Journal of Epidemiology and Public Health (2025), 10(01): 9-19
Masters Program in Public Health, Universitas Sebelas Maret

Research

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Factors Associated with Dyslipidemia among Workers: A Path Analysis

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Received: 1 September 2024; Accepted: 10 November 2024; Available online: 16 January 2025

ABSTRACT

Background: The results of the 2023 Indonesian Health Survey show that 39.5% of the Indonesian population aged ≥ 15 years old have abnormal total cholesterol levels. Dyslipidemia or plasma lipid abnormalities play a major role in the pathogenesis of atherosclerosis on the walls of blood vessels which is the cause of coronary heart disease (CHD) and stroke. The purpose of the study was to analyze the factors that affect dyslipidemia in workers.
Subjects and Method: This study uses an analytical observational design using a cross-sectional approach. The study was conducted at the Yogyakarta Labkesmas Center in October 2024 with a total of 150 worker study subjects. The sampling technique is non-probability sampling, namely total sampling. The independent variables in this study were BMI, glucose levels, stress, and depression while the dependent variables were total cholesterol levels. Data collection was carried out using secondary data and questionnaires, the data was analyzed by path analysis.
Results: Each increase of one mg/dL of glucose level (b = 0.24; CI 95%= 0.09 to 0.39; p = 0.002) and one unit of depression (b = 0.16; CI 95%= 0.01 to 0.31; p= 0.043) will be followed by an increase in total cholesterol levels. Any increase in BMI through a mediator of glucose levels and stress through a mediator of depression will be followed by an increase in total cholesterol levels.
Conclusion: Total cholesterol levels increase with increased glucose levels and depression levels. Total cholesterol levels are indirectly affected by BMI through glucose level mediators and stress levels through depression mediators.

Keywords: Dyslipidemia, total cholesterol, body mass index, glucose levels, stress, depression

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Cite this as:
Indriani F, Sumardiyono, Murti B, Dermatoto A (2025). Factors Associated with Dyslipidemia among Workers: A Path Analysis. J Epidemiol Public Health. 10(1): 9-19. https://doi.org/10.26911/jepublichealth.2025.10.-05.02.

BACKGROUND

Non-communicable diseases (NCDs) are caused by a combination of various factors, both genetic, physiological, environmental, and behavioral. In 2016, NCDs were responsible for 72% of global deaths, or nearly four times as many deaths as deaths from communicable, maternal, perinatal, and nutritional problems. Based on data from the Global Health Observatory (GHO) from the

World Health Organization (WHO) shows that the prevalence of dyslipidemia in 2008 was 37% in the male population and 40% in the female population and is responsible for 2.6 million deaths and caused another 29.7 million people to experience helplessness every year (Perkeni, 2021).

In Indonesia, data taken from the results of the 2023 Indonesian Health Survey shows that 39.5% of the Indonesian population aged ≥ 15 years old have abnormal total cholesterol levels (based on NCEP ATP III, with cholesterol levels ≥ 200 mg/dl). This figure increased from the 2018 National Basic Health Research data of 28.8% of the Indonesian population aged ≥ 15 years with abnormal total cholesterol levels (Agency for Health Research and Development, 2018). Where women are more than men and the greatest prevalence is in the job category of civil servants/ TNI (Indonesian National Armed Forces) / Polri (Indonesian National Police) / BUMN (State-Owned Enterprises) / BUMD (Regional-Owned Enterprises) compared to other jobs. Data from the 2023 Indonesian Health Survey also shows that the proportion of the population with K-LDL levels is close to optimal (100 to 129 mg/dl) at 35.1%, borderline (130 to 159 mg/dl) at 19.9%, high (160 to 189 mg/dl) at 6.5% and very high (>190 mg/dl) at 2.0%. Low K-HDL levels of less than 40 mg/dl of 87.0%, this figure increased from the 2018 RISKESDAS figure of 24.3%. Trigiceramides were respectively obtained at borderline (150 to 199 mg/dl) of 17.8%, high (200 to 499 mg/dl) of 22.8% and very high (≥ 500 mg/dl) of 1.1% (BKPK Ministry of Health, 2023).

