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A REVIEW OF THE EFFECT OF WEATHER ON THE PERFORMANCE OF ATHLETES

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Abstract. *Air pollution reduces breathing capacity in athletes and affects their performance. Some pollutants that cause health disorders, such as tropospheric ozone (O3), particulate matter (PMx), carbon monoxide (CO) have been separately identified. Nitrogen oxides (NOx) and sulfur oxides (SOX). These are usually concentrated in urban centers and are mainly, though not exclusively, caused by normal human activities such as transportation, heating, cooking, and agricultural and industrial activities. The aforementioned factors cause various diseases such as cancer, cardiovascular, respiratory and affect the performance of athletes. Conclusion: During training and physical activity, the amount of oxygen consumption increases and suspended particles, ozone, nitrogen oxide, sulfur oxide penetrates deep into the lungs and even blood flow, which is more common among endurance athletes than in the open air. But the health that sports brings is beyond the harm of air pollution, but still air pollution has a negative effect on the performance of athletes.*

Keywords: *Pollution, air, performance, athletes.*

ОБЗОР ВЛИЯНИЯ ПОГОДЫ НА РЕЗУЛЬТАТЫ СПОРТСМЕНОВ

Аннотация. *Загрязнение воздуха снижает дыхательную способность спортсменов и влияет на их работоспособность. Были отдельно идентифицированы некоторые загрязняющие вещества, вызывающие нарушения здоровья, такие как тропосферный озон (O3), твердые частицы (PMx), оксид углерода (CO). Оксиды азота (NOx) и оксиды серы (SOX). Они обычно концентрируются в городских центрах и в основном, хотя и не исключительно, вызваны обычной деятельностью человека, такой как транспорт, отопление, приготовление пищи, а также сельскохозяйственная и промышленная деятельность. Вышеупомянутые факторы вызывают различные заболевания, такие как рак, сердечно-сосудистые, респираторные, и влияют на работоспособность спортсменов. Вывод: во время тренировок и физической активности увеличивается количество потребляемого кислорода, а взвешенные частицы, озон, оксид азота, оксид серы проникают глубоко в легкие и даже в кровоток, что чаще встречается у спортсменов на выносливость, чем на открытом воздухе. Но здоровье, которое приносит спорт, выходит за рамки вреда от загрязнения воздуха, но все же загрязнение воздуха оказывает отрицательное влияние на работоспособность спортсменов.*

Ключевые слова: *загрязнение, воздух, работоспособность, спортсмены.*

INTRODUCTION

Physical inactivity has serious effects on population health and affects quality of life and health care costs in many countries. But it should be noted that the environment we run in is just as important to our health as the exercise itself, especially for outdoor runners. The issue of air

pollution and its impact on human health is one of the important issues of the day, including the role of environmental activists, especially the important role of the government in controlling air pollution is one of the important issues. (Malik, 2017) New cities have been built with the approach of attracting the population of large overflowing cities in their vicinity, which will face environmental problems in the future as the process of population attraction continues(rizvani,2021) The impact of the environment on health is a hot topic that has received attention in recent years. The right amount of exercise improves human health and strengthens immunity. However, exercising in polluted environments can affect the effectiveness of exercise and even harm the body to different degrees. Pollutants in the air such as solid particles, hydrogen sulfide, carbon monoxide, ozone, dust and acid dust and aerosols cause significant damage to the human body, which leads to various respiratory and lung diseases and can even cause cancer. This study also examines the effect of air pollution on the cardiopulmonary function of athletes. The results show that air pollution has adverse effects on human cardiopulmonary function and aerobic metabolic capacity. In addition, this study shows that air pollution is associated with significantly more adverse effects on the respiratory system of athletes than non-athletes.

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The increase in the world's population and the use of polluting sources of energy in the modern world have led to changes in the quality of the air we breathe. Airborne pollutants have harmful effects on health that have been widely studied. As a result of these studies, this type of pollution has been associated with cancer, cardiovascular disorders, acute lung infections, acute bronchial obstruction (and chronic asthma disorders, chronic obstructive pulmonary disease).

According to data provided by the World Health Organization in 2018, about 90% of people are exposed to polluted air, especially in poor or developing countries in all continents, which together cause about seven million deaths globally every year. Although we breathe a mixture of substances in the air, at the individual level it has become possible to identify some of the pollutants that cause health disorders, such as tropospheric ozone (O3), particulate matter (PMx), carbon monoxide (CO). Nitrogen oxides (NOx) and sulfur oxides (SOX). These are usually concentrated in urban centers and are mainly, though not exclusively, caused by normal human activities such as transportation, heating, cooking, and agricultural and industrial activities.

