Effect of Air Pollution on Cardio-Respiratory Performance of Active Individuals

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Abstract

Regular physical activity has a positive influence on the health of people at all stages of their life. The greater the activity level, the higher the respiratory rate and resultant of intake of air.Round-level ozone, popularly known (and loathed) as smog, has long been recognized as a threat to cardiovascular health.If there is a smog incident then athletes, especially in the endurance events, will not achieve their top performance and those who have any tendency to asthma will be badly affected. Athletes are exerting themselves to the maximum, taking in a lot of air. If that air is polluted it will inflame the air passages.

Air pollution comes from fine particulates, which can be seen only with an electron microscope.They are ubiquitous. Cars, trucks and diesel buses--the main culprits in the creation of particle pollution--spew untold millions of the microscopic pollutants into the air daily. Exercisers should take precautions against particles, experts said, by not exerting themselves near traffic, or, if they must use a path next to a highway, staying a few hundred yards away from vehicles.

Introduction:

Regular physical activity has a positive influence on the health of people at all stages of their life.The greater the activity level, the higher the respiratory rate and resultant of intake of air. Therefore, mostly in large urban centers and industrial areas, “in the fight for health and longevity,’ people are forced to exercise in the areas with inadequate conditions, extreme temperature, little ventilation, low impact absorption soil and, above all, a direct contact with air pollution. Air pollution is the contamination of our atmosphere.

Research has highlighted a number of pollutants of concern for performance athletes and the general public. These include particulate matter (PM), nitrogen and sulphur oxides, the ammonium ion, organic aerosols, and ozone. PM10 (particulate matter 10 µm and under) corresponds to particles with a diameter of about a tenth of an adult human hair and smaller, and can be breathed deep into the lung. In urban areas these particles originate from sources including traffic and industry.

. During times of temperature inversion (when temperature increases with altitude, in contrast to the more typical decrease) or when air movement is low, air pollutants can reach concentrations that can severely impede physical performance."The expected increases in traffic will certainly lead to further breaches of legal limits in areas that already suffer from poor air quality. The most common air pollutants are carbon monoxide, sulfur oxides, nitrogen oxides, ozone, peroxyacetyl nitrate, aerosols, soot, dust and smoke.

"Endurance athletes such as cyclists and runners are most at risk when pollution levels are high because they breathe harder and inhale more particulate matter," said Mike Howell, M.D., assistant professor, Department of Neurology, University of Minnesota.The air pollution dosage during exercise is much higher than during rest because of a higher ventilatory rate and both nasal and oral breathing in the former case. For example, sulfur dioxide, which is a highly water-soluble gas, is almost entirely absorbed in the upper respiratory tract during nasal breathing. However, with oral pharyngeal breathing, the amount of sulfur dioxide that is absorbed is significantly less, and with exercise and oral pharyngeal breathing a significant decrease in upper airway absorption occurs, resulting in a significantly larger dosage of this pollutant being delivered to the tracheobronchial tree. The effect of these pollutants is, in part, related to their penetration into the body.The presence of more than one pollutant, or other environmental stressors (e.g. heat, cold and altitude), which is generally the case in most smog conditions, usually has a more powerful effect on the body. As they are inhaled, the main effects of air pollutants are on the respiratory tract. The nose hairs remove large particles and highly soluble gases very effectively, but smaller particles and agents with low solubility pass easily. During exercise, when mouth breathing plays an important role, this air filtration process is much less efficient, and more pollutants reach the lungs.

Reynold A. Panettieri Jr., MD, Professor of Medicine and Director of the University of Pennsylvania's PENN Airways Biology Initiative in Philadelphia, has studied how exposure to ozone, a common air pollutant, may damage cells in the respiratory tract and cause a temporary decrease in lung capacity.

Health Risk of Ozone:

During the 2008 Beijing Olympics, pollution and poor air quality came under heavy media scrutiny. Despite the host city's efforts, they could not cover up the thick smog that lingered over the Games. In fact, some American athletes arrived in Beijing wearing masks to protect themselves from dangerous pollutants.

Most people, when they think of air pollution, think first of ozone, ozone is formed by a reaction cycle involving nitrogen monoxide, nitrogen dioxide, oxygen, hydrocarbons and energy from ultraviolet radiations. Ground-level ozone, popularly known (and loathed) as smog, has long been recognized as a threat to cardiovascular health."Ozone over the long term causes what is similar to a premature aging of the lungs," said Dr. Michelle Bell, an assistant professor of environmental health at the Yale School of Forestry and Environmental Studies.

But today most experts agree that, as Lippmann said, the "greatest overall public health impact" of air pollution comes from fine particulates, which can be seen only with an electron microscope.During light-to-moderate sub maximal exercise lasting several hours, exposures to 0.3 to 0.45 ppm O3 have resulted in decrements in pulmonary function and increased subjective discomfort. For more intense levels of exercise, the respiratory discomfort can become severe and thereby limit performance. Ozone has also been associated with eye irritation, general respiratory discomfort and nausea.

According to Keith Prowse, respiratory consultant and medical adviser to the British Lung Foundation, a summer smog like any of the five already experienced this

year in the capital could lead to some athletes needing medication and experiencing chest pains, sore throats and shortness of breath.

If there is a smog incident then athletes, especially in the endurance events, will not achieve their top performance and those who have any tendency to asthma will be badly affected. Athletes are exerting themselves to the maximum, taking in a lot of air. If that air is polluted it will inflame the air passages. It could have a significant effect on endurance events like the marathon, anything over 400-800m, even sailing," said Prowse.

London air pollution is some of the worst in Europe, but athletes are expected to suffer most in certain weather conditions brought on by a spell of hot weather when pollutants, including nitrogen dioxide, react in sunlight to form low-level ozone smog which can get trapped for several days.