In certain populations, such as in patients with diabetes mellitus (DM), plasma lipid abnormalities are much higher. A report from The Jakarta Primary non-communicable Disease Risk Factors Surveillance 2006 found that the proportion of dyslipidemia in newly diagnosed type 2 DM patients reached 67.7% (total cholesterol), 54.9% (triglycerides), 36.8% (low K-HDL) and 91.7% (high K-LDL). On the other hand, data from the CEPHEUS Pan-Asian Survey in 2011 found that in Indonesia only 31.3% of dyslipidemia patients achieved the desired therapeutic target. Dyslipidemia or plasma lipid abnormalities play a major role in the pathogenesis of atherosclerosis on the walls of blood vessels which is the cause of coronary heart disease (CHD) and stroke. These two diseases are the main causes of death in the world, reaching 17.3 million out of 54 million total deaths per year (Perkeni, 2021).

In Indonesia, data from the 2023 Indonesian Health Survey shows that the prevalence of heart disease is 0.85%, the number increases as the age increases, where the highest group is those who work as civil servants/TNI/Polri/BUMN/BUMD. Of the total stroke sufferers in Indonesia, around 37.6% result in mild to total dependence (BKPK Ministry of Health, 2023). In addition, according to a study conducted by Sudaryanto et al. (2019) that high total cholesterol increases the risk of hypertension in women. Dyslipidemia has been identified as the main risk factor for CHD and stroke in addition to other risk factors, both traditional risk factors (diabetes mellitus, hypertension, obesity, physical inactivity, smoking, gender and age) and non-traditional risk factors, including: inflammation, oxidative stress, coagulation disorders, hyperhomocysteine (Perkeni, 2021).

Considering that worker health as part of public health needs attention and protection so that workers are healthy and productive to support national development and to provide protection for workers to be healthy, safe, and productive, it is necessary to carry out occupational health efforts which are part of occupational safety and health in an integrated, comprehensive, and sustainable manner. The Government of the Republic of Indonesia stipulates Government Regulation No. 88 of 2019 concerning Occupational Health which regulates Occupational Health Standards to prevent diseases, including one of which is health checks (Government of the Republic of Indonesia, 2019).

From the results of the health examination at the Yogyakarta Public Health Laboratory Center in 2023, the findings of laboratory examination that need attention are that some workers have dyslipidemia 77 people (72.6%), this figure is higher than the prevalence of dyslipidemia in Indonesia, which is 39.5%. A previous study by Sartika and Rahmawati (2020) entitled "Analysis of Risk Factors for Dyslipidemia in Male Employees of the Head Office of PT. X, Cakung, East Jakarta" found carbohydrate intake as the most dominant risk factor. Meanwhile, in a study conducted by Andriati et al., (2024) explained that there was no correlation between lifestyle and the incidence of dyslipidemia in employees of PP Production at PT. X Cilegon. Furthermore, a study by Elhaq and Ramdhan (2024) found that age, gender, disease history, alcohol consumption, smoking habits, physical activity, BMI, and blood pressure are not risk factors for dyslipidemia in employees of PT. X in Jakarta. Further studies need to be conducted by considering other factors to determine the cause of the occurrence of dyslipidemia.

Therefore, this study aims to find out the risk factors related to the incidence of dyslipidemia that need to be known so that appropriate prevention efforts can be made against the occurrence of dyslipidemia so that they can achieve a good degree of health and have high work productivity.

SUBJECTS AND METHOD

1. Study Design

The type of study used is observational analysis using a cross sectional design, namely by observing the population and sample at the same time.

2. Population and Sample

The population in this study is workers at BB Labkesmas Yogyakarta. The number of samples per variable is between 15 and 20 subjects. The sample calculation formula is (number of variables x 15 or number of samples x 20). The sample size in this study involves 5 variables so this study uses a minimum sample of 90-120 study samples for path analysis. The consideration of the sample will be more representative if the number of samples is increasing and to avoid dropping out, the researcher uses as many as 150 study subjects. Sampling technique with total sampling. Total sampling is a sampling technique that uses all members of the population as a sample. The inclusion criteria for the study are workers at BB Labkesmas Yogyakarta. Meanwhile, the exclusion criteria are workers at BB Labkesmas Yogyakarta who are undergoing external service/study assignments during the study.

3. Study Variables

The dependent variable in this study was total cholesterol levels, while the independent variables were body mass index (BMI), glucose levels, stress, and depression.

4. Operational Definition of Variables

Total cholesterol levels: The amount of total cholesterol in the blood, measured in milligrams per deciliter (mg/dL).

BMI: A measure used to assess a person's nutritional status, which is calculated by dividing body weight in kilograms by the square of height in meters (kg/m^2).

Glucose levels: The amount of glucose present in the blood, measured in mg/dL.

