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Urban Air Pollution and Testosterone Plasma Level of Traffic Policemen in Jakarta

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Abstract

This study aims to investigate the concentration of traffic air pollution and the level of testosterone, fasting glucose, cortisol, and lipid profile among traffic police in Jakarta. Testosterone plasma and blood biochemicals in traffic police and the police officer were analyzed using ELISA kit. Air quality data from the Regional Environmental Agency (BPLHD) Jakarta 2012 were used for the characterization of exposure. The analysis used a t-test and linear regression test to show the relationship levels of pollutants exposure with the effects of reproductive dysfunction ($p<0.05$). The average plasma levels of testosterone in the traffic police 543.6 ± 170.5 mg/dL, which is higher than the police at the office 456.2 ± 133.2 mg/dL. The average plasma cholesterol levels of police at the office is 212.3 ± 42.0 mg/dL, which is higher than the traffic police 200.0 ± 40.2 mg/dL. On average fasting glucose levels police at the office is 90.0 ± 13.1 mg/dL, while traffic police 84.2 ± 5.9 mg/dL. The testosterone levels of traffic police are higher than the official police, and traffic police exposed to pollutants have lower fasting glucose levels than police officers in offices.

Inroductions

The main pollutants in an urban area that have been reported to cause health problems are particulate, hydrocarbon, sulfur, and nitrogen oxide (SOx and NOx). Many studies have reported the health effects of particulate exposure from vehicle emissions such as lung function disorder, asthma, chronic obstructive pulmonary disease (COPD), arteriosclerosis and stroke (Widziewicz et.al., 2018; Anderson, Thundiyil, & Stolbach, 2012; Kim, Kabir, & Kabir, 2015). Currently, particulate exposure is reported to be associated with an increased number of deaths due to respiratory distress and heart disease, which affects not only older age groups but also children (Shah et al., 2013; Zhou et.al., 2011).

The level of particulate emissions of size 10 µm will decrease with the advancing of vehicle engine technology with improved filtering filters and catalysts. However, particulate matter emission levels of diameter less than 2.5 µm (PM2.5), especially the ultrafine particulate (diameter less than 0.1 µm) are not decreased (Donaldson, et al., 2005). The filter will filter out solid particulate while the catalysts will remove organic compounds such as *polycyclic aromatic compounds* containing oxygen, nitrogen, and sulfur. Particulate emissions from motor vehicles are a significant source of urban air pollution (Cassee et.al., 2013). Then, the previous study showed that changes in the levels and suggested chemical stressors in urban pollutants such as lead (Pb), NO2, O_3, CO could alter plasma testosterone synthesis and secretion (Rosa et al., 2003).

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The effect of particulate exposure on reproductive function is rarely studied, very little information about it. Animal studies using Fischer 344 male rats exposed to particulate disrupted reproductive function characterized by a decrease in the number of daily sperm in line with increased levels of testosterone (Watanabe & Oonuki, 1999; Tsukue, et al., 2001). Our previous study through the Fischer 344 male rats test showed that nanometer-sized particulates derived from diesel engine effluents have led to impaired reproductive function of increased testosterone levels in the low exposure group (15.4 μg/m^3) and moderate (36.4 μg/m^3) compared with testosterone levels of the control group (Ramdhana et al., 2009; Ramdhan, 2014).

The body needs plasma testosterone at normal levels in regulating bone growth and puberty in men. The testosterone hormone is important for the development of the male fetus, puberty, and supports the production of sperm in men. The synthesis of testosterone is performed in Leydig cells where the adequacy of cholesterol supply as a raw material for cholesterol synthesis plays an important role. Therefore it is also worth investigating the effects of traffic pollutant exposure on cholesterol and insulin levels whereas in our other studies show that nanometer exposure to dust causes inhibition of lipid homeostasis in the liver and impaired insulin levels (Ito et al., 2011; Xu et al., 2011).

The increasing use of cars and motorcycles in large urban areas in Jakarta can cause severe air pollution (Badan Pusat Statistik Provinsi DKI Jakarta, 2015). Therefore, the citizens of Jakarta face the risk of major problems with the health effects of air pollution. Besides the community, others who are at higher risk of particulate and not particulate exposures from motor vehicles are road users and people who have a workplace on the traffic such as police, bajaj drivers, street vendors, pedestrian, and others. So this study carried out in four locations in Jakarta that described the conditions previously discussed. In this study, we suggested that traffic police were very vulnerable to traffic air pollution exposure. The study aims to evaluate whether air traffic pollution could affect testosterone plasma levels in the traffic police compared to the official police who relatively unexposed to air traffic pollution.

