Environmental and Public Health Risks from Air Pollution at the Beijing 2008 Olympics

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China has made enormous strides in tackling its environmental problems, but considerable work remains to be done. In an article on environment and public health published in the Winter 2007 edition of this journal, the question was raised whether the forces unleashed by China's aggressive approach to economic growth since the late 1970's --- two to three times the global average --- were too strong to be controlled by its environmental policies. The same question remains relative to health risks for the Summer Olympics this August (2008): "The main problem appears to be that well intentioned public health and environmental policies have not yet been realistically integrated into overall policies which emphatically promote economic growth."[1] In other words, theory and practice are in conflict and in practice, China has been promoting objectives that are diametrically opposed. In August, 2007, China conducted a dry run of procedures to control air pollution by restricting car use. The results were hard to interpret: official websites claimed success, while other observers and official data showed varied results of successful pollution reduction (see below). Overwhelmingly the major health as well as environmental concern for Beijing is air pollution and solutions have concentrated on the city itself, but surrounding areas are also problematic and have not been addressed as well. This article will look at the health risks to athletes and the preparations that the Chinese government has been making to forestall widespread air pollution for the games. One of the main reasons Beijing was chosen for the 2008 Olympics over Toronto and Paris was its proposals to have a "green Olympics."

Understanding the Health Risks for Athletes

The principle health risk for athletes, obviously, centers around outdoor events. Performance at an athletic event is equivalent to an episode of prolonged intense inhalation, and if pollutants are present, an acute, intense exposure. Athletes typically inhale about 10-20 times as much air as sedentary people, and thus 10-20 times the pollution. Proximity to pollution sources can be extremely important if athletes, for example, opt to run near areas with heavy automobile use, which is generally not the case in Beijing because vehicle use is to be curtailed during the Olympics. Similarly, weather conditions, mainly high heat and humidity plus stagnant air, can also create unhealthy levels of pollution that should be avoided, a factor that remains to be seen for Beijing.

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[1] James Listorti, "Is China Subordinating Health and Environmental Concerns to Economic Growth?", Journal of the Washington Institute of China Studies, Winter 2007, Vol. 2., No. 3, p. 91.

The two major pollutants of health concern are fine particulate matter and ozone (O_3), which is worse in summer. Particulate matter (PM, $PM_{2.5}$, *i.e.*, 2.5 micrometers in diameter, or PM_{10}, 10 micrometers) is significant because the fine particles can penetrate deeply into the lungs and can thus enter the blood stream or remain embedded in the lungs. (Currently, China has no standards for $PM_{2.5}$.) PM comes from power plants, motor vehicles and industrial sources. The main sources of ozone are motor vehicles and power plants. In most instances, the health damage occurs because of the accumulated effects of repeated exposures over the long term. Like so many environmental health exposures, effects are seldom immediate (with the exception of diseases like asthma) and may take up to twenty years to cause cancer or a heart attack. However, short term effects *can be* significant, and can trigger events like heart attacks. (Recall that running guru Jim Fixx, author of *The Complete Book of Running*, died of a heart attack while running in 1984 at the age of 52. It was discovered that he had heart problems. [2]) A study conducted on healthy volunteers exposed to diesel exhausts equivalent to highway rush-hour traffic showed that blood vessels were abnormally dilated, meaning blood and oxygen could not flow easily to the muscles. At the same time, levels a naturally-occurring protein that dissolves blood clots, had fallen.[3]

In theory, however, healthy athletes, who do not have heart or lung problems should be able to compete without physical harm.[4] And Olympic athletes are some of the healthiest people in the world. World record marathoner Haile Gebrselassie of Ethiopia, who announced that he will not participate in the marathon, suffers from asthma. Other athletes have chosen to deal with asthma by adjusting their medication.[5] Nonetheless, air pollution remains a concern. The big unknown will be meteorological conditions.

Air Pollution Exposure for Athletes

Close to 11,000 athletes are expected for the Olympics. The list of athletic events is shown in Table 1, with those occurring outdoors in bold. Track and field events are listed under "Athletics" and "Football" refers to the American term soccer.