Our body comes into contact with atmospheric pollutants through a large area of lung tissue, making this organ particularly susceptible to damage from the components of the air we breathe, such as particulate matter, cigarette smoke, various gases, and pollens. As a result, this interaction causes changes in the function of this organ. The amount of pollutants that reach the lungs during exercise depends on both their concentration in the air and the magnitude of pulmonary physiological phenomena that are typical of physical effort: bronchodilation, increased ventilation, mouth breathing, and increased diffusion capacity. This means that during exercise there is a greater load of tissue pollutants that affect deeper areas of the lung and may even be associated with more passage of these substances into the bloodstream, such as gases and particulate matter.

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Air pollution, caused by natural events and human activities, poses a significant threat to global health, particularly on respiratory conditions such as asthma. Air pollution significantly affects asthma exacerbations in athletes, a group that is vulnerable due to high levels of physical activity and increased respiratory demands. Key pollutants, including particulate matter (PM), ground-level ozone (O3), sulfur dioxide (SO2), and nitrogen dioxide (NO2), play an important role in the development and exacerbation of asthma)Araneda, Kosche-Cárcamo et al. 2021).

Effective management of asthma in the midst of air pollution requires personal, social and governmental actions. Patients should minimize their exposure by using N95 masks and choosing low-traffic routes. Governments must monitor pollution, inform the public, and control greenhouse

gas emissions through alternative fuels and technologies. Adherence to WHO air quality guidelines can prevent many new cases of asthma and emphasizes the importance of comprehensive air quality management, especially among vulnerable populations such as children(Kruczyk, Piętak et al. 2024).

Little is known about the prevalence, incidence, and risk factors of acute exposure to chlorine byproducts, air pollution, cold weather, or altitude in the development of respiratory diseases, especially in athletes)Bougault 2022) .People who exercise in polluted environments are at risk of respiratory and cardiovascular diseases due to the increased amount of pollutants entering the lungs(Fashi 2022).

The way of doing the work: This research has been done in a systematic way. In this review article, researches are used that mostly deal with experimental cases.

Research findings: They show that inhaling high concentrations of air pollutants can cause more damage to athletes who perform intensive training than to the general population.

Athletes are particularly vulnerable because their air intake is greater and many of them train and compete outdoors for large parts of the day. During intense exercise, athletes can breathe more than 6,000 liters per hour compared to 400 to 500 liters per hour at rest and 1,000 liters per hour with light exercise. Among other things, the increase in lung ventilation occurs during exercise. Inhaling more air through the mouth during exercise bypasses the nasal filtration mechanisms. Increasing the speed of air flow transports, the pollutants to the depths of the respiratory tracts and as a result increases the absorption of gaseous pollutants and as a result, the concentration level of individual pollutants in the human body also increases.

Despite the studies mentioned above, there is little research on the physical activity of professional athletes in a potentially polluted environment, and especially on soccer players.

Among the pollutants that are often analyzed and controlled are: ozone (O3), suspended particles (PM) and nitrogen dioxide (NO2). The first is ozone, a gas produced by the action of sunlight on hydrocarbons and nitrogen oxides, which is detrimental to athletic performance when the exposure is high enough. Subsequent respiratory distress associated with increased ozone exposure may decrease maximal work output and contribute significantly to increased overall perceived exertion. Particulate matter is mainly produced from fuel combustion in gasoline and diesel engines, combustion of wood and fossil fuels, and during construction work. There are different criteria for dividing particles. However, the most common analysis is for particles such as PM10 (with a particle diameter below 10 μm), PM2.5 (below 2.5 μm) and PM1 (below 1 μm).

The smaller the particle, the greater its potential to cause damage because it can penetrate deeper into the lungs. However, even PM10 has a harmful effect on health because its combination of sulfur dioxide (SO2) and water vapor creates particles coated with sulfuric acid that can settle in the lungs and cause irritation and asthma-like symptoms.