Method

This field study examines the effect of traffic air pollution on testosterone plasma levels in traffic police who are exposed to air pollution from traffics. Testosterone plasma levels in exposed police compared with testosterone plasma levels in unexposed police subjects, to prove the disruption of testosterone levels caused by air pollution exposure. Through statistical analysis will be obtained a correlation between air pollution exposure with testosterone plasma levels.

This study was conducted in Jakarta, and the subject of the study was the traffic police who were daily exposed to air pollution on the traffic. The number of samples from each traffic/exposed and office/unexposed group was 30 people, chosen by purposive sampling technique, then after being selected, blood samples were taken and as a comparison, then selected subjects that work indoors (office police), which are relatively unexposed to motor vehicles particulates. After taking blood samples, the number of samples became 53 people that divide into 27 exposed and 26 unexposed. There are blood samples that do not meet the criteria for blood analysis. To get a representative sample and fulfill the research requirement hence applied inclusion and exclusion criteria. Sample inclusion criteria are male sex, minimum one-year working experience, good nutritional status, no history of lung disease, no respiratory infection, and no diabetes mellitus.

Measurement of testosterone and cortisol plasma was done first by taking the blood of the subject in the morning from April – June 2012. The method of blood biochemical analysis or measurement was done by radioimmunoassay method using ELISA kit. Blood sugar taking was performed on a sample that had previously been sustained for 10 hours. Blood sampling was conducted at the time of fasting and 2 hours PP (postprandial) or 2 hours after a meal, the specimens were measured by the enzymatic method; glucose oxidase. Blood fat profiles (total cholesterol, LDL, HDL, and Triglyceride) will be measured using the Cobas Mira/Micro's Photometer by following the instruction.

This study has been reviewed by the Ethics Commission of Faculty of Public Health, Universitas Indonesia (No. 71/12).

This research used data collected by the Regional Environmental Agency (BPLHD) Jakarta to find out the concentration pattern of ambient air pollution in DKI Jakarta in 2012. The location is J1 (Bundaran Hotel Indonesia) representing the designation of roadside, J2 (Kelapa Gading) representing the commercial allocation, J3 (Jagakarsa) representing the designation of settlement, J4 (Lubang Buaya) representing the allotment of the mixture. BPLHD Jakarta Province has been monitoring the air quality at various points in the area of Jakarta. Monitoring is done by the instantaneous method and continuous method. Measurement of instantaneous/active manual method is an hourly or 24-hour measurements of air quality using manual equipment/ absorbent solution and using a pump to suck the air, that is high volume sampler equipment. Continuous/automatic method measurement is a continuous measurement of air quality, including 24 hours x 7 days nonstop data. The continuous measurement method usually uses direct reading equipment. The air pollution to be measured are PM10, SO2, CO2, and O3.

T-test was used to determine whether significant differences existed between the biochemical levels from the exposed and unexposed group. This research conducted a linear regression analysis to examine the association between testosterone levels and total cholesterol levels among the exposed group. The p-value < 0.05 was determined as the value of the significance test in the statistical analysis test.

Results and Discussion

Continuous measurement is carried out by BPLHD at four locations in Jakarta. In 2012, the average concentration of PM10 on the traffic represented by the Jakarta monitoring station ranged between 40 and 70 µg/Nm3 per 24 hours, as shown in table 1. The level of O3 was three times higher than Jakarta Air Quality Standards (2001).

The t-test result of biochemical blood measurement in table 2 shows that the mean testosterone plasma levels in the traffic police were 543.6 ± 170.5 mg/dL, higher significantly than the offiicial police, i.e., 456.2 ± 133.2 mg/dL. However, the level of office police cholesterol plasma, which is 212.3 ± 42.0 mg/dL, is not higher significantly than the traffic police, which is 200.0 ± 40.2 mg/dL. Similarly, the average office police fasting glucose level was 90.0 ± 13.1 mg/dL, higher significantly than the traffic police of 84.2 ± 5.9 mg/dL. Then, the mean office police cortisol serum was 10.3 ± 3.1 mg/dL, higher than the traffic police of 11.0 ± 3.0 mg/dL.

