International Journal Of Humanities Education And Social Sciences ***(IJHESS)*** *E-ISSN:* **2808-1765**
Volume 5, Number 2, October 2025, *Page. 826 – 831*
Email : editorijhess@gmail.com

Effect of Tropical Temperature, Humidity, Air Quality on Physical Education Students Blood Pressure Pre-Post Practical Learning

Gyta Krisdiana Cahyaningrum[1)], Naheria[2)], Didik Cahyono[3)], Muhammad Sukron Fauzi[4)], Muchamad Samsul Huda[5)]
[1,2,3,4,5)] Faculty of Teacher Training and Education, Mulawarman University

*Corresponding Author
Email: gytacahyaningrum@fkip.unmul.ac.id

Abstract

Environmental conditions such as temperature, humidity, and air quality can affect cardiovascular function, especially in individuals with high levels of physical activity. This study aims to analyze the impact of temperature, humidity, and air quality on changes in blood pressure in physical education students before and after taking practical learning outdoors in the Samarinda City environment, East Kalimantan. This study used an observational quantitative approach with a pre-post test design. The research sample involved 30 students selected through a purposive sampling technique. Environmental parameters (PM2.5, PM10, and AQI) were measured using an air quality monitoring application at the same time as blood pressure measurements. The results showed an average temperature of 30°C, PM2.5 of 7 µg/m³, PM10 of 29 µg/m³, and AQI of 39 (Good category). There was an increase in blood pressure after practical learning, but there was no statistically significant relationship between environmental factors and changes in blood pressure. These results indicate the importance of monitoring environmental conditions during outdoor practical learning.

Keywords: Blood Pressure, Temperature, Humidity, Air Quality, Practical Learning.

INTRODUCTION

Physical environmental factors are important determinants that can affect the physiological health of individuals, especially in populations that have high levels of physical activity such as Physical Education study program students in Samarinda City, East Kalimantan. A number of literature reviews have shown that exposure to high ambient temperatures, extreme humidity levels, and poor air quality has the potential to put additional strain on the cardiovascular system, which can directly or indirectly affect blood pressure (Mintarto & Fattahilah, 2019). Exposure to hot temperatures can trigger the body's thermoregulatory response in the form of vasodilation and increased heart rate (Lim, C. L., 2020). In extreme conditions this mechanism can cause homeostasis imbalance, which ultimately has an impact on increasing blood pressure Nasyafa, Saputra & Zuraida, 2024). Meanwhile, high humidity conditions inhibit the efficiency of the sweat evaporation process, resulting in an increase in the performance load of the cardiovascular system (Karim et al., 2021). Decreased air quality, especially that containing fine particles (PM2.5) and pollutant gases such as nitrogen dioxide (NO_2), is closely related to systemic inflammatory responses, oxidative stress, and endothelial dysfunction, all of which contribute to increased blood pressure (Tanjoto et al., 2021).

East Kalimantan is a region with tropical climate characteristics characterized by relatively high air temperatures and consistent humidity throughout the year. Data from the Central Bureau of Statistics of East Kalimantan Province shows that the daily maximum air temperature in this region can reach up to 36.0°C, with a daily minimum temperature of around 28.0°C. Daily maximum air humidity ranges from 88% to 98%, while daily minimum humidity is in the range of 39% to 76%. These climatic conditions create a challenging environment for physical activity, especially when performed for long periods of time in open spaces. East Kalimantan is also vulnerable to air quality degradation as pollutant emissions from the industrial, mining and motor vehicle sectors contribute to worsening atmospheric conditions, causing high concentrations of pollutant particles such as PM2.5 and harmful gases such as NO_2 in the ambient air. For example, the air quality index (AQI) in Samarinda City on 14 May 2025 was recorded at 38, which is categorized as good.