Stress: Assessment of a person's negative emotional symptoms to measure the presence and severity of stress symptoms.

Depression: Assessment of a person's negative emotional symptoms to measure the presence and severity of depressive symptoms.

5. Study Instrument

The data collection technique uses a questionnaire given to workers that contain questions that are answered by choosing the 0-3 option that suits the worker's feelings/ experiences. Recapitulating the results of the examination of total cholesterol levels, height, weight, and glucose levels from the medical check-up report. Data collection was carried out by researchers. The instrument used was a DASS questionnaire 42.

6. Data Analysis

The data was analyzed by multivariate analysis. The multivariate analysis used in this study is path analysis. Path analysis is a technique to analyze the influence of an independent variable on dependent variables whether they directly or indirectly affect them. This analysis was used to measure BMI, glucose levels, stress, and depression against cholesterol levels in workers.

7. Research Ethics

Study ethics include informed consent, anonymity, and confidence. The researcher has received a letter of ethical feasibility from the Health Study Ethics Commission of STRADA University Indonesia No. 001656/EC/KEPK/I/10/2024.

RESULTS

1. Sample Characteristics

The characteristics of the respondents were seen from several variables, namely gender variables, age, length of work, BMI, glucose levels, depression, stress and cholesterol levels. The results of the analysis are presented in Table 1.

Table 1. Characteristics of study respondents at the Yogyakarta Labkesmas Center (continuous data) (n= 150)

Characteristic	Mean	SD	Min.	Max.
Age	40.13	10.14	21	59
IMT	25.34	5.07	16.7	43.7
Glucose levels	103.04	25.04	66	347
Stress	4.83	5.94	0	29
Depression	3.53	4.60	0	24
Total cholesterol	199.65	37.86	115	298

Table 1 shows the results of the characteristics of respondents based on continuous data with a total of 150 subjects. The age of the employee showed the result (Mean = 40.13; SD= 10.14) with a minimum age of 21 years and a maximum age of 59 years. Based on the length of work with a total of 150 subjects, it shows the results (Mean = 8.81; SD= 8.86) with a minimum length of work of 1 year and a maximum length of service of 32 years. Body mass index showed results (Mean= 25.34; SD= 5.07) with a minimum score of 16.7 kg/m2 and a maximum score of 43.7 kg/m2. The variable of glucose content showed the result (Mean = 103.04; SD= 25.04) with a minimum score of 66 mg/dL and a maximum score of 347 mg/dL. Based on the stress variable, that of the 150 subjects studied, it was known that the results (Mean = 4.83; SD= 5.94) with a minimum score of 0 and a maximum score of 29. The depression variable showed the result (Mean = 3.53; SD= 4.60) with a minimum score of 0 and a maximum score of 24. Meanwhile, the cholesterol level variable showed results (Mean = 199.65; SD= 37.86) with a minimum score of 115 mg/dL and a maximum score of 298 mg/dL. The description of the characteristics of the respondents based on the dichotomy data is presented in Table 2.

Table 2. Characteristics of study respondents at BB Labkesmas Yogyakarta (dichotomous data)

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Woman	73	48.67
	Man	77	51.33
Age	< 46 years	97	64.67
	≥ 46 years	53	35.33
Working time	< 15 years	110	73.33
	≥ 15 years	40	26.67

Table 2 shows that of the 150 respondents studied, there were 73 subjects with a percentage (48.67%) in the female gender, while there were 77 subjects with a percentage (51.33%) in the male gender. Based on age, of the 150 subjects studied, there were 97 subjects with a percentage (64.67%) aged < 46 years and 53 subjects with a percentage (35.33%) aged ≥ 46 years. For the characteristics of working length, it shows that of the 150 study subjects studied, there are 110 subjects with a percentage (73.33%) having a working period of < 15 years, 40 subjects (26.67%) having a working period of ≥ 15 years.

2. Bivariate Analysis

Bivariate analysis was carried out to determine the influence of one exogenous variable with endogenous variables using a correlation test. This test is used to determine the effect of BMI, glucose levels, stress, and depression on cholesterol levels. The relationship is said to be significant if the p-value is less than 0.05. The relationship between risk factors and their impact is seen through the calculation of the Odd Ratio (OR) with a confidence level of 95% in the Confidence Interval (CI). The results of the analysis are presented in Table 3.

