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<https://ejournal.upi.edu/index.php/penjas/article/view/6-1-04>DOI: <https://doi.org/10.17509/jpjo.v6i1.27621>**Aerobic Capacity Response and Hematological Profile during Performing Physical Activity at Two Public Sport Venues with Different Air Pollution Concentrations****Samsul Bahri<sup>1\*</sup>, Dadan Resmana<sup>1</sup>, Haryo Satriyo Tomo<sup>2</sup>, Imam Safei<sup>1</sup>, Muhamad Fahmi Hasan<sup>1</sup>**<sup>1</sup>Master of Sport Science, School of Pharmacy, ITB, West Java, Indonesia<sup>2</sup>Environmental Engineering, Faculty of Civil and Environmental Engineering, ITB, West Java, Indonesia**Article Info***Article History :**Received August 2020**Revised December 2020**Accepted January 2021**Available online April 2021**Keywords :**aerobic capacity, air pollution, hematology***Abstract**

The aim of this study was to evaluate the effect of exercise on aerobic capacity and hematological profile of amateur futsal athletes at two public sport venues having the same climatic characteristics with different air pollution concentrations. The method used in this study was a quasi-experimental method with a post-test only crossover design approach. Subjects of the study were 15 futsal athletes from futsal clubs in Bandung city. The mean (SD) of age, weight, height, and BMI of the participants were  $18.73 \pm 1.7$  years,  $55.29 \pm 3.0$  Kg,  $165.90 \pm 2.6$  cm, and  $19.90 \pm 0.8$  Kg/m<sup>2</sup>. The results of this study indicated that a high amount of air pollution could significantly inhibit the increase of VO<sub>2</sub>max ( $p = 0.043$ ) and hemoglobin ( $p = 0.023$ ) and could significantly increase white blood cells ( $p = 0.042$  leukocytes). The findings of this study provide an evidence that air pollution can have a negative effect on the hematological profile of futsal athletes. Thus, the athlete and coach should consider the level of air pollution around the venue before doing the exercise. It should be anticipated because, basically, exercising can increase the rate of air ventilation in the respiratory system so that it can cause air pollution, such as PM<sub>2.5</sub> and PM<sub>10</sub>, entering the lungs and even the alveoli.

## INTRODUCTION

Air pollution, in major cities of the world, is increasing every year and becomes a serious health problem for the people living in the city. There is a scientific evidence regarding the harmful effects of air pollution on human health in the short term and the long term (Masih et al., 2020; Pope et al., 2004). Numerous epidemiological studies reveal the adverse effects of air pollution on cardiovascular health and fitness (Brook et al., 2015; Das & Chatterjee, 2015; Oliveira et al., 2006). Particular groups of people and ages are vulnerable to air pollution, which increases the mortality and morbidity of these vulnerable groups (Lee et al., 2012).

Physical activity or regular exercise results in important physical and mental health benefits and improves the quality of life associated with health and reduced risk of morbidity and mortality (Saunders, Shukla, Uk, & Igel, 2016; Thompson Coon et al., 2011; Volianitis & Secher, 2016). However, performing physical activity in a high air pollution condition becomes an unhealthy combination. The athletes competed in open areas, such as athletics, marathons, and football athletes, are one of the vulnerable groups because they have the potential to breathe in air pollution from the environment around the training or competition area. The increase of the amount of airflow entering the respiratory system of the athletes during training or competing puts them at a high risk of inhaling air pollution (Giles & Koehle, 2014).

One of the substances that play a role as a cause of pollution is a particulate. Particulates are all substances, except air, in the liquid or solid phase that present in the atmosphere under normal conditions with a microscopic or semi microscopic size, but larger than the molecular dimensions (Lestari, 2003). PM<sub>2.5</sub> is another name for particulates with a size smaller than 2.5 µm or commonly called fine particles. Previous studies have concluded that a high PM<sub>2.5</sub> concentration has an impact on the decreased performance of athletes when training or competing (Das & Chatterjee, 2015; Kargarfard, Poursafa, Rezanejad, & Mousavinasab, 2011). It is important to consider that a high air pollution concentration can have a negative impact on the health of human body. Researchers had not found any studies discussing the effect of physical activity on the number of different pollutants in two different places.

Considering the negative effect of air pollution on

an athlete's performance, this study was designed to determine the differences of aerobic capacity and hematological parameters after exercising in two places with different pollutant concentrations. It is important because some sport centers, which are usually used as training or championship sites, are located near the roads exposed to a high air pollution, while some other sport centers are located far from the road.