In the academic context, students of the Physical Education study program have regular involvement in outdoor learning activities, such as sports training, fitness measurement, field observation, and practice of subjects with sports in the field. These activities cause repeated exposure to extreme environmental conditions, including high temperatures, high humidity, and air quality that is not always optimal, and often lasts for a long duration. These conditions make this group more at risk of exposure to environmental factors compared to students from other study programs who mostly carry out activities in closed spaces. The combination of physical activity intensity and heavy environmental exposures has the potential to be a predisposing factor for physiological disorders, especially in aspects of blood pressure regulation and cardiovascular system responses (Chen et al., 2023).

Although many international studies have examined the influence of environmental factors on blood pressure, most were conducted in non-tropical or clinical settings. Prior evidence shows that air pollution can alter cardiovascular health including blood pressure (Hahad et al., 2021), while thermal variations significantly affect students blood pressure and heart rate in learning environments (Carvalho et al., 2018) and outdoor populations (Zheng et al., 2021). Despite these findings, no empirical study has specifically investigated the combined effects of temperature, humidity, and air quality on blood pressure among physical education students in tropical areas, particularly in Samarinda, East Kalimantan. This study aims to fill that gap by providing context-specific evidence that may contribute to sports science and environmental health, as well as inform adaptive policies for safer outdoor learning activities aligned with students' physiological conditions.

RESEARCH METHODS

This study employed a quantitative observational approach with a pre–post test design, a method considered suitable to evaluate short-term changes in physiological responses without experimental manipulation (Apuke, 2017). The research involved 30 active students from the Physical Education Study Program at Mulawarman University, selected using purposive sampling, which is recommended when participants must meet specific inclusion criteria (Etikan et al., 2016). The criteria included: (1) active participation in outdoor learning activities at least twice per week, (2) no history of hypertension or cardiovascular disorders (self-reported and initial screening), and (3) willingness to sign informed consent.

Environmental data were collected in parallel with physiological assessments. Temperature and humidity were measured using the AccuWeather application (accuracy ±0.1 °C and ±1% RH), while air quality (AQI, PM2.5, PM10) was obtained in real time through the IQAir platform based on GPS location. Blood pressure was measured using a validated digital sphygmomanometer in accordance with the American Heart Association guidelines (Reboussin et al., 2018) to ensure measurement accuracy and reliability.
Blood pressure measurements were taken twice for each participant, with the pre-test conducted before the practice and the post-test conducted immediately after the practice ended. Blood pressure measurements using a digital tensimeter because the results obtained are more accurate (Zuhdi et al., 2020), carried out in a calm sitting position, and after a minimum of five minutes rest to ensure accuracy. Data were analyzed using SPSS software version 21.0. A paired t-test was used to see significant differences in blood pressure before and after practice. Pearson

correlation test was used to assess the relationship between environmental variables and changes in blood pressure.

RESULT AND DISCUSSION

Results

A total of 30 respondents consisted of physical education students with an age range of 19-20 years (mean 20.1 ± 1.2 years), 66.7% male and 33.3% female. All participants were healthy and actively participated in outdoor practice activities at least twice per week. The following table presents details of the respondents' characteristics:

Table 1. Characteristics of the respondents

Characteristics	Category	Number (n)	Percentage (%)
Gender	Male	20	66,7
	Female	10	33,3
Age (years)	19-20	30	100
Outdoor activities	2 times/week	30	100

The following table shows the average blood pressure of students before and after outdoor practice learning:

Table 2. Blood pressure before and after practical learning

Parameters	Before (Mean ± SD)	After (Mean ± SD)	p-value (Paired t-test)
Systolic pressure	124,5 ± 9,2 mmHg	129,3 ± 10,1 mmHg	0,021*
Diastolic pressure	78,3 ± 7,1 mmHg	81,6 ± 6,9 mmHg	0,034*

*Significant at α = 0,05

Table 3. Correlation analysis between environmental and blood pressure

Environmental Variables	Blood Pressure (r)	p-value	Description
Temperature	-0.216	0.251	Not significant
Humidity	0.193	0.304	Not significant
Air Quality	-0.165	0.381	Not significant

Based on the table above, no statistically significant correlation was found between environmental variables (temperature, humidity, and AQI) and changes in systolic blood pressure. Nonetheless, the direction of the correlation suggests a trend of association that is worthy of further study through a more in-depth research design.