Table 3. Results of linear regression of BMI, glucose levels, stress, and depression on total cholesterol

Independent variables	OR	CI 95%		p
		Lower Limit	Upper Limit	
IMT	1.42	0.23	2.61	0.020
Glucose levels	0.29	0.18	0.46	0.001
Stress	1.09	0.08	2.18	0.035
Depression	1.62	0.31	2.93	0.016

Table 3 shows that there is a positive effect between body mass index and cholesterol levels and the relationship is statistically significant. Every increase of one kg of body weight/m2 of body mass index height will be followed by an increase in cholesterol levels by 1.42 mg/dL (OR= 1.42; CI 95%= 0.23 to 2.61; p= 0.020). With a confidence level of 95%, every increase of one kg of weight/m2 of height body mass index will be followed by an increase in cholesterol levels of 0.23 to 0.020.

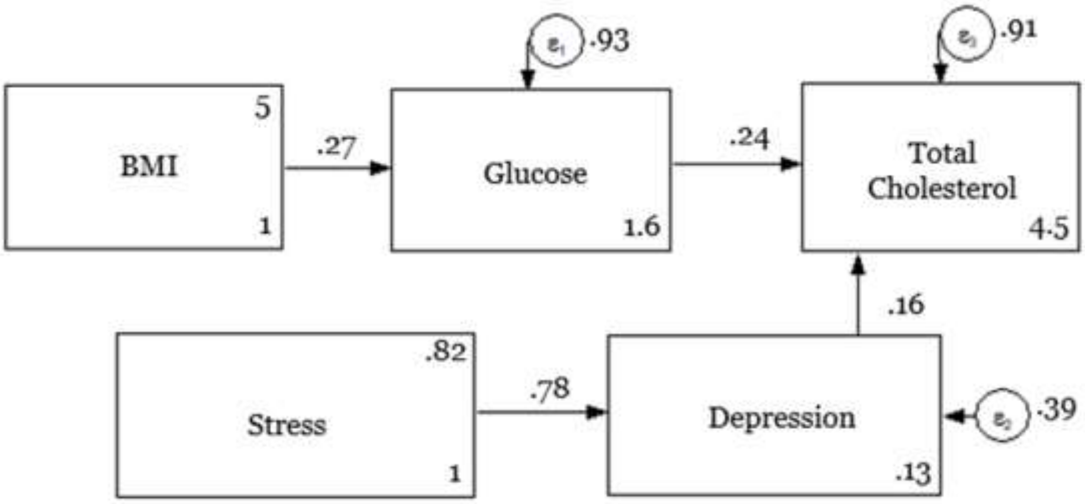
Based on the variable of glucose levels, it shows the results that glucose levels affect cholesterol levels. That there is a positive and statistically significant influence. Every increase in glucose levels by one mg/dL will be followed by an increase in cholesterol levels by 0.29 mg/dL (OR= 0.29; CI 95%= 0.18 to 2.18; p= 0.001). With a 95% confidence level, every increase in one mg/dL of glucose levels will be followed by an increase in cholesterol levels of 0.18 to 0.46.

Table 3 shows that there is a significant effect between stress and cholesterol levels with a value (OR= 1.09; CI 95%= 0.08 to 2.18; p= 0.035). Each increase in one unit of stress will be followed by an increase in cholesterol levels by 1.09 mg/dL. With a confidence level of 95%, every increase in one unit of stress will be followed by an increase in child development of 0.08 to 2.18.

Table 3 shows that there is a positive effect between depression and cholesterol levels and the relationship is statistically significant (OR= 1.62; CI 95%= 0.31 to 2.93; p= 0.016). Every increase in one unit of depression will be followed by an increase in cholesterol levels by 1.62 mg/dL. With a 95% confidence level, every increase in one unit of depression will be followed by an increase in cholesterol levels of 0.31 to 2.93.

3. Multivariate Analysis

The path analysis model made by the researcher based on theory is tested for compatibility with the best variable relationship model. The suitability of the model in this study is presented in Figure 1.



The compatibility of the model with the estimate can be seen from the results of the analysis of direct and indirect effects on total cholesterol levels. The results of the analysis are presented in Table 4.

a. Effect of glucose levels on total cholesterol levels

Table 4 shows that there is a direct effect of glucose levels on total cholesterol levels. Each increase in glucose levels by one mg/dL will be followed by an increase in total cholesterol levels by 0.24 mg/dL (b = 0.24; CI 95%= 0.09 to 0.39; p= 0.002).

b. Effect of depression on total cholesterol levels

Table 4 shows that there is a direct effect of depression on total cholesterol levels. Each increase in one unit of depression will be followed by an increase in total cholesterol levels by 0.16 mg/dL (b = 0.16; CI 95%= 0.01 to 0.31; p= 0.043).

c. Effect of BMI on glucose levels

Table 4 shows that there is a direct effect of BMI on glucose levels. Each increase of one kg of body weight/m2 of BMI height will be followed by an increase in glucose levels by 0.27 mg/dL (b = 0.27; CI 95%= 0.12 to 0.41; p< 0.001).

d. The effect of stress on depression

Table 4 shows that there is a direct effect of stress on depression. Each increase in one unit of stress will be followed by an increase in depression by 0.78 units (b = 0.78; CI 95%= 0.72 to 0.83; p< 0.001).

