Effect of Air Pollution on Athletes’ Performance, Health, and Mortality

Miguel A. Camelo Rosas

MANE 6960H01
Air & Water Pollution Control Engineering
Fall 2013
# Table of Contents

1.0 Introduction............................................................................................................................... 3  
2.0 Background............................................................................................................................... 3  
3.0 Short Term Effects of Air Pollution on Athletic Performance ................................................. 4  
4.0 Long Term Effects/Mortality of Air Pollution on Athletes ...................................................... 6  
5.0 Implications of Past and Future Research............................................................................... 7  
6.0 Conclusions............................................................................................................................... 9  
7.0 References................................................................................................................................ 10
1.0 Introduction

Several studies have shown that air pollution has a negative effect on human health. This is one of the premises in the creation of the organizations and regulatory agencies that control these pollutants. It is also one of the premises in the creation of legislation to enforce these controls. The negative effects that air pollution has on human health are widely accepted and are generally referred to as affecting the respiratory system, cardiovascular system, and recently the brain. Not only is exposure to air pollution negative on short term, but it is also very harmful in the long term.

While the health effects of air pollution have been widely studied and most leading to very similar conclusions, the short and long term effects of exposure to air pollutants to athletes is a topic that is growing in interest. Furthermore, research has been performed on the effects of air pollution on athletes’ performance, health, and mortality and how it compares to the general “less active” population. Research on the consequences of air pollution on people that exercise more than the average population still has a vast horizon ahead of it, as does the effects and practical applications of the results it finds.

2.0 Background

Air pollutants are substances introduced in the air either by nature or by anthropological ways. They can have a solid, liquid droplet, or gas state and can be classified as either primary or secondary. Primary air pollutants are produced directly from a process such as the emission of carbon monoxide from the exhaust of a motor vehicle. Secondary air pollutants are not directly
emitted, but form with the interaction of primary air pollutants with each other as well as their reaction. An example of this is ground level ozone, which can be caused by the interaction between motor vehicle emissions and sunlight.

Regulatory agencies such as the EPA monitor and control the levels of certain pollutants like sulfur oxides (SOx), nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs) and particulate matter (PM). Some of these pollutants are of particular interest due to their effects on the human respiratory and cardiovascular systems. Due to their water solubility and irritant effect on the upper respiratory system, pollutants like sulfur dioxide (SO2) and sulfuric acid (H2SO4) are of particular interest. Others, such as ozone (O3) and peroxycetyl nitrate (HNO3) have the potential for oxidation reactions in the lower respiratory system (Pierson, Covert, Koenig, Namekata, & Shin Kim, 1985).

The health effects of air pollutants include respiratory infections, difficulty in breathing, coughing, wheezing, asthma, and the aggravation of already existing cardiac and respiratory conditions. Particulates, nitrogen dioxide, ozone, and sulfur dioxide are generally the most common air pollutants that cause these negative health effects. Some more recent studies are also showing evidence that both short term and chronic air pollution can cause brain damage and neurodegeneration (Jacobs, et al., 2011).

3.0 Short Term Effects of Air Pollution on Athletic Performance

The short term effects of air pollution on athletic performance and athletes’ health are a topic that has been studied in a variety of ways. Some studies aim at looking at the effects of increased levels of air pollution on athletic performance as measured by common physiological
parameters. On a study performed in Canada and published in 2011, the association between air pollution, spirometry, blood pressure, and exercise capacity. The study showed that significant associations between exposures to elevated levels of air pollutants were associated with higher resting blood pressure and lower ventilator function. If there was higher ozone levels on the day of the study, the subjects tested achieved a lower aerobic fitness score. (Cakmak, Dales, Leech, & Liu, 2011)

Other short term studies have looked at this topic from the standpoint of the health effects of commuting by bicycle. They have aimed to look at the effect of the higher air pollution that cyclists are exposed to when compared to car commuters. Their goal is not only to look at the negative effects that air pollution can have, but is ultimately to look at the “big picture” and try to see if the health benefits of performing this outdoor exercise are somewhat negated by the detrimental effects on health caused by the elevated pollution levels. On a study performed in Dublin, this exposure to hydrocarbon concentration while commuting by bike or by car or bus concluded that when the average time of travel and breathing rates for the bus and the bicycle journeys were taken into account, the bicycle commuter inhaled a slightly greater mass of pollutants compared to the bus passenger (O'Donoghue, Gill, McKevitt, & Broderick, 2007).

A different study, performed in Atlanta, GA, focused on the effects of vigorous exercise during peak smog season on breath pH, a biomarker of airway inflammation, in adolescent athletes. They focused primarily on the effect of ground-level ozone and particulate matter (PM) on the breath acidification and although they did not observe an acute effect of outdoor exercise, they found that both resting and post-exercise breath pH values were intermittently lower than expected in a majority of subjects. It is believed that healthy individuals should have a breath pH of 7-8 (alkaline), but the majority of subjects had intermitted breath pH levels commonly
associated with severe inflammatory conditions like acute asthma. One of their potential explanations for this is that long-term exposure to outdoor air pollution may trigger intermittent endogenous airway acidification events indicative of pollution-related lung inflammation (Ferdinands, Crawford, Greenwald, Van Sickle, Hunter, & Teague, 2008).

4.0 Long Term Effects/Mortality of Air Pollution on Athletes

Long term effects and mortality of air pollution on athletes is a topic that is still not very understood, especially those dealing with life-long exposure to pollutants (and subsequent mortality) of athletes versus non-athletes. Research on the consequences of air pollution on people that exercise more than the average population still has a lot of potential for development, as does the effects and practical applications of the results it finds. The long term effects and mortality associated pose several challenges to the researchers. Not only would this research have to span over several decades, but there would also be a very large number of variables that would be very hard to quantify or separate over such a long period.

