



AIR POLLUTION EXPOSURE DURATION AND ITS CORRELATION WITH TRIGLYCERIDE, HDL, AND ATHEROGENIC INDEX IN ONLINE MOTORCYCLE DRIVERS

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ABSTRACT

Introduction: Online motorcycle drivers have a high risk of being impacted by air pollution on the highway while working. Air pollution causes increased triglyceride levels and decreased HDL levels. Increased triglyceride level and decreased HDL level are risk factors for atherosclerosis which can be seen from the atherogenic index value. Online motorcycle drivers risk increasing triglyceride level, decreased HDL level, and increased atherogenic index value. This study assesses the correlation between air pollution exposure duration and triglyceride level, HDL, and atherogenic index in online motorcycle drivers. **Methods:** This research was an observational analytic study with a cross-sectional design. Research subjects were online motorcycle drivers (n=48) selected by purposive sampling. Air pollution exposure duration was measured as the average length of working hours in one week. The triglyceride and HDL levels were examined using a colorimetric assay, and the formula = $\log(\text{TG}/\text{HDL}-\text{C})$ was used to calculate the atherogenic index values. Data were analyzed statistically by Spearman, and the Pearson correlation test, with $p < 0.05$ is considered significant. **Results:** There was a weak positive relationship between air pollution exposure duration and triglyceride levels ($r=0.15$; $p=0.307$) and the atherogenic index ($r=0.0097$; $p=0.512$), but it was not statistically significant. The correlation test between air pollution exposure duration and HDL levels showed a negative relationship ($r=-0.79$; $p=0.594$), but it was not statistically significant. **Conclusion:** There is no correlation between air pollution exposure duration on increased triglyceride level, decreased HDL level, and increased atherogenic index.

Keywords: Air Pollution, triglyceride, HDL, atherogenic index

INTRODUCTION

Air pollution is the contamination or addition of a substance in the air that makes air quality poor when inhaled by people.¹ Air pollution comes mainly from motor vehicle exhaust which contains pollutants such as CO, SO₂, NO₂, HC, metal particles, and DEP (diesel exhaust particles), with the amount of CO gas and NO₂ gas dominating as the cause of air pollution.² Online-based transportation services have become popular in Indonesia because of the variety of services provided by the company, including services served by motorcycle drivers. Online motorcycle drivers have a high risk of being impacted by air pollution for a long time due to breathing polluted air on the highway while working.

Air pollution can cause abnormalities of one or all blood lipid profile levels, such as triglyceride, HDL cholesterol, total cholesterol, and LDL cholesterol, commonly referred to as dyslipidemia.³ Air pollutants such as PM, CO, NO₂, and O₃ will produce reactive oxygen species (ROS), which can cause cell or tissue damage through lipid peroxidation.⁴ Membranes cell damage cause a release of inflammatory cytokines such as

interleukin 6 (IL-6), C-reactive protein (CRP), tumor necrotic factor-alpha (TNF- α). Increased IL-6 suppresses the lipoprotein lipase (LPL) enzyme that causes an increase in triglyceride levels. Research conducted by Shanley RP shows that the longer duration and greater concentration of PM₁₀ exposure in the air are followed by an increase in triglyceride level and total cholesterol.⁵ Hypertriglycerides will increase the exchange of cholesterol esters and triglycerides through cholesteryl ester-transfer protein (CETP), which causes a decrease in HDL level and increases LDL cholesterol level.⁶ Research conducted by Li J, et al. showed that higher air pollution concentrations were associated with a decreased HDL level.⁷ Increased triglyceride level and a decrease in HDL level in the body due to air pollution cause a high atherogenic index value as a risk indicator for the formation of atherosclerosis. It follows Fan J's research, which stated a correlation between carbon components in PM_{2.5} and an increase in atherogenic index value (r total carbon=0.307).⁸

Dyslipidemia is a major risk factor for coronary heart disease through the formation of atherosclerosis.⁹ The risk of developing



atherosclerosis can be calculated from the atherogenic index value with a logarithm formula (triglyceride level/HDL level).¹⁰ Online motorcycle drivers have a high risk of being affected by exposure to air pollution, namely an increase in triglyceride level in the body, a decrease in HDL level, and an increase in the atherogenic index value, which can cause coronary heart disease. This research aims to prove a correlation between air pollution exposure duration and triglyceride level, HDL, and atherogenic index value in online motorcycle drivers.