Table 5. Results of path analysis of factors affecting dyslipidemia

Dependent variables		Independent variables	b	CI 95%		p
				Lower Limit	Upper Limit	
Direct influence						
Total cholesterol	←	Blood glucose	0.24	0.09	0.39	0.002
	←	Depression	0.16	0.01	0.31	0.043
Indirect influence						
Blood glucose	←	BMI	0.27	0.12	0.41	<0.001
Depression	←	Stress	0.78	0.72	0.83	<0.001
N observations: 150						
Log-likelihood: 5.79						

After the estimation and equation are formed, a test is carried out goodness of fit test (model conformance test). As for the testing goodness of fit test based on Table 4. Based on the results of data processing and test acceptance criteria goodness of fit test A model based on an absolute fit measure that determines the degree of overall prediction (structural model of measurement) against the correlation and covariance matrices is good.

The results showed that the Chi Square is 0.33 so overall, the smaller the value Chi Square then the more suitable the model. Value Root Mean Square Error of Approximation (RMSEA) of 0.03 indicates RMSEA close fit because under 0.08 while based on the fit size Incremental i.e. comparing the proposed model with the base model (baseline model) also very good because of the value Comparative Fit Index (CFI) of 0.99 and Tucker Lewis Index (TLI) of 0.99, meaning greater than 0.90. So that overall the path analysis equation model used can be accepted.

DISCUSSION

The results of the study show that glucose levels have a direct effect on total cholesterol levels. Every increase in glucose levels by one mg/dL will be followed by an increase in cholesterol levels by 0.24 mg/dL. This is in line with a study conducted by Mahmoud et al. (2019) and Ali et al. (2023) that one of the risk factors for dyslipidemia is diabetes.

Hyperglycemia can stimulate the liver to produce more LDL cholesterol. This is because excessive sugar triggers various biochemical pathways leading to increased LDL synthesis by the liver. While HDL helps remove LDL from the bloodstream. However, high blood glucose levels can lower HDL levels, thereby increasing cardiovascular risk. Consuming large amounts of added sugar tends to lower HDL cholesterol levels. This is partly because the liver produces less HDL when faced with high sugar intake, thus contributing to poorer heart health (Wang et al., 2022).

In addition to LDL and HDL, triglyceride levels are also affected by blood glucose. Increased glucose can lead to an increase in triglycerides, which are a type of fat in the blood that contributes to the risk of heart disease if it is in high amounts. Excessive sugar consumption also leads to increased triglyceride levels. Because triglycerides play a role in cholesterol metabolism, high triglyceride levels combined with low HDL and high LDL can increase cardiovascular risk. Glucose inhibits enzymes involved in breaking down triglycerides, thus complicating lipid metabolism and contributing to an unhealthy cholesterol profile. Individuals with diabetes often experience dyslipidemia, which is characterized by an increase in total cholesterol and triglycerides in addition to a decrease in HDL levels. This lipid imbalance is linked to insulin resistance and poor glycemic control (Aumueller et al., 2021).

When blood glucose is high, the cells have difficulty absorbing glucose for energy due to insulin resistance. This causes the body to mobilize fat stores for energy, increasing the release of fatty acids into the bloodstream, which can increase cholesterol production. In addition, hyperglycemia can inhibit enzymes that help break down triglycerides, thereby worsening lipid imbalances. Managing blood glucose levels is essential for maintaining a healthy cholesterol profile and reducing cardiovascular risk. Strategies such as dietary modifications, limiting added sugars and refined carbohydrates, and regular physical activity can help control blood glucose and cholesterol levels effectively (Gugliucci, 2023).

