding factors related to complaints of eye fatigue among office workers at X Karanganyar, which found a significant relationship between lighting intensity and eye fatigue because poor lighting in the workplace can cause eye fatigue, decreased efficiency, headaches, and vision problems. Other factors also influence this, such as work duration, computer usage time, age, gender, and refractive errors [9]. Another related study conducted by Zogara in 2023 found that there is a significant association between lighting intensity and eye fatigue; however, not all respondents experienced eye fatigue, and lighting conditions did not meet standards. This means that lighting intensity that does not meet standards does not necessarily cause eye fatigue, and vice versa. There may be other factors causing respondents not to experience eye fatigue, such as younger age and respondents frequently taking short breaks to rest their eyes [36].

This study is inconsistent with Mindayani's 2023 study on factors associated with eye fatigue among tailors in Lubuk Alung District, Padang Pariaman Regency, which found no correlation between lighting intensity and eye fatigue. Other factors contributing to eye fatigue include work posture [37].

It can be concluded that the majority of workers experience eye fatigue and that there is a relationship between lighting intensity and eye fatigue, even though the lighting intensity mostly meets the standard (300 lux). There may be other factors causing eye fatigue that were not studied, such as age and work experience. Other factors observed may be caused by the distance between the eyes and the loom being too close and uncontrolled working hours.

5. Conclusion

The average lighting intensity used for workers in the central weaving industry in Dalangan Village, Tawangsari, Sukoharjo is still categorized as meeting the requirements based on the regulations of the Ministry of Manpower. It was found that most of the weaving workers experienced eye fatigue, with 29 people (82.9%) reporting this condition. The results of the analysis of the relationship between lighting intensity and eye fatigue showed a significant correlation. The observed eye fatigue among textile workers may be caused by several factors, such as workers aged over 40 years, having worked for more than three years, the distance between the eyes and the loom being too close, and working hours exceeding eight hours or having uncontrolled working hours. These factors can influence the occurrence of eye fatigue.

Based on the research findings on the relationship between lighting intensity and eye fatigue among weavers, it is recommended that the owners of the Weaving Industry Center adjust the lighting levels in the work area to comply with the lighting standards for detailed work, which is approximately 300 lux, to minimize the risk of eye fatigue. Owners are also advised to conduct regular inspections and maintenance of the lighting system, and to add additional lighting in areas that are poorly lit. Weaving workers should pay special attention to their health, particularly eye health, such as undergoing eye examinations, as the eyes are an important part of the body used in performing this work, alongside the hands and feet. Work schedules should be arranged to allow regular breaks for the eyes and body to minimize eye fatigue complaints among weavers, and weavers should pay attention to the lighting levels used to ensure they meet the lighting standards for weaving work. For the next generation of weavers who are beginning their careers, it is important to prioritize eye health and overall physical well-being.

This study has several limitations that must be acknowledged in conducting this research. The study was conducted in Dalangan Village, Tawangsari, Sukoharjo, focusing on the relationship between lighting intensity and eye fatigue, thus not considering other factors. Other factors that can influence eye fatigue in weavers include ergonomic factors, environmental factors, health factors, and psychological factors (mental fatigue or stress). These limitations are hoped to serve as considerations or references for future researchers to develop better studies.

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