## METHODS

### Participant

This research consisted of 15 amateur futsal athletes from a futsal club in Bandung. The inclusion criteria were healthy, did not have cardiovascular disease and asthma, did not smoking, and participated in physical exercise sessions. All research subjects received an explanation, orally and written, regarding the objectives, procedures, and risks of the research. Research subjects were directed to fill out informed consents when they decided to participate in this study. The research protocol was approved by the Research Ethics Commission of the Ministry of Health POLTEKES Bandung.

### Design

The method used in this study was a quasi experimental method with a posttest-only crossover design approach. The subjects were only tested once without providing any treatment/intervention. All subjects had to complete a test in a low-polluted area. After a 7-day of rest, participants retook the test in a high-polluted environment. Two places with the same climate condition (temperature and humidity) with different amounts of air pollution were selected, including UPI Bandung stadium, as the low-polluted environment, and SARA-GA ITB, as the high-polluted environment.

### Procedures

Two sport venues that are generally used by the public, namely SARAGA ITB and UPI Bandung Stadium, were chosen for this study. Researchers used Weather Stations and Laser Eggs which were stored at a 2-meter altitude above the ground at each area to measure the amount of air pollution. It was aimed to find out data of the concentration of PM<sub>2.5</sub>, CO<sub>2</sub>, humidity, and temperature when the research was conducted. The data read by the sensors on the device

could be seen directly through the Breathing Space application connected to the device.

The subject's weight and height were measured by a calibrated stadiometer, while the body mass index was calculated as weight (kg) divided by square meters (m<sup>2</sup>). For fitness assessment, the Cooper test was used. The test consisted of running for 2.4 km as fast as possible. Besides age and gender, the results were assessed based on the length of time taken by the subject. The results were correlated with VO<sub>2</sub>max. Participants were asked not to do any physical activity for 24 hours before the test and were required to rest at an inn near the public sport venues. After a 7 day interval, the test was repeated in another region with the same protocol. During the test at both sites, the subjects used a polar heart rate H-7 device attached to the chest to record the distance, heart rate, and energy expenditure. Immediately after the tests were carried out at both sites, 15 cm<sup>3</sup> of venous blood was taken from the antecubital vein. The blood was allowed to freeze at room temperature before being centrifuged. The serum was then stored in the freezer at -85 ° C for analysis. The hematological parameter was measured at the Brawijaya clinic in Bandung City.

### Data Analysis

It's used the one-way ANOVA test to compare the mean values of the variables of the two studied areas. Statistical analysis used the SPSS version 23 application with a significance level of  $p < 0.05$ .

## RESULT

The mean (SD) of age, weight, height, and BMI of the participants were  $18.73 \pm 1.7$  years,  $55.29 \pm 3.0$  Kg,  $165.90 \pm 2.6$  cm, and  $19.90 \pm 0.8$  Kg/m<sup>2</sup>. The environmental characteristics of the two study areas are presented in Table 1.

Table 2 shows the comparison of the pollutant number variable in two venues (ITB and UPI). The results of the data in Table 1 show that the amount of air pollution in both places had exceeded the threshold.

The measurement results of the Laser Egg Origins tool showed that the PM<sub>2.5</sub> concentration, when the research subjects exercised at 17.00 at UPI public sport venue, was 68.86 µg/m<sup>3</sup>. Meanwhile, at ITB public sport venue at the same hour in the following week, the

PM<sub>2.5</sub> concentration was 109.72 µg / m<sup>3</sup>. The results showed that the ITB public sport venue had a higher PM<sub>2.5</sub> concentration than the UPI public sports venue.

**Table 1.** Anthropometry Data

| Variable                 | Experiment ( N= 15 ) |        |        |
|--------------------------|----------------------|--------|--------|
|                          | Mean (SD)            | Min    | Max    |
| Age (Year)               | 18.73 ± 1.7          | 16.00  | 21.00  |
| Weight (kg)              | 55.29 ± 3.0          | 52.10  | 63.30  |
| Height (cm)              | 165.90 ± 2.6         | 162.00 | 172.00 |
| BMI (kg/m <sup>2</sup> ) | 19.90 ± 0.8          | 19.00  | 21.60  |

**Table 2.** Air Pollution Concentration Differences of The Two Research Venues

| Pollutant                              | ITB    | UPI   | Quality Standards |
|--|--------|-------|-------------------|
| PM <sub>2.5</sub> (µg/m <sup>3</sup> ) | 109.72 | 68.86 | < 65              |
| CO <sub>2</sub> (ppm)                  | 496.2  | 472.2 | < 150             |
| Temperature (°C)                       | 22.32  | 22.67 | 22.8 – 25.8       |
| Humidity (%)                           | 70     | 69    | 45 - 65           |

PM<sub>2.5</sub>: Particulate Matter 2.5 (particulate with diameter <2.5)  
CO<sub>2</sub>: Carbon Dioxide.