On the other hand, nitrogen dioxide is a byproduct of fossil fuel combustion. NO2 tends to coexist with PM and usually O3, and they are often inhaled simultaneously. As a result, they have a comprehensive effect on the human body, and for this reason, the analysis of all three types of pollutants mentioned above seems important, especially considering the fact that the literature lacks studies that show the integrated effect of pollutants. Three parameters that are often described from air pollution in the body of professional athletes. Numerous studies show the connection

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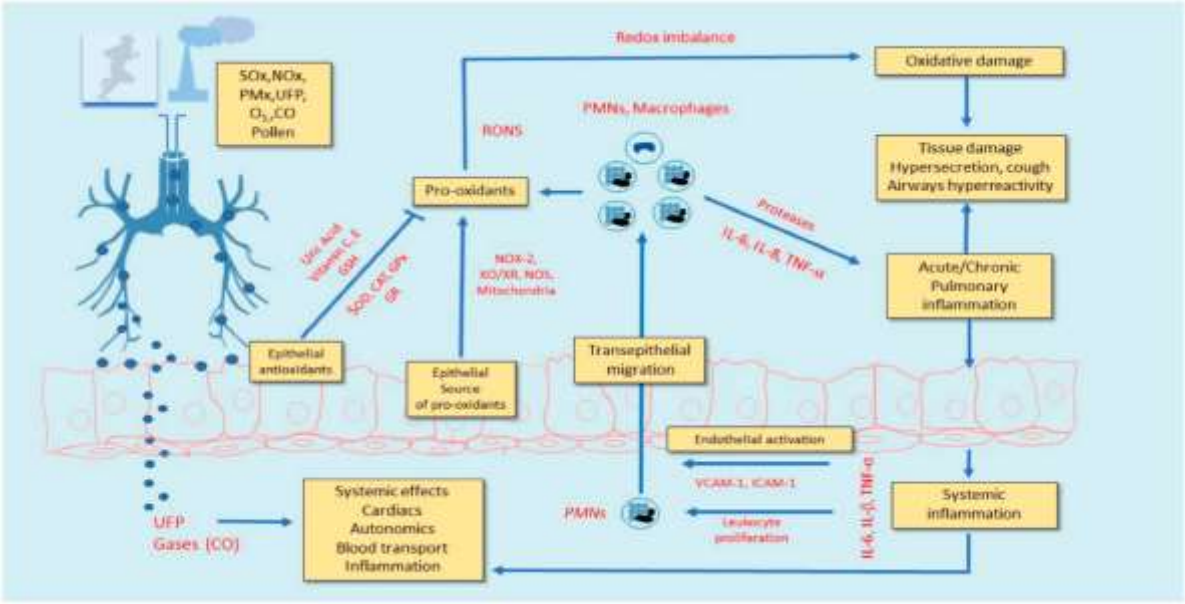
between air pollution and the cardiovascular and respiratory system, and adverse changes in the biomarkers of physiological and biochemical functions have also been identified. It is directly related to the performance of the athlete's body and consequently to their performance during sports competitions. In order to solve this problem and considering the above information, it was decided that the purpose of this study is to determine the effect of air quality based on the integration model of three types of air pollutants ((O3, NO2)), PM10). About the physical activity of football players in the Bundesliga. In a 202 research by Zacharko et al., three types of air pollutants, ozone (O3), suspended particles (PM), nitrogen dioxide (NO2)) were found on football



physical activity. It can be seen that the deterioration of only one air pollution parameter leads to a significant decrease in performance. This is important information because air pollution is now a significant problem for many countries. Improving air quality during training sessions and sports competitions leads to better athletes' well-being and athletic performance, and also helps protect athletes from the negative health effects of air pollution). Zacharko, Cichowicz et al. 2021) Exposure to air pollutants may cause allergic airway inflammation in increasing Fractional exhaled Nitric Oxide (FeNO) levels in exercise populations and negatively affect human health)Shi, Li et al. 2022) . The degree of air pollution is directly proportional to the extent of damage to the cardiopulmonary function of the athlete in outdoor sports. In the research of Liu et al., 2022, the issue of air pollution has been investigated and the study of air pollution levels, PM2.5 concentration changes and meteorological factors have been found to be effective on zinc performance(Liu, Ge et al. 2022).

(Araneda, Kosche-Cárcamo et al. 2021).

Physical inactivity has serious effects on population health and affects quality of life and health care costs in many countries. This has motivated public and private institutions to promote regular physical activity, which, paradoxically, can pose health risks when performed in areas of poor air quality(Araneda, Kosche-Cárcamo et al. 2021). A significant increase of up to 20 times in the amount of ventilation and simultaneous breathing through the nose and mouth. In addition, mouth breathing often drowns out sounds during intense exercise and increases the harmful effects

of pollutants on health and athletic performance. Although limited, any decline in athletic performance could have a potentially detrimental effect on elite athletes competing in China's next Olympics. Several Olympic records are regularly broken during the Olympic Games(Lippi, Guidi et al. 2008).