Discussion

The increase in blood pressure that occurs after outdoor practical learning represents a common physiological response to physical activity. When the body performs physical exercise, there is an increase in oxygen demand and blood flow to active muscles (Tanzila & Hafiz, 2019). This causes an increase in cardiac output and peripheral vasoconstriction, which in turn triggers an increase in blood pressure, especially in the initial phase of activity (Herawati et al., 2020). According to Kruk, et al., (2020) during intense physical activity, activation of the sympathetic nervous system will increase, accompanied by the release of catecholamine hormones such as adrenaline and noradrenaline, which play a role in increasing heart rate, strength of myocardial contraction, and causing peripheral vasoconstriction, thus supporting a physiological increase in blood pressure.

The t-test results showed that both systolic and diastolic blood pressure had a statistically significant increase after the practice, indicating that the workload of the cardiovascular system increased, although within the normal range. This is in line with the findings by Paramurthi et al. (2022), who stated that blood pressure tends to increase after acute physical activity, especially in healthy and trained individuals. Acute physiological responses as well as long-term effects are a consequence of regular and structured physical activity, known as the body's adaptation process (Lavin et al., 2022). Acute responses include increases in heart rate, respiratory rate, blood pressure, and body temperature as a form of adjustment to physical activity (Widiyono et al., 2022). Furthermore, according to Hellsten & Nyberg (2016) the increase in blood pressure during exercise is caused by an increase in cardiac output and systemic vascular resistance that occurs physiologically as an effort by the body to meet the metabolic needs of active muscle tissue during exercise.

The results of this study found no significant relationship between temperature, humidity, or air quality with changes in blood pressure. This can be explained from the aspect of physiological adaptation in physical education students generally have a good fitness level and are accustomed to physical activity in a tropical environment. Adaptation to heat such as increasing the efficiency of body cooling mechanisms such as skin vasodilation and increasing the rate of sweating can maintain body homeostasis even in temperatures of 30°C (Grodzinsky & Sund Levander, 2020). When the body temperature is in the normal range, the thermostat inhibits heat loss mechanisms and activates heat savings by constricting blood vessels, stiffening hair and stimulating heat-generating mechanisms to promote body cooling through vasodilation, sweating or panting (Junaidi et al., 2018). The adaptive physiological response that has been formed in the study subjects explains the absence of significant changes in blood pressure despite variations in temperature, humidity, or air quality during measurements.

In terms of air quality, although PM2.5 and PM10 parameters were measured, the AQI value was classified as Good. This indicates that there is no exposure to air pollution high enough to have a noticeable impact on the respiratory system or blood pressure. Physiologically, fine particulates such as PM2.5 can penetrate the lower airway and enter the systemic circulation, which in the long run can trigger inflammation, endothelial dysfunction, and vasoconstriction of blood vessels, thus increasing blood pressure and worsening cardiovascular function (Konukoglu & Uzun, 2017). The study by Suhartawan et al. (2024) revealed that long-term exposure to poor air quality, especially at high concentrations of PM2.5, can lead to increased blood pressure. However, in the context of this study, short-term exposure within safe limits was not strong enough to trigger physiological changes. In addition, the relatively short duration of practice and the stability of environmental conditions also contributed to the lack of a significant correlation. A similar study by Khraishah et al. (2022) mentioned that the impact of the environment on cardiovascular is more prominent in long-term studies or populations with certain comorbidities.

Overall, these findings suggest that the main factor influencing blood pressure in this context was the physical activity in the practical learning, not the environmental factors present. However, pre- and post-practice blood pressure monitoring is still important, especially in extreme conditions or in more vulnerable populations. Further studies with longer monitoring durations, more diverse populations, and real-time monitoring of body temperature and heart rate may provide a more comprehensive understanding.

