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Prediction Models for Decreasing Visual Acuity in Wig Makers

Model Prediksi Ketajaman Penglihatan pada Pekerja Rambut Palsu

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Abstract
One of the occupational diseases that can arise for workers with high accuracy is a decrease in their visual acuity. Therefore, it is necessary to study the risk factors of decreasing visual acuity in workers with high accuracy, such as in wig makers. This study aimed to examine the correlation between age, working period, lighting intensity, fatigue, and nutritional status with visual acuity, and to observe the main risk factors that can be used as a reference for predicting decreasing visual acuity. This study was an observational study that used a cross-sectional design. The population number for this study was 185 wig makers.A total of 85 samples were selected using simple random sampling. The study was carried out in January to March 2016 on wig makers in Purbalingga. The results showed that variables most closely associated with visual acuity were working period (p-value = 0.000 < 0.05), lighting intensity (p-value = 0.000 < 0.05), and fatigue (0.013 < 0.05). Variables that were not related to vision acuity were age (p-value = 0.846 > 0.05) and nutritional status (p-value = 0.562 > 0.05).
Keywords: Prediction model, visual acuity, worker

Abstrak
Salah satu penyakit akibat kerja yang dapat muncul karena pekerjaaan dengan ketelitian tinggi adalah penurunan ketajaman penglihatan. Oleh karena itu, perlu dilakukan penelitian tentang faktor risiko penurunan ketajaman penglihatan pada pekerja dengan ketelitian tinggi, seperti pada pekerja rambut palsu. Penelitian ini bertujuan mengetahui hubungan antara usia, masa kerja, intensitas pencahayaan, kelelahan, status gizi dengan ketajaman penglihatan serta mengetahui faktor yang paling berisiko yang dapat dijadikan acuan dalam memprediksi adanya penurunan ketajaman penglihatan. Penelitian ini merupakan studi observasional yang menggunakan desain potong lintang. Populasi penelitian berjumlah 185 orang pekerja rambut palsu. Sampel sebanyak 85 orang dipilih melalui simple random sampling. Penelitian dilakukan dari Januari hingga Maret 2016 pada pekerja rambut palsu di Purbalingga. Hasil penelitian menunjukkan bahwa variabel yang berhubungan dengan ketajaman penglihatan adalah masa kerja (nilai p = 0,001 < 0,05), intensitas pencahayaan (0,001 < 0,05) dan kelelahan (0,013 < 0,05). Sedangkan variabel yang tidak berhubungan dengan ketajaman penglihatan adalah usia (nilai p = 0,846 > 0,05) dan status gizi (nilai p = 0,562 > 0,05).
Kata kunci: Model prediksi, ketajaman penglihatan, pekerja

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Introduction

The eyes are an important organ of the human body. World Health Organization data shows an increase in eye disorders in the world's population. It is estimated that around 285 billion people in the world have experienced eye disorders, and 39 billion of those became blind as a result. Eye disorders are mostly caused by cataracts at 33% and eye impaired refraction at 43%.[1]

National Basic Health Research data shows that the proportion of population with low vision in Indonesia at 4.8% increased by 1.2% over time.[2] According to Household Health Survey data from 2001, eight provinces have higher rates of low vision than national figures, including Central Java with a rate of low vision of 5%.

Visual acuity is defined as the eye's ability to see an object clearly, and it is highly dependent on the eye's accommodation ability. One of the symptoms of decreased visual acuity is difficulty seeing objects normally within a distance of less than 6 meters.[3] Siswanto,[4] stated that for jobs that require a high level of accuracy, including wig-making, visual acuity is influenced by the distribution of luminance in the vision field, size of the observed object, contrast between the object and its surroundings, length of work period, age, and a person's physical condition.

The results of a study by Amrita,[5] found that there is an effect of lighting on visual acuity that is associated with speed and accuracy for welding workers in the small industry of Tabanan, Bali. The study also proved that poor lighting causes the workers to do their work quickly but to pay less attention to the results of their work. A study by Atmodipoero,[6] showed that lighting systems support improved work performance.

The results of a study by Aziz,[7] found a relationship between the number of years a person has worked (working period) and visual disability. Respondents with a 6–15 year working period had visual disabilities, while respondents with a 1–5 year working period did not have visual disabilities. The visual defect found in respondents was myopia. Myopia is a further symptom of decreased visual acuity in which the eye is unable to see objects that are near.

According to Setyawati,[8] human beings over the age of 40 years will experience a functional decline in organ function. A study by Roestijawati,[9] found that the age factor is associated with dry eye syndrome, with an odd ratio of 4.50. Workers aged 40 years and above, who used computers, have a 4.5 times higher risk of suffering from dry eye syndrome than workers less than 40 years old. Visual acuity decreases with age. In workers older than 40, a visual acuity of 1.0 (6/6 vision) was rarely found. Therefore, the contrast and size of an object needs to be larger to see it with the same sharpness.[10] Sherwood,[11] stated that the decline in the ability of age-related accommodation is called presbyopia. Presbyopia begins at about the age of 40.

