Relationship between Age, Body Mass Index, Length of Work with Superoxide Dismutase in Roof Tile Manufacturing Workers

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Abstract. Physical activity causes an increase in oxygen consumption, increasing free radicals. As such, cellular conditions occur due to physiological imbalances between antioxidant levels and oxidants (free radicals or reactive oxygen species). The study aimed to explore factors influencing workers' SOD (superoxide dismutase) levels and analyze the relationship between age, length of work, and BMI with SOD levels. The study used a cross-sectional approach with 150 workers based on predetermined inclusion and exclusion criteria. The study variables were age, BMI, length of work, and SOD. Non-parametric statistical tests using Spearman rank correlation analyzed the correlation between independent and specific variables. SOD levels in critical workers are influenced by several related factors, namely age, length of work, and BMI. The study results showed a relationship between age, BMI, and length of work with SOD levels ($p < 0.05$). Older age, long work periods, and a high BMI correlated with reduced SOD levels.

Keywords: Antioxidant, SOD, Workers.

1 Introduction

Physical activity causes an increase in oxygen consumption while working, which increases free radicals [1]. Oxidative stress induces uncontrolled lipid peroxidation that causes cell injury through DNA damage (deoxyribonucleic acid) that directly inhibits proteins [2, 3]. The impact of oxidative stress results in several mental disorders, such as atherosclerosis, diabetes, cancer, neurodegenerative disorders, cardiovascular

disorders, and other chronic conditions [4]. Excessive production of free radicals can harm the endogenous antioxidant system, associated with increased oxidative stress [5]. Cellular conditions occur due to physiological imbalances between antioxidant and oxidant levels (free radicals or reactive oxygen species) [6]. Antioxidants, when oxidative stress decreases. SOD (Superoxide Dismutase) is an enzymatic antioxidant that acts as an intracellular defense system limiting ROS (Reactive Oxygen Species) and other enzymes [7]. SOD is the cells' first detoxification enzyme and the most potent antioxidant [6]. Therefore, enzymes are indispensable for cell health, protecting the body's cells from excess oxygen radicals, free radicals, and other harmful agents that promote aging or cell death. Some factors that can cause a decrease in SOD are individual characteristics, occupational factors, and work environment factors.

Tile-making workers is a job that involves physical activity. Several factors are thought to affect workers' SOD levels. The type of work carried out is the first process of workers taking and processing clay using a clay processing machine. The clay processing process is where the soil is mixed with water to make it easy to print. The second process is pressing or printing clay until it forms a tile. The printed tile is dried until it hardens, and then the third process is the tile burning process. The process of burning is the process that takes the most time. Ripe or hardened tile is ready for circulation. The absence of machines that help the production process results in workers potentially experiencing work fatigue. Therefore, we evaluate tile manufacturing workers who perform work activities. This study aimed to analyze whether SOD levels were influenced by age, length of work, and BMI.

2   Methods

This study is observational to describe the relationship between the independent and dependent variables, as evidenced by hypothesis testing and interpretation. The approach used is cross-sectional; observation and measurement are carried out simultaneously at one time. The respondents in this study were tile manufacturing workers in Karangasem Village, Wirosari District, Grobogan Regency, Indonesia. The sampling technique in this study used inclusion and exclusion criteria. Inclusion Criteria: The subject is willing to become a respondent by filling out informed consent, the subject is able-bodied (doctor's certificate), and the subject is a precarious manufacturing worker. Exclusion criteria: subjects were unwilling to be respondents, resigned while the study was ongoing, and stopped working in the tile-making industry. The total respondents were 150 respondents.

The independent variables in this study were age, BMI, and length of work. The dependent variable in the study was superoxide dismutase (SOD). Meanwhile, the variables of sex, exercise habits, and smoking habits will be interpreted descriptively. The instruments used were interview questionnaires for variables of age, gender, length of work, exercise habits, and smoking habits. BMI (body mass index) data is obtained by measuring body weight using scales and height using microtome. SOD is tested laboratory using workers' blood samples and then examined by the ELISA method. Spearman rank correlation analysis was used to determine the relationship between the

independent and dependent variables for the bivariate test. The ethical feasibility of this study was obtained from the Health Research Ethics Committee of the Faculty of Public Health Unimus (No.537/KEPKFKM/UNIMUS/2021).

3   Results

3.1   Univariate Results

In Table 1, the working time variable values distribution shows a maximum of 10 working hours. This means that workers who work for 10 hours risk experiencing a decrease in SOD levels. In addition, the age of workers has a maximum value of 63 years, which indicates that age is at risk of decreasing SOD. BMI measurement in research subjects showed a maximum result of 29.7 (kg/cm). SOD levels show a maximum amount of 13.8.

Table 1. Univariate analysis distribution of numerical research variables.

Variable	Minimal	Maximum	Mean	Standard deviation
Length of work	6	10	7.88	1.204
Age	14	63	37.76	12.455
BMI (kg/cm)	17	29.7	24.123	3.0637
SOD Level	11.1	13.8	12.575	0.6361

Table 2. Univariate analysis distribution.

Variable	Category	Frequency	Percentage (%)
Gender	Woman	58	38.7
	Man	92	61.3
Sports Habits	Often	16	10.7
	Infrequently	134	89.3
Smoking Habits	Smoke	76	50.7
	No Smoking	74	49.3

Based on the results in Table 2, the frequency distribution of sex in the study subjects was male primarily, 61.3%. The majority of study subjects rarely exercised 89.3%. As many as 50.7% of the study subjects had smoking habits.

