



AIR POLLUTION EXPOSURE AND PHYSICAL EXHAUSTION IN RELATION TO GSH : GSSG RATIO OF ONLINE-BASED MOTORCYCLE DRIVERS

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ABSTRACT

Background: Online motorcycle drivers work more than 10 hours a day, surpassing the international working hour regulations. Working hours are proportionally correlated with air pollution exposure generating reactive oxygen species (ROS). On the other hand, physical exercise also contributes to the generation of ROS due to greater oxygen utilization by mitochondria. The ratio of GSH to GSSG represents the oxidative stress level in body tissues. **Objective:** This study aimed to analyze the relationship between the length of air pollution exposure and the level of physical exhaustion to GSH:GSSG ratio of online motorcycle drivers. **Methods:** This study was a cross-sectional study of 16 male online motorcycle drivers. The GSH:GSSG ratio was assessed by ELISA with cyclic DTNB reaction principle. Length of air pollution exposure and level of physical exhaustion data were obtained from the interview. Statistical analysis was done to determine the correlation between variables. **Results:** The mean GSH:GSSG ratio in studied population is 0.69 ± 0.26 , lower than 1 value of GSH:GSSG ratio represents high oxidative stress condition. Based on the correlation test, there are no correlation between length of air pollution exposure ($r = -0.464$, $p = 0.070$) and level of physical exhaustion ($r = -0.439$, $p = 0.089$) to GSH:GSSG ratio in online motorcycle drivers. **Conclusion:** Our findings suggested that online motorcycle drivers have a high level of oxidative stress, length of air pollution exposure, and status of physical exhaustion, which is not associated with the GSH:GSSG ratio.

Keywords: Oxidative stress, GSH:GSSG ratio, air pollution, physical exhaustion, online motorcycle driver

INTRODUCTION

Online-based transportation service has become popular in Indonesia. People have widely used this application because the provider offers various features, including motorcycle-taxi services, food delivery service, delivery courier, shopping courier, etc. Its perks on security, safety, availability, and cost determination¹. Each year, an online-based transportation company contributes 8.2 trillion rupiahs to the national economy. However, behind that impressive contribution, a study conducted in 2017 stated that online motorcycle drivers had not met decent work standards. The drivers tend to work more than 10 hours a day, surpassing the International Labour Organisation (ILO) regulation about working hours².

Around 87% of air pollutants originated from the transportation sector consist of NO₂ gases, formaldehyde, SO₂, ozone, and particulate matter (PM)³. The online-based motorcycle drivers' length of the working hour is directly proportional to the size of air pollution exposure. The latest literature suggests that ultrafine particles (UFP), < 0.1 μm in diameter PM, may have more significant potential to

induce oxidative stress and inflammation than larger particles. This is likely because UFP has a higher airway deposition efficiency than larger particles, generating higher particle number (P.N.) concentration and surface area. Also, higher concentrations of organic components induce oxidative stress responses. Long-term exposure to this particle may cause a higher risk of cancer development, atherosclerosis, and other respiratory problems⁴.

The previous toxicological study indicates that PM, including UFP, contains large polycyclic aromatic hydrocarbons (PAHs). The toxicity of PAH is related to their biotransformation into reactive metabolites, resulting in the generation of reactive oxygen species (ROS) capable of inducing lipid and protein oxidation and the depletion of endogenous antioxidants within an organism⁵.

In addition, physical exercise also contributes to the generation of ROS. The increasing energy demand following exercise generates a greater oxygen utilization by mitochondria. During muscle contraction, increased uncoupled transfer of electrons



in the electron transport chain leads to superoxide radical production, a primary member of ROS⁶.

Glutathione sulfhydryl (GSH) is a tripeptide (L- γ -glutamyl-L-cysteinyl- glycine) with multiple functions in living organisms. It acts as an antioxidant either directly by interacting with reactive oxygen/nitrogen species (ROS/RNS) or operating as a cofactor for various enzymes. GSH may be oxidized directly by oxidants, leading to the production of thiol radicals, resulting in GSSG formation. GSSG produced from the consumption of GSH can be either restored by the action of glutathione reductase (G.R.) or excreted from the cell. The concentration ratio of GSH and GSSG can be assessed as the GSH:GSSG ratio and represent the oxidative stress level in the tissue⁷.

This study aimed to analyze the relationship between the length of air pollution exposure and the level of physical exhaustion to GSH:GSSG ratio of online motorcycle drivers.

METHODS

This study used an observational cross-sectional design of 16 male online motorcycle drivers in Semarang City, Java, Indonesia. The inclusion criteria are male online motorcycle driver who has been working for at least two years, are 20-40 years old, non-smoker, and agree to be part of the study by signing the informed consent. Subjects with chronic diseases (cancer, cardiovascular diseases, diabetes mellitus, chronic infection, and degenerative diseases), acute infection, and long-term antioxidant supplements consumption were excluded from the study. Demographic data of the study population were recorded. The Faculty approved the study protocol of Medicine Diponegoro University Ethics Committee, and all participants were given written informed consents.