METHODS

This study was an observational analytic study with a cross-sectional design conducted from July to August 2020. This research included online motorcycle drivers around Semarang City who had worked for at least two years, aged 20-40 years, male gender, body mass index between 18.5-24.9, no history of diabetes mellitus, not smoking, and not drinking alcohol by purposive sampling (n=48).

Air pollution exposure duration on online motorcycle drivers was measured as the average length of working hours in one week. Measurement of height and weight were examined before blood sampling. Height was measured by a stature meter, and a spring scale measured body weight. BMI was calculated by the formula of (body weight (kg) / body height (cm))². Triglyceride and HDL levels were obtained by blood samples fasting for 12 hours. Triglyceride levels were measured by the enzymatic colorimetric GPO-PAP (Glycerine Phosphate oxidase - peroxidase) method. The absorbance of the sample was measured using a spectrophotometer and compared with the absorbance of a standard solution to obtain triglyceride levels. HDL levels were measured by the enzymatic colorimetric CHOD-PAP (Cholesterol Oxidase Phenol 4-aminiantipyrine - peroxidase) method. The absorbance of the sample was measured using a spectrophotometer and compared with the absorbance of a standard solution to obtain HDL levels. And the formula = log (TG/HDL-C) was used to calculate the atherogenic index values.

Correlation between the air pollution exposure duration and triglyceride and HDL level analyzed by Spearman correlation test because the data were not normally distributed. The relationship between air pollution exposure duration and the

atherogenic index value was analyzed by Pearson correlation test because the data were normally distributed. The correlation test is significant if $p < 0.05$.

Ethical clearance was received from the Medical Research Ethics Commission of the Faculty of Medicine, Diponegoro University No. 178 / EC / KEPK / FK-UNDIP / VII / 2020. The identity of the research subject is kept secret, and the researcher fully funds all research costs. Research subjects have already signed informed consent after giving an oral explanation of the aims, benefits, and research procedures. Subjects have the right to resign if they do not wish to join the research.

RESULTS

This study involved 48 samples of online motorcycle drivers who met the inclusion and exclusion criteria. The characteristics of research subjects can be seen in Table 1. All subjects had a BMI in the range of 18.5-24.9, and the BMI average of the samples was 23.2 ± 2.04 . The average age of the research subjects was 32.27 ± 6.26 years, with the youngest was 21 years, and the oldest was 40 years. Research subjects have worked as online motorcycle drivers for at least two years with an average of 2.7 ± 0.86 years.

Table 1. Research Subjects Characteristics

Characteristics	Mean	Min	Max
Length of time work as an online motorcycle driver (years)	2.7 ± 0.86	2	5
Age (years)	32.27 ± 6.26	21	40
Bodyweight (kg)	65.4 ± 8.48	47	79
Body height (cm)	167.8 ± 0.05	158	180
BMI	23.2 ± 2.04	18.6	24.9

Data in Figure 1 showed that 28 online motorcycle drivers had normal triglyceride levels, eight subjects had borderline high triglyceride levels, ten subjects had high triglyceride levels, and two subjects had very high triglyceride levels. Twenty-one subjects had low HDL levels, 23 subjects had good/moderate HDL levels, and four had high HDL levels. Five subjects were in the low-risk category for coronary heart disease, two subjects were at moderate risk for coronary heart disease, and 41 people were at high risk for coronary heart disease.



Descriptive analysis and variable normality test can be seen in table 2. The study subjects' average exposure to air pollution was 63 ± 14.7 hours a week. The study subjects had an average of borderline high triglyceride levels normal HDL levels and had an increased risk of developing coronary heart disease.

The Shapiro-Wilk normality test for air pollution exposure duration and atherogenic index variables shows that the data were normally distributed ($P > 0.05$). The Shapiro-Wilk normality test for variable triglyceride levels and HDL levels showed that the data were not normally distributed ($P \leq 0.05$).

The correlation test between air pollution exposure duration and triglyceride levels and HDL levels was analyzed by the Spearman correlation test because data were not normally distributed. The Pearson correlation test between air pollution exposure duration and the atherogenic index variables was analyzed because the data were normally distributed.