Endurance events, *i.e.*, those lasting longer than an hour, like prolonged running, cycling and marathon activities, collectively place athletes under the greatest stress from extended exposure to pollutants, coupled with intense respiration. Even in light of all the positive steps that the government has taken to make these "green Olympics," the International Olympic Committee (IOC) as late as this April said that it was prepared to postpone endurance events, although it did not consider a substantial risk unless conditions are very bad. The IOC also noted

[2] "Exercise and death: Am I safer on the couch?" CBS News In Depth --- Exercise and Fitness, October 4, 2006; http://www.cbc.ca/news/background/exercise_fitness/exercise_death.html
[3] "For Athletes, an Invisible Traffic Hazard;" Gretchen Reynolds, The New York Times, July 12, 2007. http://www.cleanairpartnership.info/Media percent20Room/New percent20York percent20Times percent20-percent20For percent20Athletes, percent20an percent20Invisible percent20Traffic percent20Hazard.pdf
[4] "Beijing smog raises health fears;" http://newsvote.bbc.co.uk/mpapps/pagetools/print/news.bbc.co.uk/sport2/hi/other_sports/6949483.stm
[5] "Beijing Olympics: Radcliffe Cools Pollution Fear;" Telegraph, 8 Apr. 2008; http://www.telegraph.co.uk/sport/main.jhtml?xml=/sport/2008/04/08/ubradcliffe108.xml

Table 1: List of Olympic Events

Archery	**Cycling Track**	Judo	Table Tennis
Athletics	Diving	Kayak Flatwater	Taekwondo
Badminton	Equestrian	Kayak Slalom	**Tennis**
Baseball	Fencing	**Modern Pentathlon**	**Triathlon**
Basketball	**Football**	Rowing	**Volleyball**
Beach Volleyball	Gymnastics Artistic	Sailing	Water Polo
Boxing	Gymnastics Rhythmic	Shooting	Weightlifting
Cycling BMX	Gymnastics Trampoline	**Softball**	Wrestling
Cycling Mountain Bike	Handball	Swimming	
Cycling Road	Hockey	Synchronised Swimming	

that air pollution is a recurrent concern for the Olympics, and that it should not pose a hazard for events under one hour.[6] Heat and humidity are also recurrent concerns for summer Olympics. The IOC acknowledged, however, that a consequence of air pollution athletes may not perform at the best level, which could influence setting world records under unfavorable conditions.[7]

Events are also being held in six other cities, where pollution threats vary, as shown in Table 2. However, the events are minimal in number when compared with Beijing.

Table 2: Events in Cities outside Beijing

City	**Population**	**Olympic Event**
Hong Kong	6,980,412[8]	Equestrian
Qinqdao	1,642 245[9]	Sailing
Qinhuangdao	759,718[10]	Football Preliminary
Shanghai	16,740,000[11]	Football Quarter Finals
Tianjin	9,848,731[12]	Football Semi Finals
Shenyang	5,680,000[13]	Football Quarter Finals

Regional Risks

Most attention, certainly that of the government, has focused on curtailing air pollution in Beijing, but there is a concern that much of the air pollution experienced in Beijing itself is actually *regional* in nature and thus not necessarily attributable to local sources and thus

[6] "IOC Admit Beijing Olympics Could Be Health Risk to Athletes;" 2 April 2008, Associated Newspapers Limited, http://www.metro.co.uk/sport/other/article.html?in_article_id=132094&in_page_id=52
[7] Olympic Officials Want to Clear the Air: Pollution Could Affect Athletes in Beijing, The Washington Post, March 18, 2008; p. A01. http://www.washingtonpost.com/wp-dyn/content/article/2008/03/17/AR2008031700973.html
[8] http://www.infoplease.com/ipa/A0108114.html
[9] http://www.fullworld.eu/city?i=429787&n=Qingdao
[10] http://population-of.com/en/China/10/Qinhuangdao/
[11] http://www.unescap.org/esid/psis/population/database/chinadata/shanghai.htm
[12] http://www.citypopulation.de/China-Tianjin.html
[13] http://www.chinamaps.info/Shenyang/Shenyang-Population.htm