Early research on the effects of ozone on lung function in man dealt with concentrations which are unrealistically high in terms of expected ambient levels (Clamann and Bancroft, 1959; Young et al., 1964; Bates et al., 1972). These studies demonstrated that ozone caused decreased maximum expiratory flow, tracheal irritation and decreased diffusing capacity.

Pollution and Exercise:

“Endurance athletes such as cyclists and runners are most at risk when pollution levels are high because they breathe harder and inhale more particulate matter,” said Mike Howell, M.D., assistant professor, Department of Neurology, University of Minnesota. “Further airborne pollution can trigger an asthmatic response with exercise (even among people without asthma). Acute airborne pollution exposure can also lead to impaired lung and vascular function.”

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Particles can sail past nasal hairs, the body's first line of defense, and settle deep in athletes' lungs. Some remain there, causing irritation and inflammation. Others, so tiny they can bypass various bodily defenses, migrate into the bloodstream.

"Blood vessels do not like those particulates," said Dr. David Newby, a cardiology professor at the University of Edinburgh.

Rundell KW finds that Exposure to freshly generated mixed combustion emissions such as those observed in proximity to roadways with high volumes of traffic and those from ice-resurfacing equipment are of particular concern. This is because there is a greater toxicity from freshly generated whole exhaust than from its component parts. The particles released from emissions are considered to cause oxidative damage and inflammation in the airways and the vascular system, and may be related to decreased exercise performance.

Newby has seen the effects of those particles on active people. In 2005, he and his colleagues had 30 healthy volunteers ride exercise bikes inside a laboratory for 30 minutes, while breathing piped-in diesel exhaust at levels approximately those along a city highway at rush hour.

Afterward, the researchers did “kind of stress test of the blood vessels” in the participants’ forearms, Newby said, and found that the vessels were abnormally dilated; meaning blood and oxygen could not flow easily to the muscles. At the same time, levels of tissue plasminogen activator, or tPA, a naturally occurring protein that dissolves blood clots, had fallen."Those are ideal conditions for a heart attack," Newby said. A heart attack can start when arteries constrict and a clot forms. Without sufficient tPA, the clot is not dissolved, the artery is blocked and the heart is damaged.

The effect of air pollution on athletes came to the fore during the 1984 Los Angeles Olympics, where British middle-distance runner Steve Ovett collapsed with respiratory problems after the 800-metres final, citing air pollution as a major trigger for his "exercise-induced" asthma.

With respect to the short-term effects of pollutants on exercise performance, the main problems are irritation of the upper respiratory tract, respiratory discomfort and reductions in the oxygen transport capacity of the blood. Carbon monoxide (CO) emissions in urban areas are greater than emissions of all other pollutants combined. CO primarily affects exercise performance through its strong (200 times stronger than that of oxygen) capacity to bind to hemoglobin (COHb) in the blood, thereby reducing the blood’s capacity to transport oxygen to the tissues. Very high levels of COHb are needed to produce reductions in sub maximal exercise performance. Therefore, under realistic outdoor conditions, the effects of CO only become evident when maximal exercise performance is an issue. For example, maximal oxygen uptake is reduced at COHb concentrations above 4.3 percent (during prolonged exposure to heavy traffic, COHb concentrations of 5 percent have been observed).

For those with cardiovascular impairment, problems may occur during sub maximal exercise at lower concentrations of COHb (2.5 percent to 3 percent). Sulfur oxides (Sox), mainly in the form of sulfur dioxide(SO2), exert their influence through irritation of the upper respiratory tract, which can cause reflexive bronchoconstriction and increased airway resistance. Nose breathing strongly reduces this effect compared with mouth breathing.

Before the Olympics started, scientist’s worldwide and casual observers expected the worst from Beijing's polluted air. According to biomedical researchers at the University of Verona, Italy, Beijing is one of the world's most polluted megacities. The concentrations of carbon monoxide, ozone, nitrogen oxides, sulfur dioxide, and particulate matter approach and often exceed the current limits established by the US Environmental Protection Agency as safe. Scientists also said that these air pollutants would be detrimental to athletes competing in Beijing due to the marked increase in ventilation rate (up to 20-fold) and concomitant oral breathing, which often bypasses the nose during strenuous exercise, increasing the deleterious effects of pollutants on the respiratory system and athletic performance.

Oxides of Nitrogen: Principally caused by cars and electrical utilities can cause an increase in airway resistance.

*Ozone:*Caused by photochemical reaction of excess nitrogen and hydrocarbons. Ozone irritates the airways of the lungs, increasing the symptoms of those suffering from asthma and lung diseases.

Particular Matter: These particles are generated by combustion sources (power plants and cars) as well as coarse dust particles. With a diameter less than 10µm these particles

can penetrate into the upper respiratory tract and amplify asthma symptoms and even trigger asthma symptoms in non-asthmatics.

Sulfur Dioxide: Typically caused by power stations burning fossil fuels. Even moderate concentrations may result in a decrease in lung function in asthmatics. Sulfur dioxide pollution is considered more harmful when particulate and other pollution concentrations are high.

Carbon Monoxide: Carbon Monoxide interferes with haemoglobin-oxygen transport by binding to the oxygen carrying sites on the haemoblobin molecules. Therefore the potential effect of carbon monoxide on exercise performance is related to impaired transport of oxygen in the blood.

In urban environments, it appears essential that both recreational and elite athletes be properly educated about protecting themselves from the worst effects of high pollutants while exercising. As it is difficult to actually change the air that we breathe, most of the advice comes down to commonsense methods to reduce exposure.

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