Because the cholesterol is the raw material of testosterone synthesis in Leydig Cells in the testes, then further analyzing a relationship testosterone plasma levels with total cholesterol. While in the exposed group, there was no significant relationship, as shown in figure 1(a). Figures 1(b) shows that there is a relationship between testosterone levels and blood cholesterol levels in the traffic police. The regression test result showed a negative comparison between plasma testosterone levels and total cholesterol levels in the police group

Table 1. Concentration Level of Pm_{10}, So2, Co, And O_3 In Jakarta

Location	**PM_{10}** (µg/m³)	**SO2 (µg/m³)**	**CO (µg/m³)**	**O_3 (µg/m³)**
Bundaran Hotel Indonesia	64.8 ± 17.5	41.3 ± 9.0	2.3 ± 0.3	113.8 ± 12.8
Kelapa Gading	77.7 ± 19.1	25.1 ±7.9	1.3 ± 0.1	143.6 ± 57.9
Jagakarsa	46.6 ± 15.1	7.9 ±4.7	1.0 ± 0.2	73.4 ± 21.7
Lubang Buaya	108.8 ± 40.3	10.5 ±5.6	1.3 ± 0.7	75.9 ± 22.6
All	74.5 ± 26.2	21.2 ±15.4	1.5 ± 0.6	101.7 ± 33.5
Standard	150	60	9	30

Source: Primary Data

Table 2. Blood Biochemical Levels of Office Police And Traffic Police

Variable	Office police (mean ± SD)	Traffic police (mean ± SD)
Subject (n)	26	27
Age (years old)	36.7 ± 7.8	34.3 ± 2.8
BMI	25.5 ± 3.1	25.6 ± 3.4
Fasting glucose(mg/dL)	90.0 ± 13.1	84.2 ± 5.9*
Cholesterol Total (mg/dL)	212.4 ± 42.0	200.0 ± 40.3
HDL (mg/dL)	41.7 ± 6.6	42.6 ± 5.8
LDL (mg/dL)	140.9 ± 37.4	140.6 ± 36.3
Apo-B (mg/dL)	108.8 ± 25.7	101.7 ± 23.7
Trigliserida (mg/dL)	185.1 ± 150.5	131.5 ± 60.8
Testosterone (ng/dL)	456.2 ± 133.2	543.6 ± 170.5*
Cortisol serum (μg/dL)	10.3 ± 3.1	11.0 ± 3.0

*P<0.05

Source: Primary Data

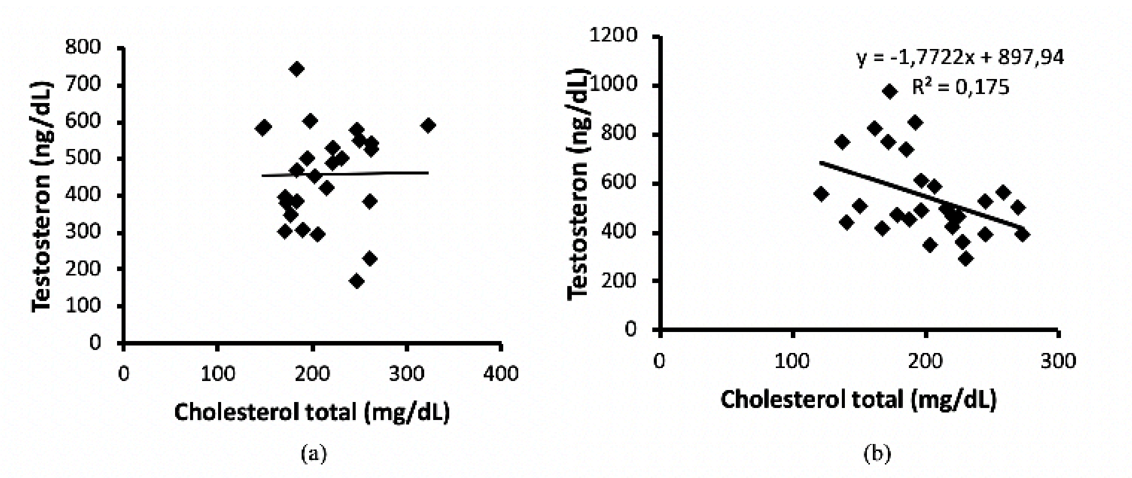

Figure 1. The Association of Testosterone Levels with Blood Cholesterol Levels in Office Police (a) and Traffic Police (b)

exposed.

This study shows the testosterone levels of traffic police is higher compared to the office police. Also, traffic police exposed to pollutants have lower fasting glucose levels compared to police officers in offices (not exposed to pollutants). The level of O_3 was three times higher than Jakarta Air Quality Standards (2001).