unaffected by local measures of pollution reduction. A recent study explicitly examined regional air pollution in the context of the Olympic Games. [14] A very broad area was shown to have a pronounced impact on Beijing. Tianjin, a city of 9.3million people, lies about 120 km., or about 2 1/2 hrs., southeast of Beijing. Surrounding Beijing are three large heavily populated, urbanized, and industrialized provinces, Hebei, Shandong, and Shanxi. In addition, four large urban centers of Shijiazhuang, 9.1 million, Qingdao, 7.2 million, Jinan, 5.8 million, and Taiyuan, 3.3 million, lie within several hundred kilometers of Beijing. Each is a typical industrial, coal-burning city where emissions controls are not as strong as Beijing.[15] Shanghai is China's largest city, and is heavily polluted.

The study notes that the specific objectives for the Olympic Games are;

(a) that concentrations of SO_2, NO_2, and O_3 should meet WHO guidelines; and

(b) that particle concentrations should be comparable to levels in major cities in the developed countries.

The study found that prevailing winds in summer daytime are from the south and southeast --- *i.e.*, Hebei, Shandong, and Shanxi provinces --- and that there is a definite regional contribution to both peak and average ozone concentrations in Beijing. For example, it has been estimated that Hebei Province contributes 30 percent or more of Beijing's $PM_{2.5}$ and Tianjin contributes about 10–20 percent, mostly to the eastern part of Beijing. For O_3, the contributions are lower, with Hebei Province contributing about 10–20 percent to ozone concentrations in the eastern part of Beijing and Tianjin's contribution being less than 10 percent for most of Beijing.[16] The study concludes:

> "There is no doubt that the measures planned to limit air pollution in Beijing will greatly improve Beijing's air quality for the period of the 2008 Olympic Games. But will they be sufficient to achieve the stated objectives? This study shows that, even in the limit that Beijing generates no manmade emissions, levels of fine PM and ozone could still be high and could exceed healthful levels under unfavorable meteorological conditions." [17]

In another study, Chinese scientists found that emissions in China's third largest city, Tianjin, contributed 10-33 percent of the smog in Beijing, and that emissions in Hebei Province contributed 6-13 percent of Beijing's smog.[18]

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[14] "Air Quality during the 2008 Beijing Olympic Games;" David G. Streets, Joshua S. Fu, Carey J. Jang, Jiming Hao, Kebin He, Xiaoyan Tang, Yuanhang Zhang, Zifa Wang, Zuopan Lib, Qiang Zhang, Litao Wang, Binyu Wang, Carolyne Yu; Atmospheric Environment; Vol. 41, Issue 3, January 2007, p. 480-492.
[15] "Air Quality during the 2008 Beijing Olympic Games;" op. cit., p. 481.
[16] "Air Quality during the 2008 Beijing Olympic Games;" op. cit., p. 488-89.
[17] "Air Quality during the 2008 Beijing Olympic Games;" op. cit., p. 490.
[18] "Regional Pollution Could Overwhelm Beijing's Clean Air Efforts;" Environment News Service, Apr. 13, 2007; http://www.ens-newswire.com/ens/apr2007/2007-04-13-04.asp

Preparations for Air Pollution Control

Beijing certainly has an "image problem" to overcome. According to the World Bank, 20 of the world's 30 most polluted cities, largely due to high coal use and motorization, lie in China.[19] And in 2005, the Guardian carried a headline: "Satellite Data Reveals Beijing as Air Pollution Capital of World."[20] Preparations for the Olympics to promote a healthy environment and reduce air pollution have been extensive and varied. According to the official Olympic website, *Beijing 2008*, the city has spent more than $15 billion on anti-pollution measures such as moving factories, adding subway lines, upgrading boilers and converting coal-heated homes to electric.[21] In May, the government banned smoking in public places in Beijing in preparation for the Olympics.[22] The government has even had a massive drive to collect stray cats because some are diseased.[23] Other measures announced by the Chinese government include:

- suspension of construction from July 20 to September 20 (the latter date to accommodate the Para-Olympics);

- 19 heavy-polluting industries have been asked to cut emissions by a further 30 percent;

- gas stations, tanker trucks and oil depots will be closed if they haven't completed "oil --- vapor recovery" technical upgrades;

- outdoor spray-painting is forbidden throughout the city;

- quarrying operations will be stopped;

- the government will remove as many as half of Beijing's 3.3 million vehicles off the roads during the Games (automobiles, excluding taxis, buses and emergency vehicles, are to stay off roads every day, determined by even-odd license plate numbers);

- as of March 20, all earthwork construction projects have been suspended on windy days;

- new car emission standards have been implemented since March 1 to match those in the European Union; and

[19] World Bank, "China Quick Facts"; http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/CHINAEXTN/0,,contentMDK:20680895~pagePK:141137~piPK:141127~theSitePK:318950,00.html, and *East Asia 10 Years After the Financial Crisis*, Apr. 2007.

[20] "Satellite Data Reveals Beijing as Air Pollution Capital of World," Jonathan Watts, The Guardian, Oct. 31, 2005; http://www.guardian.co.uk/news/2005/oct/31/china.pollution

[21] "Beijing on Track 100 Days before Games;" Beijing 20008, http://en.beijing2008.cn/100days/publicevent/s214328673/n214331198.shtml

[22] "Beijing to Enact Extended Smoking Ban in May;" China Daily, 28 April 2008. http://www.chinadaily.com.cn/citylife/2008-04/25/content_6644005.htm

[23] "Olympics Clean-Up Chinese Style: Inside Beijing's Shocking Death Camp for Cats;" Daily Mail, 12 March 2008 http://www.dailymail.co.uk/pages/live/articles/news/worldnews.html?in_article_id=528694&in_page_id=1811

- coal-burning industries have been relocated out of built-up areas. [24]

According to the United Nations Environment Programme (UNEP), Chinese authorities have relocated and refitted major polluting industries and switched away from coal-fired energy generation towards less polluting fuels like natural gas. ... Older buses, taxis and cars have been scrapped in favor of ones powered by compressed natural gas or new vehicles and fuels that meet tougher, internationally recognized emissions standards. Nonetheless, levels of small particles in the atmosphere, or PM_{10} … often greatly exceed World Health Organization Air Quality Guidelines. The city's geographical location exacerbates the problem. The mountains surrounding Beijing block air circulation and prevent the dispersion of pollutants.[25]

The official website is understandably quite positive. Beijing has input 120 billion yuan ($17.1) in improving air quality in the past years, and the number of "blue sky" days increased to 246 last year from 100 in 1998, when the capital launched the "blue sky" drive. It also points to other efforts to help control regional pollution. It notes that Beijing recorded 67 "blue sky days" in the first quarter, 12 more than in the corresponding period last year and aims to have 70 percent of the days up to standard this year, or 256 blue sky days. In addition, major pollution indices kept dropping markedly. Tianjin, about 75 miles (120 km) to the southeast, and the provinces of Hebei, Shanxi and Shandong, and the Inner Mongolia Autonomous Region are collaborating to attain anti-pollution goals for Beijing. These efforts include closing major polluters, removing outmoded cabs and reconditioning gas stations to capture harmful chemicals.[26] However, by comparison, a World Bank report notes that, from 2000 to 2005, China failed to meet 10 of 13 targets for air and water reducing pollution, and that air pollution indicators have remained constant or, in some instances, have increased. (It should be noted that the 13 indicators measured domestic and industrial "soot" and did not cover O_3.)[27] That same report states that only 1 percent of the country's urban population lives in cities with annual levels of PM exposure that are considered safe by European Union standards (average PM_{10} levels below 40 $\mu g/m^3$).[28] Thus, there are reasons for continued concern.