The results of the study showed that depression had a direct effect on the increase in cholesterol levels. Each increase in one unit of depression will be followed by an increase in cholesterol levels by 0.16 mg/dL. Depression is often accompanied by chronic inflammation, which can interfere with lipid metabolism. An increase in inflammatory markers can lead to dyslipidemia which is characterized by an increase in LDL and triglycerides while lowering HDL levels. This inflammatory state can also affect the hypothalamic-pituitary-adrenal (HPA) axis, further complicating lipid regulation. Stress and depression activate the HPA axis, which leads to an increase in cortisol levels. This is in line with a study from Assadi et al. (2017) that psychological stress is a risk factor for dyslipidemia.

Cortisol can stimulate lipolysis (fat breakdown), increasing free fatty acids that can be converted into triglycerides and LDL cholesterol in the liver. This mechanism highlights how psychological stress can directly affect lipid profiles (Kim et al., 2019). People with depression often make unhealthy lifestyle choices such as poor diet, lack of physical activity, and substance abuse, which can worsen dyslipidemia. This behavior contributes to metabolic syndrome, which is characterized by increased triglyceride and LDL levels along with decreased HDL levels. The interaction between depression and lipid metabolism involves complex biological mechanisms including changes in cholesterol synthesis, inflammatory responses, stress-induced lipolysis, unhealthy lifestyle choices, and the impact of stress early in life. These factors contribute to dyslipidemia characterized by increased LDL and triglycerides as well as decreased HDL levels (Mehdi et al., 2024).

The results of the study showed that BMI had a direct influence on glucose levels. Every increase of one kg of body weight/ m2 of BMI height will be followed by an increase in glucose levels by 0.27 mg/dL. Higher BMI is associated with an increase in blood glucose levels. Studies have consistently shown that individuals with obesity or higher BMI categories tend to have higher levels of fasting blood glucose and post-prandial glucose. For example, one study found that patients with a higher BMI had significantly higher average plasma glucose levels compared to patients with a normal BMI, which showed a strong positive correlation between BMI and glucose levels (Patel et al., 2017).

Increased BMI is a major risk factor for insulin resistance, which can lead to increased glucose levels. Insulin resistance occurs when the body's cells become less responsive to insulin, resulting in reduced tissue glucose absorption and increased blood glucose levels. This mechanism is particularly relevant in individuals with Diabetes Mellitus Type 2 (T2DM), where obesity worsens the condition by further interfering with insulin action (Bonna et al., 2024).

In diabetic patients, there is an important correlation between BMI and fasting glucose levels. Studies show that when BMI increases from the normal category to the pre-obesity and obesity category, there is an increase in the average plasma glucose and saliva levels. This shows that regulating weight is very important for controlling glucose in diabetics (Hussain et al., 2019).

A higher BMI is generally associated with increased glucose levels due to mechanisms such as insulin resistance and metabolic dysregulation. This is in line with the results of a study from Radhina et al. (2023) that there is a relationship between BMI values and current blood glucose levels and total cholesterol. Managing weight through lifestyle changes can be an effective strategy to improve glycemic control and reduce the risk of diabetes-related complications. A study by Marlina et al (2020) also stated that the quality of life of people with type 2 diabetes increased in patients with a normal BMI.

The results of the study show that stress has a direct influence on depression. Each increase in one unit of stress will be followed by an increase in depression by 0.78 units. Studies consistently show that stressful life events are a strong predictor of depression. A systematic review highlights that acute and chronic stressors significantly increase the risk of developing major depressive disorder (MDD). Stressful experiences can trigger depressive episodes, especially in vulnerable populations. Individuals who experience high levels of stress are more likely to develop depressive symptoms. Psychological stress activates physiological responses, including the hypothalamic-pituitary-adrenal (HPA) axis, which can lead to neurobiological changes associated with depression (Yang et al., 2015).

Recent studies also explore the link between burnout—a syndrome caused by chronic stress at work—and depression. While some studies show a moderate correlation between the two, indicating that burnout has similarities with depression, other studies argue that the two are different phenomena with different mechanisms. However, both conditions can significantly interfere with a person's quality of life (Koutsimani et al., 2019).

AUTHOR CONTRIBUTION

Fenita Indriani as the main researcher who designed the study, searched for articles, and analyzed the data. Sumardiyono and Bhisma Murti as assistant researchers improved the article, providing input and consideration in writing the article.

ACKNOWLEDGMENT

The researcher would like to thank all parties who have contributed to the preparation of this article, as well as to the data-

base providers Google Scholar, Scopus, and ProQuest.

FUNDING AND SPONSORSHIP

This study is self-funded.

CONFLICT OF INTEREST

There was no conflict of interest in this study.

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