**Table 3.** Air Pollution Concentration Differences at The Two Research Sites

| Variable                               | ITB        | UPI        | P-value |
|--|------------|------------|---------|
| VO <sub>2</sub> max (mL/kg/min)        | 51,83±1,45 | 52,41±1,47 | 0.043*  |
| Hemoglobin (gr/dl)                     | 14,69±1,02 | 15.14±1.28 | 0.023*  |
| White blood cell (10 <sup>3</sup> /µl) | 10,50±1,95 | 8,48±1,88  | 0.042*  |

The high concentration of PM<sub>2.5</sub> at ITB public sport venue was due to the increased activity of motor vehicles on the Siliwangi and Tamansari streets that surround ITB public sport venue. Meanwhile, UPI public sport venue, which was far from the main road, had a lower PM<sub>2.5</sub> concentration. The measurement results of the PM<sub>2.5</sub> concentration device installed at the two sites were not much different from previous studies which stated that PM<sub>2.5</sub> concentrations at sport areas close to roads tended to be high, while the highest PM<sub>2.5</sub> concentrations in public sport areas occurred at night (Bahri, Resmana, Tomo, & Karim1, 2017; Les-tari, 2003; Vecchi, Marcazzan, & Valli, 2007).

Table 3 shows that there is a significant decrease of mean of VO<sub>2</sub> max and Hb. Meanwhile, a significant increase of white blood cell mean was higher at the high-polluted site than the lower-polluted site.

## DISCUSSION

Our research showed that exercising in an area with high pollution concentrations resulted in a significantly lower aerobic capacity value or VO<sub>2</sub>max and a poor hematological profile. The results of this study indicated a lower value of aerobic capacity or VO<sub>2</sub>max after performing physical activity in a more polluted public sport venue. It occurred due to impaired oxygen distribution function and lung dysfunction during performing physical activity in a more polluted air (Deshpande & Deshpande, 2014; Gomeñuka et al., 2020). The results of the study are relevant with previous studies which state that air pollution affects VO<sub>2</sub>max in children and physical exercise in a polluted environment may not have a beneficial effect on cardio-pulmonary fitness (An & Yu, 2018; Buka, Koranteng, & Osornio-Vargas, 2006).

Hematological parameters suggested that the significantly lower value of hemoglobin after exercise in high-polluted air might be due to a slight increase of blood volume after an exposure to higher levels of air pollutants. The results of our study are in line with previous studies which state that there was a decrease in hemoglobin after carrying out physical activity in a high air pollution condition (Das & Chatterjee, 2015; Davidson & Penney, 1988; Kargarfard et al., 2011). In addition, this study also found an increase of white blood cells in research subjects after doing physical activity in both public sport venues. However, a higher concentration of white blood cells was found after the subjects engaged in physical activity at ITB sport venue. This result is in line with previous research which states that individuals who do physical activities with lower air pollution have a lower number of white blood cell than individuals who do it at a higher air pollution level (Das & Chatterjee, 2015; Jacobs et al., 2010; Kargarfard et al., 2011; Margolis, Manson, & Greenland, 2005). The increase of white blood cells, after performing physical activity in an environment exposed to a high PM<sub>2.5</sub>, might be due to the effect of PM<sub>2.5</sub> which could damage the tissue of the body so that the body produces more antibodies in response to a high expo-

sure to PM<sub>2.5</sub>.

## CONCLUSION

The negative impact caused by the high level of air pollution in public sport facilities should not be neglected. Doing physical activity in public sport areas exposed to a high air pollution can cause a decrease on the studied futsal athlete performance. Therefore, an athlete or coach should consider the air pollution concentration in the environment before exercising. It should be anticipated because, basically, exercising can increase air ventilation rate in the respiratory system, which can cause air pollution, such as PM<sub>2.5</sub> and PM<sub>10</sub>, entering the lungs.

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