Most ambitious is the plan to remove half the private automobile fleet during the Games. Automobile pollution is incontestably one of Beijing's biggest environmental headaches. Vehicle growth has been increasing at nearly 15% percent a year.[29] The number of vehicles has

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[24] "Measures to Improve Air Quality in Beijing;" Chinese Government's Official Web Portal, 15 April 2008; http://english.gov.cn/2008-04/15/content_945131.htm

[25] "Greening" of 2008 Beijing Olympic Games Impressive Says UN Environment Programme Report --- Remaining Concerns include Air Pollution; Offsetting of Greenhouse Gas Emissions; Public Awareness and Need to Boost Public Transport Use;" UNEP Press Release, Beijing/Nairobi, 25 October 2007. http://www.unep.org:80/Documents.Multilingual/Default.Print.asp?DocumentID=519&ArticleID=5687&l=en

[26] "Beijing Reports More 'Blue Sky' Days in First Four Months;" Beijing 2008, http://en.beijing2008.cn/news/olympiccities/beijing/n214334991.shtml

[27] *Cost of Pollution in China Economic Estimates of Physical Damages*; The World Bank and the State Environmental Protection Administration, P. R. China; 2007; p. 1; http://siteresources.worldbank.org/INTEAPREGTOPENVIRONMENT/Resources/China_Cost_of_Pollution.pdf

[28] *Ibid*., p. 3.

[29] "Controlling Vehicular Emissions in Beijing During the Last Decade;" Jiming Hao, Jingnan Hu and Lixin Fu, Transportation Research Part A: Policy and Practice, Vol. 40, Issue 8, Oct. 2006, pp. 639-651 20 Jan. 2006; http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VG7-4J32JBF-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=626ce1d54b93bfcefc36c38c77a540e4

tripled since 2000, --- Beijing has been adding 1,000 vehicles a day![30] And the fastest growing segment of the market is gas-guzzling luxury cars and SUVs.[31] In August of last year, the city embarked on a four-day experiment to implement its intended plans for traffic control during the Olympics. The deputy director of the Beijing Olympic organizing committee said the system was intended to take 1.3 million cars off the road every day --- more than a third of the city's 3 million vehicles. The official Xinhua News Agency said the plan would remove 400,000 private cars daily. Reports of the experiment vary considerably about its success. For example, The Washington Post reported that the government's own statistics showed that the air quality during the test rated among the top 10 worst days of the month and slightly worse that the same period a year ago. However, the pollution during the test was nonetheless at acceptable levels.[32] According to the official Olympic website, wind speeds were low during the test period.[33] By contrast, in a similar test a year earlier, when officials kept about 800,000 vehicles off the road for three days, air pollution (mainly NO_x) was reduced by about 40 percent, there was some skepticism because the reduction coincided with strong winds from the northwest.[34]

Notwithstanding marked improvements, readiness is still a matter of debate. In May, just three months before the Olympics, the People's Daily reports that "the air quality qualification dates in Beijing have kept rising, and the target for Olympic greening met more than a year in advance."[35] By contrast, in January, the International Herald Tribune cites a study finding flaws in Beijing's "Blue Sky" monitoring system and that the city changed its formula for measuring pollution in 2006, stopped including readings from two polluted areas, instead using readings in three other less polluted stations. "Without this switch, Beijing would have fallen far short of its goals in 2006 and 2007."[36]

Athletes are also making preparations for air pollution. Despite the progress made in controlling air pollution, nearly two dozen countries plan to train their athletes in Korea and Japan due to lingering concerns about air quality (as well as food quality). Teams from Finland, France, Germany, Britain, Sweden, Ireland, the Netherlands, and the U.S. will hold pre-Olympics training camps in Japan, and more are expected to sign on in the coming months, according to Japanese Olympic Committee. Ten countries, including Singapore, Switzerland, and New Zealand, have committed to sending athletes to Korea, while Bulgaria, Algeria, and