The average testosterone plasma level of traffic police (exposed to pollutants) is higher than official police (not exposed to pollutants). In regards to the testosterone plasma levels in the traffic police, the previous study showed changes in the levels and suggested chemical stressors in urban pollutants such as lead (Pb), NO2, O_3, CO could alter plasma testosterone synthesis and secretion (Rosa et al., 2003). Although the results are in contrast to the research conducted by Sancini *et al.* showing the testosterone levels of traffic police were lower than the control group, our previous study shows that exposure to the small concentration of vehicle exhaust particulate could increase the level of testosterone plasma levels (Sancini et al., 2011). Other than that, this study found that the concentration level of O_3 is quite high. The previous study has shown that O_3 is associated with low sperm counts, which means there is a disruption in testosterone levels, while sperm synthesis requires normal testosterone levels (Rengaraj et.al., 2014). Associated O_3 with low sperm counts can be explained by the existence of oxidative stress (OS) and reactive oxygen species (ROS). O_3 induced oxidative stress is associated with decreased reproduction in men and plays a key role in regulating some of the important molecular pathways for maintaining homeostasis at the cellular, tissue, organ, and system levels (Merhi et al., 2018). However, in the future, it should be investigated the mechanism of O_3 induce testosterone plasma.

Regression test results showed a negative comparison between plasma testosterone levels and total cholesterol levels in the police group exposed to air pollution, while in the exposed group, there was no significant relationship. Cholesterol is the raw material testosterone synthesis in Leydig Cells in the testes (Gao et al., 2018). The high levels of testosterone plasma and low total cholesterol in the exposed group showed an increase in testosterone synthesis. That is, cholesterol is widely used for testosterone synthesis. In our previous study show that the synthesis of testosterone increased due to the induction of acute steroid receptor (StAR) and *cytochrome* P450 1A (CYP1A) due to nanoparticle rich-diesel exhaust exposure (Ramdhana et al., 2009).

The body mass index between exposed police and not exposed police have varying values. Body mass index with obesity category for traffic police (exposed to pollutant) was higher than office police (not exposed to pollutants). Body mass index with *overweight* category was higher for office police (not exposed to pollutants) which is 12 people (40%) of 30 people compared to traffic police (exposed to pollutants) that is 9 (30%) of 30 people. From the above explanation, the group at risk of testosterone levels is traffic police (exposed to pollutants) because the number of obese in the traffic police (exposed to pollutants) is higher. These results explained in the study of obesity that can increase blood sugar levels (Bell, Kivimaki, & Hamer, 2014). With weight gain, the body becomes less sensitive to insulin. As a result, the pancreas will produce insulin in even more quantities. When the ability of the pancreas to produce insulin is weighed down by the level of insulin resistance, then the blood sugar will increase. Thus, obesity can reduce insulin receptors resulting in increased blood sugar (Jung & Choi, 2014; Makki et.al., 2013).

The age of the respondent explains the relationship with blood sugar levels. The older a person's age can increase the risk of rising blood sugar levels. In table 2, respondents aged ≥ 40 years, amounted to 33.7% of police who are not exposed to pollutants. The police exposed to pollutant respondents aged ≥40 years, amounted to only 6.7%. Diabetes mellitus type II appears at the age of ≥ 45 years because at age 45 years and above the body undergoes many changes, especially in the pancreas organ that produces insulin in the blood (Kautzky-Willer, Harreiter, & Pacini, 2016). People with type 2 diabetes mellitus is usually around > 60 years old because insulin resistance tends to increase at the age of 60 years, so the ability of organs began to decrease (Ärnlöv, Sundström, Ingelsson, & Lind, 2011). It should be further investigated whether air pollution exposure also affects the balance of glucose metabolism.

The average glucose content in the blood of exposed police officers on duty in the traffic is 91.63 mg / dL. Blood glucose values between 75 mg / dL to 100 mg / dL have a high enough frequency or there are 27 people who have blood glucose levels of 75 mg / dL up to 100 mg / dL. While the average blood glucose level of office police is 102.6 mg / dL. The number of respondents who have blood glucose levels between 0 mg / dL up to 100 mg / dL is 24 people. Research results showed that there is extreme data, where there is one policeman who served in the office has blood glucose levels in the range of 300 mg / dL up to 400 mg / dL.

Based on data already obtained, blood glucose levels of police officers in office (not exposed to pollutants) are higher than the traffic police who are on duty on the traffic (exposed to pollutants). The results of this study contradict the theory, the higher the pollutant exposure will be, the higher the effect on blood glucose levels. Because one of the policemen in office has blood glucose levels in the range of 300 mg/dL up to 400 mg/dL so that the average blood glucose level of police officers in office (not exposed) greater than the traffic police. This glucose content is also influenced by smoking history, body mass index, history of drinking coffee, and age (Song et al., 2016; Yin et al., 2015).

Conclusion

The testosterone levels of traffic police are higher compared to the official police and traffic police exposed to pollutants have lower fasting glucose levels compared to police officers in office (not exposed to pollutants). It should be further investigated whether air pollution exposure also affects the balance of glucose metabolism.

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