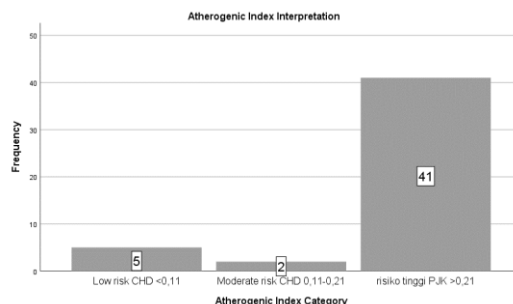


Figure 1. Characteristics of triglyceride levels, HDL levels, atherogenic index values of the study subjects

Table 2. Descriptive analysis and normality test

Variable	Mean	Min	Max	p*
Air pollution exposure duration (hours)	63 ± 14.7	40	91	0.36
Triglyceride level (mg/dl)	172.4 ± 127.9	44	729	< 0.001
HDL level (mg/dl)	44.3 ± 13.9	21	94	< 0.001
Atherogenic index value	0.52 ± 0.36	-0.33	1.34	0.77

* Shapiro-Wilk normality test

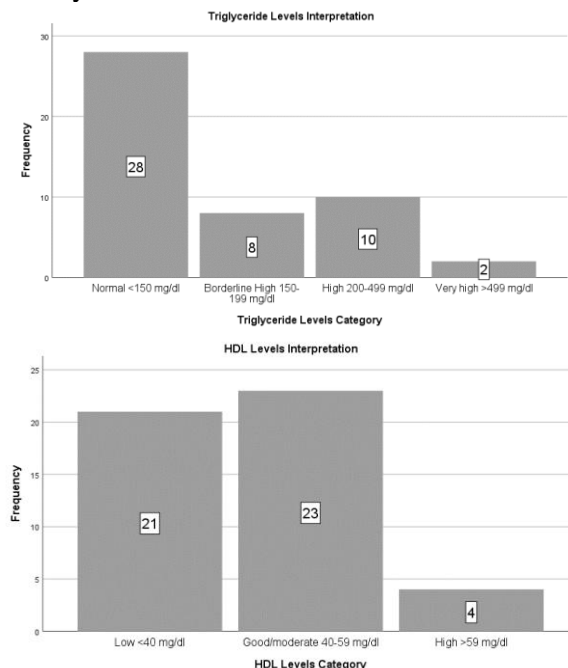


Table 3 showed no correlation between air pollution exposure duration and triglyceride levels in online motorcycle drivers ($r=0.151$; $p=0.307$). This means the hypothesis that there is a correlation between air pollution exposure duration and triglyceride levels is rejected.

There was no correlation between exposure to air pollution and HDL ($r=-0.079$; $p=0.594$). This means the hypothesis that there is a correlation between air pollution exposure duration and HDL levels is rejected.

There was no correlation between air pollution exposure duration and atherogenic index value ($r=0.097$; $p=0.512$). Based on this data, the hypothesis that there is a correlation between air pollution exposure duration and atherogenic index in motorcycle drivers is rejected.



Table 3. Correlative analysis between air pollution exposure duration and triglyceride level, HDL level, and atherogenic index value

Correlative Analysis	Coefficient Correlation	P.
Air pollution exposure duration - triglyceride level	0.151	0.307 *
Air pollution exposure duration - HDL level	-0.79	0.594 *
Air pollution exposure duration - atherogenic index value	0.097	0.512 **

*Spearman correlation test

**Pearson correlation test

DISCUSSION

This study showed that air pollution exposure duration has no correlation with an increase in triglyceride level, decreased HDL level, and increase in the atherogenic index value of online motorcycle drivers. This result did not match the hypothesis, which states a correlation between air pollution exposure duration and triglyceride level, HDL, and the atherogenic index value on online motorcycle drivers.

The content of air pollution such as PM, CO, NO₂, and O₃ that enter the human body through the respiratory tract can trigger the formation of reactive oxygen species (ROS).⁴ Continuous exposure to air pollution increases ROS levels in the body. If ROS level is not balanced by the level of antioxidants in the body will cause a state of oxidative stress. In oxidative stress conditions, ROS will cause cell damage through lipid peroxidation in cell membranes and produce the final product malondialdehyde (MDA).¹¹