3.2   Bivariate Results

Based on Table 3. the normality test with the Kolmogorov-Smirnov one-sample test found that all variables, namely length of work, age, BMI, and SOD levels were abnormal (P value = 0.000). So, the relationship test used for this study used rho spearmans.

    The relationship test results explain a relationship between the variable length of work and SOD levels with a P-Value value of 0.000. Subjects who work more than 8

hours will be at risk of decreasing SOD levels; this is evidenced by the results of the correlation coefficient test, which obtained a value of $r = -0.340$ (Table 4), so that it has a fragile relationship; the value shows the results of negative data distribution.

Table 3. Normality test.

Variable	P value
Length of Work	0.000
Age	0.000
BMI Leve	0.000
SOD Level	0.000

Table 4. Test the relationship of each variable.

Variable	SOD level	
	P value	Correlation coefficient (R)
Length of Work	0.000	- 0.340**
Age	0.000	- 0.801**
BMI	0.003	- 0.241**

** Significant correlation at the level of 0.01 (2-tailed).

The correlation coefficient between age variables and SOD levels obtained a value of $r = -0.801$, so it has a significant relationship shown by the distribution of data that has a negative value, meaning that SOD levels at a young age are higher than in old age. The results of the relationship test analysis have a P-Value value of 0.000, meaning that there is a relationship between age and SOD levels. Furthermore, the correlation coefficient results between the BMI variable and SOD levels obtained a value of $r = -0.241$ can be concluded that the variable has a weak relationship. This is indicated by the distribution of data that has a negative value. This means that if the study subjects have an overweight BMI, they are more at risk of experiencing a decrease in SOD levels compared to subjects who have a normal BMI.

4   Discussion

The tests conducted showed that there was a relationship between age and SOD levels of tile manufacturing workers. This aligns with the theory that SOD levels decrease with age while the formation of free radicals increases [6]. Research conducted on children explains that SOD levels are high [5]. Previous research explains that SOD levels are positively associated with age, with an average age of 83 -90 [8]. A previous study explained that there is an age relationship between SOD and GPx in the Turkish population [9]. Compared to free radicals, low antioxidants create oxidative stress that causes various diseases. The interaction between a trio of antioxidants, free radicals, and disease is vital in maintaining health, aging, and age-related diseases [10]. It has been suggested that proper daily SOD supplementation will protect the immune system, significantly reduce a person's chances of developing disease, and ultimately

slow the aging process [6]. In addition, efforts to reduce exposure to free radicals and increase the intake of antioxidant-rich foods or antioxidant supplements will increase the body's potential to minimize the health risks associated with free radical problems [11].

Research proves a significant relationship ($p = 0.000$) where people with high BMI (overweight), then SOD decreases. The results of this study are by previous studies, namely, the SOD of a person with normal nutritional status is higher than that of an overweight with significant results ($p = < 0.001$) [12]. Another study found that obesity in young adults experienced lower SOD activity than in young adults with normal nutrition [13]. Other data available in the literature on the relationship of SOD to nutritional status that have been published provide conclusions similar to this study. According to the results of their study, SOD activity is negatively correlated with BMI [14]. Obesity is a degenerative disease caused by oxidative stress (imbalance of free radicals with the amount of antioxidants in the body). Superoxide dismutase (SOD) is one of the secondary antioxidant enzymes produced by the human body (endogenous antioxidants) as an antidote to free radicals or stop the formation of free radicals [15, 16].

Processing of fried foods in the form of flour is a food that contains fat oxidation, fat oxidation products that enter the body will be in lipoproteins in the blood, so that too much will cause oxidative damage [17]. As long as there is no continuous increase in free radicals and decreased antioxidant activity, it will not cause disturbances in the balance of oxidation-reduction reactions (redox) or oxidative stress because oxidative stress can cause damage to fats, proteins, DNA, and other cell components, resulting in health problems [18, 19]. The activity of antioxidant enzymes must be balanced to prevent cells from oxidative damage [20]. SOD is one of the secondary antioxidant enzymes produced by the human body (endogenous antioxidants) as an antidote to free radicals or stop the formation of these free radicals. Exposure to free radicals that is too high or increased and too long results in decreased SOD activity, as biomolecules can be damaged [16].

There is a significant correlation (P Value 0.000) between the length of work and SOD levels in precarious workers. This study shows that the longer a worker's working hours, the higher the likelihood of decreased SOD levels. Prolonged work can result in sustained exposure to potentially damaging factors or reduce SOD levels in the worker's body [21]. Inflammation and immune system changes are associated with altered mood and decreased well-being, thus highlighting the need for better risk management in the workplace [22]. Therefore, it is important to strictly supervise working conditions and provide adequate protection for workers in the precarious manufacturing industry sector to prevent excessive reduction in SOD levels. This study aligns with research conducted on health workers, which states the relationship between the length of work and the decrease in SOD levels in the body [23].

5   Conclusions

SOD levels in critical workers are influenced by several related factors, namely age, length of work, and BMI. Older age, long work periods, and a high BMI correlate with reduced SOD levels. Therefore, it is necessary to make appropriate prevention and management efforts, such as improving the regulation of the work environment, reducing exposure to harmful factors, as well as encouraging a healthy diet, optimal weight management, and consuming supplementation containing high antioxidants to maintain healthy SOD levels in precarious manufacturing industry workers.

Acknowledgements

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