

Air Pollution and Sports Performance in Beijing

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Abstract

The Beijing Olympics will begin in August 2008 and athletes will face an unpredictable challenge. Based on present data, Beijing is one of the most polluted megacities in the world; the air concentrations of carbon monoxide (CO), ozone, nitrogen oxides (NO and NO₂), sulphur dioxide (SO₂) and particulate matter approach or exceed the current limits established by U.S. Environmental Protection Agency (EPA). Although the athletes who will be competing in Beijing are physiologically very different to the participants in most published studies, and it is therefore difficult to predict individual responses, there is little doubt

that the presence of these air pollutants might be detrimental to athletic performance due to the marked increase (up to 20-fold) in ventilatory rate and concomitant nasal and oral breathing. Moreover, mouth breathing often bypasses the noise during strenuous exercise, increasing the deleterious effects of pollutants on health and athletic performance. Although limited, each decrement in athletic performance would have a potentially deleterious impact on top-class athletes competing in the next Olympics in China. Several Olympic records are regularly broken during the Olympics. Will this be the case for Beijing?

Introduction

The Olympics are here again: this August, the 2008 Beijing Olympics will begin, and athletes will face an unpredictable challenge. The rapid urbanisation in China since the 1980s has resulted in increasingly poor air quality, and 16 of the world's 20 most polluted cities are in China [3]. Beijing, as the capital city of China and a typical megacity with a population of nearly 10 million inhabitants, has battled with increasing urbanisation and traffic congestion in recent years, both resulting in heavy air pollution [13,20]. Pollutants can harm human health, and air pollution during the Olympics might be a serious problem, resulting in health risk for athletes and visitors [10]. However, competing in Beijing poses additional threats, even greater than those of the last games in Athens [5]: how much will athletic performance be influenced by air pollution; moreover, is there any chance that Olympic records will be broken under such environmental conditions? No one can predict the potential scenario at this time. But we can still make some conjectures.

Air Pollution and Athletic Performance

The annual average concentrations of organic carbon (OC, a term used to describe the thousands of dissolved compounds found in water that derive from organic materials) and elemental carbon (EC, a marker for diesel particulate matter), at the urban site in Beijing are much higher than those in some cities with serious air pollution [19,20]. Although standards for air pollution can be acceptable in light of what is scientifically known about the effects on health and environment, the current U.S. Environmental Protection Agency (EPA) limit for carbon monoxide (CO), a colourless and odourless toxic gas, is 10 mg/m⁻³ (9 parts per million, ppm) averaged over 8 hours [15], a threshold that can be worryingly approached in Beijing: the average daily concentration of CO during the heating period of the year is 3.5 ± 2.6 mg/m³ (3.15 ± 2.34 ppm), with peaks from 14 (12.6 ppm) to 17 mg/m³ (15.3 ppm) [16]. With increased blood concentrations of CO, maximal cardiac output and maximal arteriovenous difference are lowered, resulting in a higher heart rate, in a decrease in maximal oxy-

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gen uptake and work output, which will finally penalize athletic performance, especially endurance competitions (e.g., 10 000 m, marathon, 20- and 50-km race walking, etc.) [2]. Ozone concentration on the ground is linear with temperature in Beijing: the maximum values appear in the heating period, from 0.085 ppm by volume on the ground to more than 0.09 ppm in the stratosphere [21], thus exceeding the EPA 2008 limit (0.075 ppm) [15]. Ozone is an unpleasant gas, and its effects are detrimental to athletic performance if exposure is sufficiently high. In fact, the respiratory discomfort associated with increased ozone exposure may cause decreased maximal work performance, and contributes significantly to increase the overall relative perceived exertion [2]. Exposure to elevated ozone concentrations has also been reported to give rise to symptoms that include cough, chest pain, difficulty in breathing, headache, eye irritation, and a decrease in forced expiratory volume in one second [4]. Responsiveness to ozone is a function of concentration, exposure duration, and level of ventilation. Therefore, its effects might be enormously magnified by exercise [6,17]. The oxides of nitrogen, traditionally referred to as NO_x, are mainly represented by nitrogen oxide (NO) and dioxide (NO₂). Nitrogen oxides are common byproducts of combustion, and cars and fossil-fuel burning power plants are two chief sources of the molecules. Although a substantial drop in the concentration of NO₂ has been achieved in the 1995–2000 period (from 122 µg/m³ to 71 µg/m³), because of rapid motorisation, values are now approaching the EPA 100 µg/m³ (0.053 ppm) threshold [15] and the predictable increment of traffic during the Olympics might worsen the situation [7].