CONCLUSION

This study demonstrated a significant increase in blood pressure after outdoor practical learning. The average systolic pressure increased from 124.5 ± 9.2 mmHg to 129.3 ± 10.1 mmHg ($p = 0.021$), while diastolic pressure increased from 78.3 ± 7.1 mmHg to 81.6 ± 6.9 mmHg ($p = 0.034$). However, environmental factors including temperature, humidity, and air quality were not significantly associated with these changes ($p > 0.05$). Therefore, physical activity was identified as the main factor influencing blood pressure responses, while continuous monitoring of blood pressure and environmental conditions should remain an essential part of safety standards in practical learning conducted in tropical environments

REFERENCES

Apuke, O. D., 2017, Quantitative research methods a synopsis approach. Arabian Journal of Business and Management Review (Kuwait Chapter), Vol. 6, No. 11, pp. 40-47, https://doi.org/10.12816/0040336

Carvalho, J. P., Barroso, B. I. L., Da Silva, L. B., Neves, A. I. A., Torres, M. G. L., Falcão, C. A., & Da Silva, J. F., 2018, Students' blood pressure and heart rate in learning environments with thermal changes. International Journal of Occupational and Environmental Safety, Vol. 2, No. 1, pp. 29-37, https://doi.org/10.24840/2184-0954002.0010004

Chen, X., Hu, Z., & Wang, J, 2023, PS-P03-8: Influence of Average Air Temperature, Pressure, and Air Relative Humidity on Blood Pressure, Journal of Hypertension, Vol. 41, e244, https://doi.org/10.1097/01.hjh.0000915216.02267.3c.

Etikan, I., Musa, S. A., & Alkassim, R. S., 2016, Comparison of convenience sampling and purposive sampling. American journal of theoretical and applied statistics, Vol. 5, No. 1, https://doi.org/1-4.10.11648/j.ajtas.20160501.11

Grodzinsky, E., & Sund Levander, M., 2020, Thermoregulation of the human body, Understanding Fever and Body Temperature: A Cross-disciplinary Approach to Clinical Practice, pp. 49-65, https://doi.org/10.1007/978-3-030-21886-7_5

Hahad, O., Kuntic, M., Frenis, K., Chowdhury, S., Lelieveld, J., Lieb, K., Daiber, A., & Münzel, T., 2021, Physical Activity in Polluted Air—Net Benefit or Harm to Cardiovascular Health? A Comprehensive Review. Antioxidants, Vol. 10, No. 11, 1787. https://doi.org/10.3390/antiox10111787

Hellsten, Y., & Nyberg, M., 2016, Cardiovascular adaptations to exercise training, Comprehensive physiology, Vol. 6, No. 1, pp. 1-32.

Herawati, C., Indragiri, S., & Melati, P., 2020, Physical activity and stress as risk factors for hypertension in people aged 45 years and above, JKM (Journal of Public Health) Cendekia Utama, Vol. 7, No. 2, pp. 66-80, https://doi.org/10.31596/jkm.v7i2.502

Junaidi, N. S., Daruwati, I., Febriani, Y., & Hatika, R. G., 2018, Relevance of Physics in learning the Human Body Adaptation System to Temperature Changes, Collaborative Medical Journal.

Karim, A., Munir, R., Rasyidi, Z., Hayati, S., & Pratiwi, Y., 2021, The Relationship between Environmental Temperature and Blood Pressure in Processing Section Workers at PT Mitra Bumi MCC, Bukit Sembilan District, Kampar Regency in 2021, Collaborative Medical Journal (CMJ), Vol. 4, No. 2, pp. 69-78, https://doi.org/10.36341/cmj.v4i2.2725

Khraishah, H., Alahmad, B., Ostergard, R.L. et al., 2022, Climate change and cardiovascular disease: implications for global health. Nat Rev Cardiol, Vol. 19, No. 12, pp. 798-812, https://doi.org/10.1038/s41569-022-00720-x

Konukoglu, D., & Uzun, H., 2017, Endothelial dysfunction and hypertension. Hypertension: from basic research to clinical practice, No. 956, pp. 511-540, https://doi.org/10.1007/5584_2016_90