One of the articles found on this subject, aimed at answering the question of whether regular exercise protected against air pollution-associated mortality. It was performed in Hong Kong, China and they tried to determine any relationship between the exposure to air pollutants and the quantity of exercise performed. They did so by comparing the health effects of air pollution on mortality in people who did or did not exercise about 10 years before death. They concluded that people who exercised were less susceptible to the adverse effects of air pollution mortality compared to sedentary people. However, they also found that high level of exercise would provide less protection against pollution-associated mortality than low or moderate
exercise (which they hypothesize is due to the relationship between air pollution exposure and increased intake of air pollutants during exercise) suggesting that an appropriate level of exercise is important in order to maximize the benefits.

5.0 Implications of Past and Future Research

Research has shown that the exposure of athletes to air pollution is undesirable for performance and health on both short term and long term. This is generally accepted, as seen by organizations such as the World Olympic Committee and their decision to enforce control and prevention of high levels of air pollution during their renowned competitions. Future research should focus on obtaining more varied statistical data, and perform long term studies instead of studies only lasting a few years at most. There are only a few studies that show the effect of air pollution on the mortality of athletes as compared to that of non-athletes and these are not done using data gathered over several decades.

In addition, measures to prevent the exposure of high concentrations of air pollutants to the athletic urban and rural population, but more specifically urban population, should be more widely publicized and implemented into meaningful activities such as urban planning. Using the widely available modeling tools that show plume dispersion (such as the Gaussian Plume Model), and data showing a correlation between time of day and air pollutant concentration, city planners could design urban parks and exercise locations in order to minimize the exposure of pollutants to the users.

Using the information derived from these studies, athletes themselves can also make changes in their exercise schedule in order to minimize their exposure to pollutants. They can
Limit outdoor exercise to either the early morning or late evening. It’s during these times that ozone levels are the lowest, as the reaction between automobile and industrial emissions has not had the chance, or already did, react with sunlight to form ozone. They can also check websites like www.airnow.gov to monitor the Air Quality Index (AQI), a measurement developed by the EPA to report the levels of air pollution. AQI ranges from 0 to 500 and when a level of over 100 is occurring, arduous outdoor activity should be limited. If a level of over 200 is occurring, it should be avoided as serious health concerns are brought up. A level of over 300 is very rare in the United States, but needless to say, if it did occur, the athletes should stay indoors. In addition, athletes should avoid exercising if the air is stagnant or thick feeling. Just feeling something is out of order and feeling an unusual shortness of breath could be an indication of higher than desirable air pollution levels.

Another ways that athletes can control their exposure to air pollutants is avoiding congested streets. Even though this seems trivial, the concentration of pollutants next to the road is significantly higher that the concentration as low as 50 feet from the road. A study performed in 2006 in Ireland comparing the exposure to hydrocarbon concentrations while commuting or exercising in Dublin, showed that the levels of exhaust derived pollutant were higher for the bus commuter (sitting on the floor) than the bicycle. They said that this was to be expected, since the bus sits directly in the slow moving traffic on some parts of the route and passes adjacent to the congestion when using the bus lane. The cyclist however, is normally further displaced from the main source of pollutants, by travelling at the side of the road. They conclude, that the lower results for the cyclist are evidence of the effects of dispersion across that small distance (O'Donoghue, Gill, McKeivitt, & Broderick, 2007).
Finally, further research in the correlation between specific vitamins in athletes’ diets and their interaction with certain types of air pollutants needs to be carried out. Initial research on this topic has not found conclusive evidence that there is a correlation between vitamin intake and the “neutralization” of the negative health effects of certain air pollutants. In a journal article examining the implications of air pollution effects on athletic performance, several studies on the relationship between dietary vitamin E levels and pulmonary susceptibility to ozone were mentioned. Studies in animals show that vitamin E, an antioxidant, can prevent some morphological biochemical effects of O3 exposure which have been attributed to ozone-initiated peroxidation. Similar studies in human volunteers were also performed and neither study showed any indication of added protection from vitamin E against O3 induced blood chemistry or lung function change following O3 exposure (Pierson, Covert, Koenig, Namekata, & Shin Kim, 1985). This is just one vitamin, and the correlation has not yet been made or disproved. Further studies, showcasing other vitamins and pollutants can still be made.

6.0 Conclusions

Exposure to air pollution is regarded as an item of concern for the general population, but as the air intake of athletes is higher, the athletic population seems more vulnerable to high concentrations of outdoor air pollutants. The short term effects of air pollution on athletic performance have been studied fairly deeply. On the other hand, long term effects are still not very understood especially those dealing with life-long exposure to pollutants (and subsequent mortality) of athletes versus non-athletes. Research on the consequences of air pollution on people that exercise more than the average population still has a vast horizon ahead of it, as does the effects and practical applications of the results it finds. The hypothesis that a large amount of
air pollution exposure during rigorous exercise tends to negate the benefits that exercise apparently has is one that has still to be examined by a large number of researchers. Many practical measures to control or decrease the exposure to air pollutants can already be implemented based on the results and conclusions of past studies. In addition, further studies on the relationship between certain vitamins and the “reduced” negative health effect of certain air pollutants need to be done. This could be very important in the prevention of any harmful long term effects that larger than average exposure to air pollutants by athletes could have.

7.0 References