Also, Kabul is one of the most polluted cities in the world, where various types of diseases exist among its citizens and the citizens struggle with it. In the picture below, you can practically see the pollution of Kabul city.

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Air pollution, caused by natural events and human activities, poses a significant threat to global health, particularly on respiratory conditions such as asthma. Air pollution significantly affects asthma exacerbations in athletes, a group that is vulnerable due to high levels of physical activity and increased respiratory demands. Key pollutants, including particulate matter (PM), ground-level ozone (O3), sulfur dioxide (SO2), and nitrogen dioxide (NO2), play an important role in the development and exacerbation of asthma (Kruczyk, Piętak et al. 2024). Vehicles and road traffic produce particulate matter (SPM), sulfur oxides (SO2), nitrogen oxides (NO2), and carbon monoxide (CO), which cause adverse health effects on exposed populations)Das and Chatterjee 2014). Little is known about the prevalence, incidence, and risk factors of acute exposure to chlorine byproducts, air pollution, cold weather, or altitude in the development of respiratory diseases, particularly in athletes(Bougault, Adami et al. 2022). Most of the studies conducted pollutant monitoring in indoor environments used for physical exercises and sports training. The first studies were conducted in ice skating rinks and the newest gyms, fitness centers and sports centers were evaluated. The concentrations of CO, suspended particles and NO2 were the most investigated and had the longest history of investigation. These contaminants were within the range set by the guidelines in most studies. Studies that have examined the relationship between air quality have documented the adverse effects of pollution. There is a need for more studies focusing on the relationship between pollution and health)Andrade and Dominski 2018).

Airway epithelial damage may be caused by dehydration and physical stress applied to the airways during severe hyperpnoea during exercise or by inhalation of noxious agents. This is thought to initiate a cascading, inflammatory repair process that can ultimately lead to airway hyper responsiveness (AHR) and asthma in predisposed athletes. The authors review the evidence for preventing or reducing the risk of AHR/asthma. Appropriate measures must be taken when athletes are trying to reduce dehydration stress and reduce exposure to harmful weather agents.

Environmental interventions are the most important of them. Non-pharmacological strategies can help, but currently, pharmacological measures have not been shown to be effective.

Whether early prevention of airway injury in elite athletes can prevent or reduce progression to AHR/asthma remains unclear)Kippelen, Fitch et al. 2012).

Air pollution is a major problem worldwide, which can be even more serious for athletes who train in urban environments. Exercise increases minute ventilation and exposure to pollutants, but the literature on the effects of air pollution in athletes is relatively sparse, with the exception of chlorine exposure in aquatic athletes and secondary air pollution to the ice surface in athletes on ice rinks. they play Although air pollution may have detrimental effects on athletic performance, little has been published on this topic. The largest body of information relates to the impact of air pollution on active urban transportation, i.e. walking and cycling in cities, due to the potential risk of air pollution in citizens and the need to revise urban transportation strategies accordingly. In healthy people, the benefits of physical activity greatly outweigh the harms of exposure to air pollutants. However, harmful effects have been shown in susceptible individuals, such as patients with heart or respiratory disease and children. Improving air quality, personal protective behaviors and prompt communication with the population of air quality hazards may help limit the negative effects of air pollution on respiratory health)Morici, Cibella et al. 2019).

The lack of clean air in big and industrial cities prevents sports activities and the countless benefits of sports are not taken into account. A literature search found 89,094 articles related to air pollution published in SID, PubMed, and Web of Science until December 2021. Finally, 80 articles were extracted after selecting the articles and limiting the search to exercise inflammation and lung tissue. After removing old articles that were not published between 2000 and 2021 and articles without full text, 65 articles were reviewed. Based on the review, exposure to air pollution is associated with increased inflammation and decreased cellular immune function, characterized by activation of toll-like receptors and downstream signaling pathways. Regular exercise improves the inflammatory condition in various lung diseases.

People who exercise in polluted environments are at risk of respiratory and cardiovascular diseases due to the increased amount of pollutants entering the lungs. However, the studies did not consider the potential anti-inflammatory effects of exercise training, which could inhibit the pro-inflammatory events caused by air pollution. Regular exercise appears to modulate lung inflammatory responses and body mass, and to some extent reduce the risk of lung disease(Fashi 2022).