The annual recorded concentration of particulate matter with aerodynamic diameter less than 10 microm (PM₁₀) ranges from 141 to 166 µg/m³, and it could be very harmful to human health [20]. Although PM₁₀ is unlikely to modify the athletic performance significantly [2], it has still harmful effects on health, since its combination with sulphur dioxide (SO₂) and water vapour forms sulphuric acid coated particles which deposit inside the lung and produce irritation and asthma-like symptoms. The particles themselves contain, among a variety of substances, compounds including carcinogenic hydrocarbons and lead [14]. The extent of SO₂ pollution is mainly determined by the sulphur content of the fuel and/or sulphur in the air when the air is used for combustion. Ambient concentrations of SO₂ have decreased dramatically in several megacities. At present, however, Beijing can be considered to have serious pollution. The ambient levels in this city are in excess of PEA guidelines (78 µg/m³, 0.14 ppm) [15] by a factor of nearly three for annual average concentrations, and peak daily concentrations exceed 700 µg/m³ [9]. In humans, a combination of exercise and air pollutants, including ozone or sulphur dioxides, cause a significant increase in bronchoconstriction and air flow obstruction when compared to the same exposure at rest [12]. Epidemiologic studies have also suggested the association between environmental exposure to volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) and the increased risk of incurring asthma [8]. Moreover, acute exposure to air pollutants might produce significant variations of the renal function, such as increase urine volume, NH₃ and CO₂ excretion [16]. As most anti-doping tests use urine as biological matrix to detect illicit substances, the potential influence of air pollution on test results should be carefully taken into consideration to prevent either false-negative results or unfair sanctioning due to false-positive results. It should also be mentioned that the air pollution and following respiratory

problems will increase the use of drugs (e.g., antiasthmatics, such as beta-2 adrenergic agonists and corticosteroids) properly prescribed and administered, but possibly used unfairly.

There are already some reactions to the potentially unfavourable environmental conditions in Beijing. Athletes and coaches are talking openly about the dirty air. Several countries are planning pre-Olympic training camps outside China, especially in Japan or South Korea. The American swim team is basing itself far away in Singapore. There are plans to test facemasks – if not in competition, at least during training and leisure time. Such a declared intent of single athletes or teams to perform training far away and join the Olympic Village only in the days of games could be an unerring method for avoiding problems, but it will increase suspects and probably litigations during and after the Olympics. Olympic tennis champion Justine Henin pulled out of a tournament in Beijing last year because pollution aggravated her asthma, and she is considering to pull out of the Games. Haile Gebrselassie, the marathon world record holder, is also considering to miss the Olympics and, should he finally come, he will decide then whether he will run the marathon or the 10 000 metres [11].

Conclusions



Based on present data, Beijing is one of the most polluted megacities in the world, second only to Dhaka [9]. The International Olympic Committee (IOC) has exerted huge pressure on China to solve the problem, and president Jacques Rogge has warned that some endurance events might be even postponed if the air is too bad. Accordingly, Beijing's Olympic organisers are launching urgent measures to clean up the city's air in time for the Games in August. Despite these sterling efforts, many predict that athletes will be still affected by air pollution problems on an unprecedented scale, especially for those disciplines that will be performed outdoors. With the Olympic Games approaching, the air quality in Beijing must be improved not only to protect the athletes, but also to provide the optimal environmental conditions for athletic performances. Although the athletes who will be competing in Beijing are physiologically very different to the participants in most published studies, and it is therefore difficult to predict individual responses, there is little doubt that the presence of several air pollutants might be detrimental to athletic performance due to the marked increase (up to 20-fold) in ventilatory rate and concomitant nasal and oral breathing. Moreover, mouth breathing often bypasses the nose during strenuous exercise, increasing the deleterious effects of pollutants on health and athletic performance [5,12]. Although limited, each decrement in athletic performance would have a potentially deleterious impact on top-class athletes competing in the next Olympics in China. Several Olympic records are regularly broken during the Olympics [1]. Will this be the case for Beijing?

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