In addition to lighting factors, working period, and age, decreased visual acuity can also occur due to a worker's physical condition. Physical fatigue due to anemia and malnutrition can decrease people's resistance to illness and the ability to see the results of their labor.[12] Monotonous work that requires high precision very easily causes boredom and fatigue. A study by Dochi et al,[13] on workers in Japan found that female workers suffer a greater reduction in work capacity based on fatigue than male workers.

Vision is the sense that plays an important role in all human activities. The eye is considered healthy if it functions well as the sense of sight. Vision and eye disorders can occur due to environmental factors, habits, and because of the eyes own workings. In jobs that require high accuracy or that require someone to work with small and delicate objects, the eye is forced to focus on objects repeatedly;[14] for example, wig makers in Purbalingga District, Central Java, make wigs that demand a precision of height with a variance tolerance of only 0.2 to 0.3 mm.

In collaboration with the Semarang Center for Occupational Safety and Institutional Hygiene and Occupational Health, the Manpower and Transmigration Office of Central Java Province conducted eye health examinations on 274 hair factory workers in 2003. The participants were sampled from five big companies in Purbalingga. The examinations revealed that 180 or 66% of the people were experiencing a disturbed visual acuity. Disorders were present in the form of decreased sharpness in either one eye or both. A total of 94 people or 34% of the workers were declared to have healthy eyes/vision.

Based on this data, this study aimed to determine risk factors for decreased visual acuity in wig makers in Purbalingga.

Method

This study was an observational study that used a cross-sectional design. The population number for this study was 185 wig makers. A total of 85 samples were selected using simple random sampling. The study was conducted in January to March 2016 in Purbalingga. The dependent variable was visual aquity, and the independent variables were period of work, exposure level, work fatigue, and nutritional status. The inclusion criteria were respondents who were willing to be interviewed and not under sick condition. The exclusion criteria included workers, who, at the time of study, got other jobs. Data retrieval techniques that were used included interviews with questionnaires and measurement of eye sharpness using a Snellen chart. This study applied univariate analy-

Table 1. Characteristics of Respondents Based on Age, Working Period

Variable	Category	n	%
Age	18-25 years	21	24.71
	26-33 years	33	38.82
	34-40 years	31	36.47
Working period	1-5 years	19	22.35
	5-10 years	62	72.94
	>10 years	4	4.71
Education	Elementary school	20	23.53
	Junior high school	28	32.94
	Senior high school - higher education	37	41.18
Nutritional status	Low (IMT 0-18.5)	19	22.35
	Normal	44	51.76
	Overweight	22	25.88

Table 2. Exposure Level at the Workplace

Variable	n (Total Point of Measurement)	Minimum	Maximum	Mean	SD
Local Exposure	85	150	295	220	42.944

Note:
SD= Standard Deviation

Table 3. Visual Acuity Measurement

Visual Acuity	n
Normal (6/6–6/7.5)	20
Near normal (6/9–6/15)	8
Mild low vision (6/16–6/22)	14
Moderate low vision (6/23–6/29)	23
Severe low vision (6/30–6/36)	2
Profound low vision (6/37–6/60)	4
Near blindness (6/60–6/90)	9
Blindness (>6/90)	5

sis to determine the frequency distribution of each variable, bivariate analysis to determine the relation between variables, and multivariate analysis to predict decreasing visual acuity by the most influential variable. This study has obtained a code of ethics 112/KEPK/III/2015.

Results

Table 1 shows that the majority of respondents (33 people or 38.83%) were between 26 to 33 years old; 21 respondents (24.71%) were 18–25 years old; and 31 respondents (36.47%) were 34–40 years old. The oldest respondent's age was 40 years and the youngest was 19 years.

The most respondents (62 people or 72.94%) had worked for 6–10 years, with an average working period of 6.4 years. A total of 19 respondents (22.35%) had a working period of 1–5 years, and four respondents (4.71%) had a working period of more than 10 years. The shortest working period by a respondent was one year, and the longest was 11 years.

Table 1 also indicates that the education levels for 85 respondents varied from completion of elementary school up to senior high school. The majority of respondents (37) were senior high school graduates (43.53%); 20 respondents (23.53%) were elementary school graduates (23.53%); and 28 respondents (32.94%) graduated from junior high school. This education category was based on formal education attained by the respondents as of the time of this study.

In addition, most of the respondents (44 people or 51.76%) had a normal nutritional status as measured by a body mass index between 18.5 and 25.0, while 19 respondents had low nutritional status, and 22 respondents (25.88%) were overweight.