Length of air pollution exposure and physical exhaustion data were obtained from the interview with the studied population. Meanwhile, the GSH:GSSG ratio was measured by the cyclic reaction of DTNB using the colorimetric method (ELISA Total Glutathione / Oxidized Glutathione Assay Kit No. E-BC-K097).

A computer statistical software was used for the statistical analysis. In assessing the normality of all data, the Shapiro-Wilk test was employed. Then, Pearson's correlation coefficient and Spearman's rho correlation coefficient were performed to determine

the correlation between results. All statistical analyses were done in a 95% confidence interval.

RESULTS

The mean age and BMI of studied population were 30.90 (SD = 6.50) years and 23.10 (SD = 2.90) kg/m², respectively. The characteristics of the study population are shown in table 1.

Table 1. Characteristics of the study population

Variables	Mean \pm SD
n = 16	
Age (year)	30.90 \pm 6.50
Body weight (kg)	66 \pm 12.15
Body height (m)	168.60 \pm 5.80
BMI (kg/m ²)	23.10 \pm 2.90
Length of air pollution exposure (months)	28.50 \pm 9.42
Level of physical exhaustion (hours)	60.13 \pm 13.78
GSH:GSSG ratio	0.69 \pm 0.26

BMI: body mass index, GSH: glutathione sulfhydryl, GSSG: glutathione disulfide

The mean glutathione sulfhydryl: disulfide ratio in the studied population is 0.69 \pm 0.26. The GSH:GSSG ratio value < 1 represents a high oxidative stress condition. Length of air pollution exposure and level of physical exhaustion was not correlated to GSH:GSSG ratio (p > 0.05) (Table 2).

Table 2. Correlation between length of air pollution exposure, level of physical exhaustion, and GSH:GSSG ratio

Variables	BMD	
	r	p
Length of air pollution exposure	-0.464	0.070 *
Level of physical exhaustion	-0.439	0.089**

* Spearman's rho test with significance at the level of 0.05

** Pearson test with significance at the level of 0.05

DISCUSSION

Compared to former studies, which obtained a correlation between chronic exposure to traffic-related air pollution biomarkers of inflammation and oxidative stress in taxi drivers and the correlation between the intensity of physical activity and oxidative stress indicator, in the present study, it was found that the longer exposure to air pollution and the higher level of physical exhaustion, the lower



GSH:GSSG ratio will be, but alas through statistical analysis this correlation was shown to be not significant^{5,8}.

Normally, GSH:GSSG ratio in the tissue is preserved at a high level as a part of the body mechanism to minimize the accumulation of intracellular disulfide concentration that may give toxic effects to the tissue. When chronic oxidative stress attacks certain tissue, it would lead to buffer changes through decreasing GSH levels and increasing GSSG levels. Thus, GSH:GSSG ratio would decrease as well. This may explain why there was an inversely proportional correlation between length of air pollution exposure and level of physical exhaustion to GSH:GSSG ratio in this study.

In a normal cell, the GSH:GSSG ratio exceeds 100:1, while in oxidative stress conditions, this ratio has been demonstrated to decrease to values of 10:1 and even 1:1⁹. In this study, the mean GSH:GSSG ratio is 0.69 ± 0.26 , lower than one value of GSH:GSSG ratio represents high oxidative stress condition in online motorcycle driver.

Our findings, which showed no significant correlation between length of air pollution exposure, level of physical exhaustion, and GSH:GSSG ratio, maybe due to the variations of dietary intake, BMI, physical activities, and factors contributing to level of physical exhaustion of the studied population. The former study showed that exposure to particulate air pollution caused inflammation in adipose tissue and higher stress oxidative biomarkers in people with a high-fat diet^{10,11}.

Body mass index (BMI) could also become a major factor in the result of this study. A former study found a significant increase in glutathione reductase activity after physical exercise in young, sedentary, severely obese, not overweight, or normal-weight subjects⁶. In summary, the variation of BMI in this studied population may interfere with the result of this study.

Working hours are not the only factor contributing to physical exhaustion. Non-occupational physical activity, recess, workload, and psychological stress may also contribute to the level of physical exhaustion¹²⁻¹⁴.

In conclusion, online motorcycle drivers have a high level of oxidative stress. The higher length of air pollution exposure and level of physical exhaustion may be associated with a lower GSH:GSSG ratio. Our study provides additional

evidence for the association between length of air pollution exposure, level of physical exhaustion, and GSH:GSSG ratio in online motorcycle drivers, which could be a basis for future investigations.

CONCLUSION

Our findings suggested that online motorcycle drivers have a high level of oxidative stress, length of air pollution exposure, and status of physical exhaustion, which is not associated with the GSH:GSSG ratio in online motorcycle drivers.

ETHICAL APPROVAL

This research has been approved by *Komisi Etik Penelitian Kesehatan* (KEPK) Faculty of Medicine, Diponegoro University with etical clearance number as follow: No. 46 / EC / KEPK / FK-UNDIP / IV / 2020.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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