Damaged cells will produce IL-6 cytokines, which inhibit the lipoprotein lipase (LPL) enzyme, which functions as hydrolyzing triglycerides to free fatty acids as an energy source that causes an increased triglyceride level in the body.^{4,12} Exposure to air pollution also increases inflammatory cytokines such as CXCL5, CCL2, IL-6, TNF- α , IL-6, and TNF- α , which cause an increase in blood glucose level due to the effect of insulin resistance.⁵ The liver will convert high blood sugar to fatty acids and then synthesize them into triglycerides. Hypertriglyceride increases the exchange of cholesterol esters and triglycerides between HDL

and LDL by cholesteryl ester-transferin-protein (CETP). This indirectly causes an increase in LDL cholesterol level and a decrease in HDL level.⁴ The atherogenic index value indicates atherosclerosis, which causes coronary heart disease. The atherogenic index was obtained by formula logarithm (Triglyceride level/HDL level), increased triglyceride level and decreased HDL level lead to high atherogenic index value.¹⁰

The results of this study did not show a significant correlation between air pollution exposure duration and an increase in triglyceride level, a decrease in HDL level, and an increase in the atherogenic index. This is inversely proportional to the results of previous research conducted by Wei et al. on rats about the correlation of chronic air pollution exposure to the risk of obesity and metabolic syndrome. Rats were divided into two groups, where the first group was in a container that was directly exposed to air pollution (PM_{2.5} = 64.6 \pm 72.7 $\mu\text{g} / \text{m}^3$). The other groups were in a container that had been given an air filter (PM_{2.5} = 16.7 \pm 9.6 $\mu\text{g} / \text{m}^3$), after 14 days, the group of mice exposed to air pollution without air filter showed a significant decrease in the antioxidant GSH, increased level of MDA, LDL level, and triglycerides. A high level of MDA indicates a process of lipid peroxidation due to ROS in the body caused by air pollution exposure (Wei et al., 2016). The research method by Wei et al. Had good variable controls, same diet for each sample, the same level of exposure to air pollution in one container, and the absence of exposure from other free radicals in one sample group. This research method produced homogeneous characteristics of the research sample.

Another study conducted by Shanley et al., Where the lipid profile of a sample of 11,623 compared to levels of exposure to PM₁₀ air pollution in each area of residence, showed that the higher and longer exposure to air pollution could affect an increase in triglyceride levels and total cholesterol.¹³

Research conducted by Li et al. by followed-up 73 healthy adults with four repeated study visits in 2014-2016 under traffic air pollution exposure showed that higher air pollution concentrations were associated with impairments in HDL functionality.⁷

Another study conducted by Holme et al., a case study of the relationship between PM and HDL



exposure, showed that exposure of fine particulate matter (PM_{2.5}) and Ultrafine particulate matter (PM_{0.1}) caused a decrease in HDL levels through oxidative processes.¹⁴

Research conducted by Fan et al., where the atherogenic index value of 112 samples compared to the total carbon, organic carbon, and elemental carbon components at PM_{2.5} showed that the three components of PM_{2.5} had a significant correlation the increase in atherogenic index value, total carbon. $r=0.307$, organic carbon $r=0.287$, elemental carbon $r=0.252$ (Fan et al., 2014).

In this research, there were several uncontrollable variables such as physical activity, different levels of air pollution exposure in online motorcycle drivers because they work in various locations, the use of personal protective equipment such as masks that can reduce levels of air pollution exposure to the body, and other exposure apart from air pollution. Physical activity such as regular exercise can increase the amount of antioxidants in the body to prevent oxidative stress conditions that cause the lipid peroxidation process.¹⁵ Exposure to other free radicals such as UV rays and cigarette smoke from online motorcycle coworkers can affect triglyceride and HDL levels in the body.¹⁶ Some of these reasons may cause this study's results to be inconsistent with the research conducted by Wei et al., Shanley et al., Li et al., and Fan et al.^{5,8,13}

The limitations in this study are research subjects of online motorcycle drivers who took part in the study was not completely homogeneous, where researchers could not control physical activity outside of online motorcycle jobs, the concentration of air pollution exposure on online motorcycle drivers, other free radical exposure apart from air pollution, and the use of personal protective equipment such as masks worn while working. In addition, the number of samples used was still relatively minimal when compared to previous studies. The variation in the characteristics of the online motorcycle drivers sample and a minimal number of samples can cause bias in the study results. The minimal number of samples and vary of samples characteristic can cause an insignificant correlation between air pollution exposure duration and increased triglyceride level, decreased HDL levels, and increased atherogenic index value.

CONCLUSION

There is no significant correlation between air pollution exposure duration on increased triglyceride level, decreased HDL level, and increased atherogenic index.

CONFLICTS OF INTEREST

The authors declare no conflict of interest in this research article.

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