The descriptive result of the exposure intensity variable data obtained an average local lighting intensity of 220 lux. The highest lighting was 295 lux and the lowest was 150 lux. According to the Regulation of Minister of Manpower and Transmigration No. 13/Men/X/2011 on Threshold Limit Value (TLV) of Physical and Chemical Factors at The Workplace, the minimum lighting requirement in the workplace for wig processing is 500–1000 lux. At 220 lux, the average lighting calculation result shows that the level of lighting workers receive does not meet minimum lighting requirements. Using the Snellen card, the measurement results for respondents' visual acuity indicate that most of the respondents (85 people) have a decreased level of visual acuity.

As seen in Table 4, the average respondents' work fatigue was 71.29 ml/sec, with a standard deviation of 22.57. The minimum work fatigue was 45 mL/sec and the maximum was 156 mL/sec.

Risk factor variables that affected vision sharpness were as follows: age, working period, lighting level, and nutritional status. Table 5 shows the results of bivariate

Table 4. Distribution of Respondents' Work Fatigue

Variable	n	Minimum	Maximum	Mean	SD
Work fatigue	85	45 (mL/sec)	156 (mL/sec)	71.29	22.57

Note: SD= Standard Deviation

Table 5. Variable Relations

Variable	p-Value	r
Age with visual acuity	0.000	−0.370
Period of work with visual acuity	0.000	−0.965
Exposure level with visual acuity	0.000	0.982
Work fatigue with visual acuity	0.193	−0.143
Nutritional status with visual acuity	0.594	−0.059

Table 6. Results of Multivariate Analysis

Model	Unstandardized Coefficients		Standardized Coefficients	t	p-Value
	B	SE	β		
(Constant)	−2.388	1.059		−2.255	0.027
Working period	−229	0.052	−0.286	−4.366	0.000
Local Exposure	.035	0.003	0.702	10.701	0.000
Work Fatigue	−.005	0.002	−0.047	−2.560	0.012

Note: SE= Standard Error

analysis among variables of age, period of work, exposure level, work fatigue; nutritional status with visual acuity.

After bivariate analysis, multivariate data were analyzed to determine the most influential variables and the model of linear regression equation. This model of linear regression equation was applied to predict decreased visual acuity by significantly related risk factors.

Table 6 displays the results of a linear regression equation for visual acuity with the following formula: visual acuity = −2.388 + (−0.222) × working period + 0.035 × lighting + (−0.005) × fatigue. This means that any 1 year increase in working life can decrease the visual acuity value by 0.229 times; any increase of 1 lux lighting can increase the visual acuity value by 0.035 times; and any increase of 1 mL/sec of fatigue can decrease the visual acuity value by 0.005 times.

Discussion

The results of regression analysis found that age had no relation to visual acuity with p value = 0.846 > 0.05. The results of this study align with a study by Dewi,[15] which showed no significant relation between age and eye fatigue. In this study, the older respondents had better visual acuity than the younger ones did.

This is contrary to the American Academy of Ophthalmology's statement that dry eye syndrome is most commonly found in women aged an average of 50–70 years. The theory most often proposed is the hormonal theory. Androgen hormone deficiency is one of the risk factors in the pathogenesis of dry eye. In the 40–50 age group, dry eye complaints increase because this age group most commonly experiences a change in the ability of accommodation of the eye.[9]

According to Ilyas,[14] one of the factors that affects vision acuity is age. Visual acuity decreases with age. Workers older than 40 years old were rarely found to have a visual acuity of 1.0 (6/6 vision); their visual acuity was reduced. Hence, the contrast and size of objects must be larger to be seen with the same sharpness. Increasing age causes the lens to grow larger, flatter, more yellow, and harder. These conditions result in the lens losing elasticity and the flexibility to curve. Increasing age also causes close points to move further away from the eye, whereas the distant point is generally the same.

The results of regression analysis showed that visual acuity was significantly related to working period, with (p-value = 0. 000) < 0.05 and r = −0.965, which means that the longer a person's working period, the more decreased their sharpness of vision.

In addition to the intensity of exposure, Siswanto,[4] states that for precision work, visual acuity is also influenced by the distribution of luminance in the field of vision, the size of the observed object, the contrast between the object and its surroundings, duration of observation, age, and the colors and materials of the object that determine its luminance.

Workers had an average working period of 6.4 years. The longest working period was 11 years, while the minimum working period was one year. Based on the results of the study, the worker with the 11-year working period has a vision of 6/61, which means that the worker can see the letters on the Snellen card at a distance of 6 meters, while people with normal vision can read the same letters at a distance of 61 meters. Meanwhile, the worker with the 1-year working period has a vision of 6/6 (normal vision), which means that the worker can see the letters on the Snellen card at a distance of 6 meters, which is the same for people with normal vision. This striking difference proves that length of working period affects the sharpness of one's eyes. The longer the working period, the lower is the visual acuity.