The aim of this systematic review is to synthesize the scientific evidence for the health effects of exposure to air pollution and outdoor exercise. We conducted a literature search in PubMed, Cochrane, EMBASE, and Web of Science for articles evaluating the combined effect of air pollution exposure and exercise on health. Each included study needs a clear exercise

intervention plan. The quality of each included study was assessed, and the quality of evidence was also measured for each outcome assessed in the meta-analysis. Six studies found that exposure to traffic pollution or high PM during exercise may contribute to changes in blood pressure, systemic luminal artery function, and microvascular function. The combined effect of air pollution and exercise is associated with an increased risk of potential health problems of cardiopulmonary function, immune function, and exercise performance)Qin, Yang et al. 2019). Air pollutants and meteorological agents are associated with lung function and respiratory symptoms and have cumulative effects among elite athletes. In the multi-pollutant model, temperature has the greatest effect on lung function(Lee, Kim et al. 2023). Physical activities should be done in the early hours of the morning before 7 am in Tehran. Due to the presence of air pollution at all hours of the day and night, efforts to reduce air pollution are vital(Mohaghegh, Kordi et al. 2012). Exposure to high concentrations of air pollutants may be associated with decreased lung function in sedentary, trained boys, despite regular participation in an exercise program may improve lung function. It is a well-known fact that sports, aerobic or training exercises, if performed regularly, have a favorable effect on various body systems. Previous studies have shown that athletes have higher values of lung volume compared to their control counterparts who do not exercise regularly. Many studies have shown the effect of air pollution on children's lung function, and it has been stated that in areas with high concentrations of nitric oxide, the values of children's lung function parameters are low and their growth is relatively delayed(Das and Chatterjee 2014).

The prevalence of rhinitis in athletes has often been studied in combination with asthma, but the effect of exercise on the paracrine and secretory functions of the nasal mucosa has been less proven. This systematic review was conducted with the aim of investigating the effect of exercise on the nasal mucosa in elite athletes. There is no evidence in the available literature to suggest exercise-induced narrowing of the nasal airway. Olfaction and mucosal transit time were affected in swimmers, possibly attributable to chlorine irritation, and resolved with cessation of exercise. Short-term intense exercise may cause changes in cytology and prolongation of mucosal transit time, which resolves rapidly with rest(Surda, Walker et al. 2018).

In the 2018 research of Orji et al., it is said that many citizens of polluted cities exercise in closed spaces)Oroji, Solgi et al. 2018). In the 2024 research of Savja et al., fossil fuels are considered to be the cause of pollution and their effect on health is harmful and exercise is a way to reduce it. Although increased exposure to air pollution may partially offset the positive effects of exercise, the overall health benefits outweigh it(SAVĞA and GÜNGÖR 2024).

CONCLUSION

The lack of clean air in big and industrial cities prevents sports activities and the countless benefits of sports are not taken into account. Air pollution has become an important public health concern. During exercise, many physiological factors are thought to increase the effects of air pollution. Air pollution affects lung function and respiratory symptoms more.

Elite athletes, especially those who participate in endurance sports and are chronically exposed to airborne pollutants/stimulants or allergens, are at increased risk of upper and lower airway dysfunction due to indoor exercise injury. Reduces contamination in athletes.

Nowadays, people cannot avoid the global problem of air pollution caused by car exhaust as long as they live in urban areas. Exposure to air pollution is associated with increased cardiovascular and respiratory diseases and mortality in many countries.

Fine particles less than 10 micrometers (PM10), carbon monoxide (CO) and ozone (O3) were the main air pollutants in Tehran. The hourly PM10 concentration changes were minimal and beyond the optimal level. Sports, aerobic or training exercises, if done regularly, have a favorable effect on different body systems. The problem of air quality has been noticed by the World Health Organization (WHO), which estimated that in 2012 there were about 7 million deaths caused by living in polluted areas. Air is a global problem that affects many countries in the world. High or excessive levels of air pollutants in certain periods and places also apply to European countries that are highly developed in terms of economy and industry. In Germany, most urban areas still do not meet the air quality standards of the World Health Organization.

Although there are different air quality assessment scales, domestic scales are usually less STRINGENT than European standards. However, air quality standards or guidelines are often not met.

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