

## Clinicians prescribing exercise: is air pollution a hazard?

*A common-sense approach to reducing exposure to polluted air is required*

It is an unquestionable fact that regular physical activity is beneficial to health and longevity. Accordingly, it is common practice for physicians and other health care professionals to encourage exercise. However, people exercising in urban regions may be unwittingly at risk because of exposure to concentrated automotive pollution, a known risk factor for cardiovascular and respiratory disease. The physiological changes that occur during exercise probably act to compound the toxic effects of environmental air pollution, and certain patient populations may have increased sensitivity. People should not be deterred from regular exercise, as it is of known benefit, but when prescribing exercise, clinicians should extend appropriate advice to patients to avoid areas with high pollutant concentrations.

What, then, is the evidence to support such advice? Automotive exhaust comprises a heterogeneous mixture of suspended particles and gases, the most common gases being sulphur dioxide, nitrogen dioxide, carbon monoxide and ozone. Unburnt fuel emits volatile organic compounds (eg, benzene, toluene) and the fuel combustion process liberates many thousands of chemicals in addition to particulate matter of varying size and composition. Ultrafine particulate matter, with an aerodynamic diameter  $<0.1\mu\text{m}$ , is thought to be particularly harmful to health, as it is readily inhaled and absorbed into the circulation.<sup>1</sup> Epidemiological data have identified individual components of air pollution, or pollution collectively, as promoters of cardiovascular and respiratory disease.<sup>2,3</sup> Some compounds are also known or suspected carcinogens.<sup>4</sup>

Harmful effects on the body from pollutants are multifactorial, with acute or chronic exposures increasing the cellular processes associated with atherogenesis (the underlying cause of most cardiovascular disease), impairing pulmonary function, provoking local and systemic inflammation, disrupting cardiac autonomic control and inducing vascular dysfunction. Deleterious health effects may result from exposure to pollutants at concentrations that are lower than recommended air quality standards.<sup>5</sup> Indeed, research to date has failed to determine a "threshold" limit for which there is no adverse health effect.<sup>6</sup> In general, most large-scale time series analyses of the physiological effects of air pollution find an exposure-dependent relationship that crosses socioeconomic boundaries and poses a significant threat to everyone's health. Importantly, certain populations may be particularly vulnerable to the effects of polluted air, such as children,<sup>7</sup> people with asthma,<sup>8</sup> diabetes<sup>9</sup> or acute lower respira-

tory disease; and frail or elderly people with pre-existing heart and lung conditions.<sup>10</sup>

Why may exercise in polluted areas be particularly hazardous? During aerobic exercise, even at relatively low intensities, inspired air is taken in predominantly through the mouth, and there is a major increase in minute ventilation and diffusion capacity. These factors augment the respiratory uptake of airborne contaminants, with increased penetration to the lower gas-exchange regions of the lung. Indeed, the total amount of ultrafine particulate matter deposited in the respiratory tract of humans during moderate exercise has been shown to be about five times that at rest.<sup>11</sup> As would be expected, when the concentration of pollutants increases, so too does the amount of inhaled matter. Thus, habitual exercise in highly polluted localities, such as alongside busy roadways, may increase the overall intensity, duration and frequency of exposure, all of which are relevant to the evaluation of an individual's risk profile for disease.<sup>6</sup>

Pulmonary function may markedly decline after inhalation of pollutants during exercise. In one study, when adolescents with asthma were exposed to sulphur dioxide and sodium chloride aerosol during treadmill running, many displayed symptoms of wheezing and shortness of breath.<sup>12</sup> Several other studies have shown that poor air quality and acute exposures during exercise may induce symptoms in people with asthma, impair athletic performance in healthy people,<sup>13</sup> and contribute to exercise-induced myocardial ischaemia in patients with stable coronary artery disease.<sup>14</sup> This information should not be interpreted as a reason for people living in cities to stop exercising. Rather, a common-sense approach to reducing or avoiding exposure to polluted air during exercise is advisable.

In summary, there is sound evidence for an exposure-dependent relationship between air pollution, morbidity and mortality, particularly in relation to cardiovascular and respiratory illnesses. Although regular aerobic exercise is recommended for good health, there may be adverse health consequences for people who habitually exercise in areas of high ambient pollution. Despite this, it is not uncommon to see people running or cycling alongside congested roadways, and clinicians should advise patients to exercise on quiet roads or in parks and recreation areas. The best time of day to exercise is early in the morning, before the build-up of traffic and when it is cooler. This is relevant because the combination of sunlight and heat with

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certain compounds increases ozone production. Importantly, certain groups may be acutely susceptible to the effects of air pollution, and clinicians should advise them accordingly.

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