Susila,[16] states that a decrease in the sharpness of the eye can occur in a person who observes small objects at close range over a long time. The results of a study by Aziz,[7] indicate a relation between working period and visual disability; respondents with a 6–15 year working period experience visual disabilities and respondents with a 1–5 year working period do not.

A study by Katsuro,[17] on occupational safety and health benefits for workers in the Zimbabwean food industry shows that the components affecting workers' health include the following individual factors: age at 25%, sex at 15%, and tenure at 10%. The remaining 50% are influenced by workload and nutrition. The results of this study contradict Katsuro's study that found no correlation between asthenopia and the number of working hours in a day in Visual Display Terminal. Asthenopia is correlated with age and sex.

The results of regression analysis showed that a person's visual acuity was significantly related to the intensity of lighting (p-value = 0.000 < 0.05) with r = 0.982, which means that the higher the intensity of the lighting, the higher the visual acuity. This aligns with the results of the study by Niti,[19] who found that the relationship of the factors of lighting intensity and working attitude show the tendency toward the incidence of myopia in laborers. A study by Amrita,[5] showed how the speed and accuracy in work is affected by a low lighting level of only 56 lux in the small welding industry in Denbantas, Tabanan.

According to the Australian Government Publishing Service,[20] lighting system functionality in a working environment can be divided into two parts that are the main function and the secondary function. The main function of the lighting system is to provide a safe environment; that is, the worker can move around inside and recognize his or her working environment safely. Workers can move around the workplace freely and can make informed decisions quickly, allowing them to easily carry out visual tasks. The ability to perform visual tasks depends on the quality and quantity of light directed at the visual task, the area around the visual task, and the surrounding surface. The worker should be able to carry out visual tasks for long periods of time and should be able to see objects clearly; the lighting should provide a comfortable and pleasant visual environment. Many variables affect the ability to obtain a comfortable and pleasant visual environment. These include avoidance of excessive illumination variations; the absence of direct glare from lights or armatures; the use of suitable primary interior surfaces; and the use of lamps with suitable characteristics. The secondary function of the main lighting system that must be accomplished is that the lighting system should be as efficient as possible and easy to clean and maintain.

Suma'mur,[10] states that good lighting enables workers to see objects clearly, quickly, and without excessive effort. Moreover, adequate lighting provides a good impression of scenery and a comfortable environment.

The results of regression analysis showed that work fatigue was significantly related to visual acuity, with p-value = 0.000 < 0.05.

Work fatigue is a condition that is often experienced by workers after performing an activity. Work fatigue reduces a person's general physical condition, including, among others, decreased accommodation power, which results in decreased visual acuity, performance decline, etc.[21]

Results of regression analysis show that nutritional status is related to visual acuity, but it is not significant, with p-value = 0.562 > 0.05. A total of 44 respondents (51.76%) had a normal nutritional status with a Body Mask Index of 18.5–25 kg; 19 respondents had low nutritional status; and 22 respondents (25.88%) were overweight. Based on a study that showed that women in South Asian countries are more affected by eye disease with age, this may be due to posterior disturbance or posture at work and vitamin A deficiency.[22]

The results of bivariate analysis showed that nutritional status has nothing to do with visual acuity because all the workers (100%) experienced decreased visual acuity, but 50% of respondents had a normal nutritional status.

The results of this study contradict the study by Yamaji,[23] that indicates a relation between nutritional status and visual acuity. Workers with a BMI of 71.4 kg had visual acuity above 0.8, and workers with a BMI under 71.4 had lower vision acuity. In line with the Yamaji study, Chasan's,[24] study delivered data that the nutrients lutein, carotenoids, and vitamin A could reduce the risk of cataracts in women in the United States by 22%.

According to a study by Berson,[25] supplementation of vitamin A in the past four years can slow the course of diseases associated with eye disorders. In another study, Berson found that the addition of docosahexaenoix acid 1200 gram/day will slow the course of eye disease for two years.

As seen in Table 6, a linear regression equation for visual acuity was obtained with the following formula: visual acuity = −2.388 + (−0.222) × working period + 0.035 × lighting + (−0.005) × fatigue. This means that any one year increase in working life can decrease the visual acuity value by 0.229 times; any increase of one lux lighting can increase visual acuity by 0.035 times; and any increase of 1 mL/sec of fatigue can decrease visual acuity by 0.005 times.

Conclusion

The factors affecting wig makers' visual acuity are working period, lighting, and fatigue. Any one year increase in working life can decrease the visual acuity value by 0.229 times. Any increase of one lux lighting can increase visual acuity by 0.035 times. Any increase of 1 mL/sec of fatigue can decrease visual acuity by 0.005 times. The factors that do not affect the visual acuity of wig makers are age and nutritional status.

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