Kruk, J., Kotarska, K., & Aboul-Enein, B. H., 2020, Physical exercise and catecholamines response: benefits and health risks: possible mechanisms, Free Radical Research, Vol. 54, No. 2-3, pp. 105-125, https://doi.org/10.1080/10715762.2020.1726343

Lavin, K. M., Coen, P. M., Baptista, L. C., Bell, M. B., Drummer, D., Harper, S. A., & Buford, T. W., 2022, State of knowledge on molecular adaptations to exercise in humans: historical perspectives and future directions. Comprehensive Physiology, Vol. 12, No. 2, pp. 3193-3279, https://doi.org/10.1002/j.2040-4603.2022.tb00211.x

Lim, C. L., 2020, Fundamental concepts of human thermoregulation and adaptation to heat: a review in the context of global warming, International Journal of Environmental Research and Public Health, Vol. 17, No. 21, pp. 7795. https://doi.org/10.3390/ijerph17217795

Mintarto, E., & Fattahilah, M., 2019, Effects of Environmental Temperature on body physiology during exercise training, Journal of Sport and Exercise Science, Vol. 2, No. 1, pp. 9-13.

Nasyafa, S. F., Saputra, O., & Zuraida, R., 2024, Body Homeostasis. Medical Profession Journal of Lampung, Vol. 14, No. 2, pp. 249-253, https://doi.org/10.53089/medula.v14i2.941

Paramurthi, I. P., Negara, N. L. G. A. M., Prianthara, I. M. D., & Sarasdianthi, P. A., 2022, Study of Physical Activity, Blood Pressure, and Oxygen Saturation in the Elderly in Batubulan Kangin Village, Indonesian Physiotherapy Scientific Magazine, Vol. 10, No. 3, pp. 174, https://doi.org/10.24843/MIFI.2022.v10.i03.p09

Reboussin, D. M., Allen, N. B., Griswold, M. E., Guallar, E., Hong, Y., Lackland, D. T., & Vupputuri, S., 2018, Systematic review for the 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Journal of the American College of Cardiology, Vol. 71, No. 19, 2176-2198.

Suhartawan, B., et al., 2024, Air Quality. Introduction to Environmental Engineering, 15, Padang: CV. Gita Lanera.

Sumerta, I. K. , Santika, I. G. P. N. A., Dei, A., Prananta, I. G. N. A. C., Artawan, I. K. S., & Sudiarta, I. G. N., 2021, The Effect of Circuit Training on the Agility of Soccer Athletes, Journal of Recreational Health Education, Vol. 7, No. 1, pp. 230-238, https://doi.org/10.5281/zenodo.4460071

Tanjoto, E. A., Fakhrurrazy, F., & Suhartono, E., 2021, Literature Review: Correlation of Oxidative Stress with Blood Pressure in the Elderly, Homeostasis, Vol. 4, No. 1, pp. 227-236, https://doi.org/10.20527/ht.v4i1.3392

Tanzila, R. A., & Hafiz, E. R., 2019, Physical exercise and its benefits on cardiorespiratory fitness, In Conferences of Medical Sciences Dies Natalis Faculty of Medicine Sriwijaya University, Vol. 1, No. 1, pp. 316-322.

Widiyono, S. K., Indriyati, S. K., & Tika Budi Astuti, S. K., 2022, Physical Activity to Manage Hypertension, Chakra Brahmana Lentera Institute.

Zheng, S., Wang, M. Z., Cheng, Z. Y., Kang, F., Nie, Y. H., Mi, X. Y., & Bai, Y. N. 2021. Effects of outdoor temperature on blood pressure in a prospective cohort of Northwest China. Biomedical and Environmental Sciences, Vol. 34, No. 2, 89-100, https://doi.org/10.3967/bes2021.014

Zuhdi, M., Kosim, K., Ardhuha, J., Wahyudi, W., & Taufik, M., 2020, Advantages of Blood Pressure Measurement Using Digital Tensimeter Compared to Spring Tensimeter and Mercury Tensimeter, Indonesian Journal of Physics Research and Learning, Vol. 2, No. 2, https://doi.org/10.29303/jppfi.v2i2.58