[30] "Beijing Grounds Drivers in Bid to Clear the Air;" Jonathan Watts, The Guardian, Aug. 17, 2007; http://www.guardian.co.uk/environment/2007/aug/17/china.pollution
[31] "Gas guzzlers Are a Big Hit in China;" Associated Press, Apr. 21, 2008; http://www.msnbc.msn.com/id/24242758/
[32] "Beijing: Traffic Ban Cleared the Air;" Christopher Bodeen, The Washington Post, Aug. 21, 2007; http://www.washingtonpost.com/wp-dyn/content/article/2007/08/21/AR2007082100667.html
[33] "Beijing Officials Hail Improved Air Quality during Car Ban;" The Official Website of the Beijing 2008 Olympic Games; Aug. 21, 2007; http://en.beijing2008.cn/news/dynamics/headlines/n214135069.shtml
[34] "Beijing Car Ban Cut Air Pollutant by 40%;" Reuters; 5 May 2007; http://www.chinadaily.com.cn/china/2007-05/01/content_864762.htm
[35] "Upholding Solemn Commitment Made to the World;" People's Daily Online, May 12, 2008 http://english.peopledaily.com.cn/90001/90780/91342/6408917.html
[36] "Air Quality Improvements in Beijing Challenged;" Jim Yardley, International Herald Tribune, Jan. 10, 2008; http://www.iht.com/articles/2008/01/10/asia/beijing.php ---Chinese Environmental Agency (SEPA) monitoring data: http://www.sepa.gov.cn/quality/air.php3

four other countries were also scouting out sites.[37] The US has developed special masks for athletes which include a carbon filtration system.[38]

However, in April, the IOC stated that it was satisfied by the assurances we received on environmental contingency plans for improved air quality.[39]

One of the most significant analyses assessing Beijing preparedness comes from UNEP, *Beijing 2008 Olympic Games - An Environmental Review*.

> "While it cannot be denied that the Beijing Municipal Government has made, and continues to make, strenuous efforts to improve air quality through addressing emissions from the transport, energy and industrial sectors, air pollution is still the single largest environmental and public health issue affecting the city. The extensive use of coal and the growing number of motor vehicles, has contributed to the slow pace of improving air quality. Particularly worrying are the levels of small particulate matter (PM_{10}) in the atmosphere, which is severely deleterious to public health. While the concentration of pollutants such as sulphur dioxide (SO_2), carbon monoxide (CO) and nitrogen dioxide (NO_2) dropped between 2000 and 2006, levels of PM_{10} remain well above World Health Organization Air Quality Guidelines, sometimes by as much as 200 per cent or more. … Thus, while UNEP applauds Beijing's efforts, including initiatives to limit traffic volumes on specific days, it has to be recognized that only long-term planning, and the enforcement of measures over time will show significant results. On the basis of the data, especially PM_{10}, and despite the relatively positive trends of recent years, air quality remains a legitimate concern for Olympic organizers, competitors and observers, as well as for the citizens of Beijing."[40]

Thus, *cautious optimism* may be the most appropriate sentiment regarding preparations for air pollution control for the Olympics. The efforts have been enormous, progress has been impressive, but, as is often the case, the final fate will be controlled by Mother Nature.

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[37] "Beijing Reports More 'Blue Sky' Days in First Four Months;" Beijing 2008, http://en.beijing2008.cn/news/olympiccities/beijing/n214334991.shtml

[37] "China's Commuter Olympics --- Many Countries Will Train Their Athletes in Japan and Korea Before the Games, Due to Concerns About Pollution and Food Quality in Beijing;" Business Week, Beijing Olympics Feb. 12, 2008; http://www.businessweek.com/globalbiz/content/feb2008/gb20080212_300947.htm?chan=top+news_top+news+index_global+business

[38] "Olympic Teams Vying to Defeat Beijing's Smog;" The New York Times; Juliet Macur, Jan. 24, 2008; http://www.nytimes.com/2008/01/24/sports/othersports/24mask.html?_r=6&ref=sports&oref=slogin&oref=slogin&oref=slogin&oref=slogin&oref=login

[39] "IOC Satisfied With Renewed Assurances from Beijing Organisers," Press Release, 3 April 2008, http://www.olympic.org/uk/news/media_centre/press_release_uk.asp?id=2528

[40] UNEP, *Beijing 2008 Olympic Games - An Environmental Review*; pp 17-18; http://www.unep.org/sport_env/Activities/beijingconf07/media/index.asp