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COMMENT

The Last Summer Olympics? Climate Change, Health, and Work Outdoors

Kirk R. Smith, Alistair Woodward, Bruno Lemke, Matthias Otto, Cindy Chang, Anna Mance, John Balmes, Tord Kjellstrom

School of Public Health, University of California, Berkeley, CA, USA (Prof Kirk Smith PhD, Prof. John Balmes MD, Anna Mance MDP)

School of Population Health, University of Auckland, Auckland, New Zealand (Prof Alistair Woodward MBBS)

Nelson Marlborough Institute of Technology, Digital Technology, Nelson, New Zealand (P. Matthias Otto ME, Bruno Lemke PhD)

Departments of Orthopaedics and Family & Community Medicine, University of California, San Francisco, CA, USA (Prof. Cindy Chang MD)

Centre for Technology Research and Innovation, Limassol, Cyprus (Prof Tord Kjellstrom MD)

Correspondence to: Prof. Kirk R. Smith, MPH, PhD, Professor of Global Environmental Health, School of Public Health, University of California, Berkeley, California, 94720-7360, USA
krksmith@berkeley.edu

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Climate change threatens human health in many ways through, for example, heat waves, extreme weather events, and shifts in disease vectors, as well as economic and social stresses on populations living in or trying to escape areas affected by seawater intrusion, drought, lower agricultural productivity, and floods.[1] In the short term, most of these impacts could be substantially ameliorated by actions to reduce background disease risks and other known causes of vulnerability. The world beyond 2050, however, poses more difficult challenges, not only because of the inherent uncertainties in estimating what will happen, but because the extent and speed of change may exceed society's ability to adapt.[2] In addition, there will be a much greater risk of experiencing "pernicious impacts"— those that require trade-offs between what is generally assumed and valued as part of normal human society and what is healthy.

Perhaps the most pernicious of these is the growing expansion in season and geography of outdoor conditions (or unprotected indoor spaces) in which heavy work is no longer safe. As more than half the planet's workforce labors outdoors, primarily in construction and agriculture, society faces an increasingly serious trade-off between population health and labor productivity.[3] If workers are allowed to sit in the shade in the hottest times of day and take breaks during hot humid months, then the risk to their health could be minimized. If not however, exertional heat stroke with all its negative outcomes, including mortality, will become a larger part of outdoor work around the world.[4] More and more, we will face a choice between doing what we have done for millions of years – work hard outdoors essentially any time we wish – and being safe.[5]

Heavy work outdoors is already limited in some parts of the world by heat stress (as measured by the Wet Bulb Globe Temperature (WBGT), a combination of temperature, humidity, heat radiation, and wind) and with climate change more regions will be affected for a greater part of the year.[6]

Athletes are especially prone to heat stress in outdoor endurance events, as shown in the 2007 Chicago Marathon, which was cancelled mid-race after hundreds of heat-stricken runners required medical care.[7] More recently, only ~70% of the elite competitors in the 2016 U.S. Olympic Team Trials Marathon in Los Angeles finished.[8] It was the warmest in Trials history with a temperature of 67°F (19.5°C) and 47% humidity at the start (no recorded WBGT).[9,10] Peak temperature reached 78°F (25.6°C).[10]

The Summer Olympics represents only a small part of all outdoor work but it is iconic, being the most prestigious and inclusive sporting competition in the world. Using the mean of two standard climate models, we made projections of rising temperature and humidity over the next century, assuming the high emissions RCP8.5 scenario,[11] and estimate the effects on the number and global distribution of cities eligible to hold the Summer Olympic Games.

We focus only on the Northern Hemisphere, which contains nearly 90% of world population and allows a consistent and customary definition of "summer" as July–August, noting this is not always the hottest period in some countries such as India. We include only cities over 600,000 population in 2012, this being the lower limit among host cities since WWII, reflecting the massive expectations in financing and logistics for a city to run the Olympics, expectations that have escalated even faster than average size of cities. Given problems due to high altitude (low air resistance and low oxygen partial pressure) that became apparent at the Mexico City Olympics in 1968, we have included only cities below 1600 m (one mile) in elevation.

The most demanding endurance event is the Marathon (42.2 km) and this provides a fair indication of whether conditions will likely be safe for any other Olympic event.[12] We assume

26°C WBGT in the shade as the low-risk limit to run the Marathon, but also examine 28°C WBGT as the medium/high risk threshold.[13] As most real events likely will be run at least partly in sunlight, the full WBGT is almost certain to be higher.

Anticipating a significant risk of unpredictable disruption of a schedule that involves billions of dollars, years of planning, hundreds of thousands of people, and massive global media attention, a conscientious attempt to avoid serious risk to the athletes would greatly reduce the attractiveness of a venue for bidding. We assume that any venue with more than a 10% chance of having to cancel the Marathon at the last minute due to exceedance of the safe WBGT limit will not be a viable choice to hold the games as they are structured today, but also examine the implications of accepting a ~25% probability. A 10% criterion has been recently used to exclude venues for the Winter Olympics in terms of prospects for cold nights and sufficient snow.[14]

Modeled atmospheric parameters of the two commonly used climate models (HAD-GEM2-ES[15] and GFDL-ESM2M[16] were used to calculate WBGT in the shade for each city in 2085. To be conservative, the lowest estimate for the 10% warmest day was used for the analysis, i.e. the WBGT of the 3rd hottest day during the coolest of the two months. For ~25% probability, it is the 7th hottest day.

As shown in Figure 1, by 2085 outside of Western Europe, only 8 (1.5%) of 543 cities would meet the low risk category (<10% probability of ≥26°C WBGT).[17-19] If the threshold is lifted to 28°C WBT (medium risk), only 33 more cities (6%) would be included, totaling 41 viable cities (7.5%). The remaining 502 cities would be in the high risk category (≥10% probability of ≥28°C). If accepting a much higher probability of exceeding the limit during the Games (~25% rather than 10%), 76 cities qualify, making 14% of cities available. Western Europe, however, shows a quite different pattern with 25 cities (25%) meeting the strictest risk criteria (<10% probability of ≥26°C) and 49 (48%) meeting the least constrictive requirements (<25% probability of ≥28°C). Projecting out to the early 22nd century, which adds even more uncertainty of course, the last cities in the northern hemisphere with low-risk summer conditions for the Games are likely to be Belfast, Dublin, Edinburgh, and Glasgow.

The Games might be run entirely indoors, in winter, or without the marathon and other heat-sensitive endurance events, but they would then be quite different from what the world has come to consider the Summer Olympics. High-visibility international athletic events such as the Summer Olympics represent just a small fraction of heavy exertion outdoors, but increasing restrictions on when, where and how the Games may be held due to extreme heat are a sign of a much bigger problem.

If our most elite athletes need to be protected from climate change, what about the rest of us?

Contributors

All authors designed and contributed to the report.

Conflicts of Interest

We declare no competing interests.

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Figure 1:

Summary of all 645 Northern Hemisphere cities in 2085 capable of mounting the Summer Olympics by region and whether (A) their estimated summer WBGT will put them at low, medium, or high risk. About 88% of cities would be at high risk, 7% in medium risk, and 5% in low risk conditions. (B) List of cities in low risk category in 2085, only eight of which are outside Western Europe.