

Assessing the impact of the 2022 Commonwealth Games on background air quality across Birmingham

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Summary

- The Birmingham 2022 Commonwealth Games brought thousands of athletes and 1.5 million spectators to venues in Birmingham and across the West Midlands. The associated changes in activity had the potential to impact local air pollutants such as nitrogen dioxide (NO₂) and fine particulate matter (PM_{2.5}).
- Detailed analysis of ambient air quality measurements showed that the Games had little impact on background NO₂ concentrations in Birmingham, and no significant impact on background PM_{2.5} concentrations.
- Actions taken by the Organising Committee to limit carbon emissions associated with the Games are likely to have delivered co-benefits for local air quality.

Importance of air quality

Air quality is the greatest environmental threat to human health in the UK, associated with ~30,000 premature deaths each year¹. The most important air pollutants in the UK are nitrogen dioxide (NO₂), a gas mainly emitted from vehicular combustion, and fine particulate matter. Particulate matter is classified by particle diameter; smaller particles penetrate deeper into the lungs and therefore can have greater impact on human health. PM_{2.5}, or particles with a diameter of less than 2.5 micrometres, are termed fine particles and are the focus of much of the current air quality policy. PM_{2.5} is directly emitted from a broader range of sources than NO₂ including domestic combustion (e.g. woodburning), traffic and industry and can also be formed in the atmosphere. NO₂ and PM_{2.5} both directly impact human health and are two of the main pollutants regulated in the UK.

The Birmingham 2022 Commonwealth Games brought thousands of athletes, support teams and 1.5 million spectators to the region. As traffic is a major source of air pollution, changes in activity associated with this short-term influx of people to the region had the potential to impact air quality in the West Midlands. Here we assess the impact of the Games on background air quality in Birmingham.

The Impact of the Games on air quality

While localised elevated pollutant concentrations were observed at Games venues, this report focuses on the impact the Games had on urban *background* concentrations in Birmingham. For this assessment, data from two urban background sites were used: the Birmingham Air Quality Supersite (BAQS) situated on the University of Birmingham campus in Edgbaston; and the Defra Automatic Urban and Rural Network (AURN) site at Ladywood in central Birmingham. This enables us to determine the impact of the Games on the broader city, representative of the air quality experienced by most residents, rather than specifically at Games venues.

The concentration of an air pollutant is determined by the rate of emission of the pollutant and its precursors, as well as the local weather conditions (in wet or windy conditions pollutants are washed from or dispersed into the atmosphere). In order to determine the impact of the Games specifically, the influence of short-term changes driven by local weather were removed ('de-weathered'). This

¹ COMEAP (2018). Associations of long-term average concentrations of nitrogen dioxide with mortality, PHE, London

was done using a machine learning technique^{2 3 4}. To determine whether changes in the resulting de-weathered NO₂ and PM_{2.5} concentrations were driven by the Commonwealth Games activities, or by other factors such as a change in regional emissions or socio-economic factors, a synthetic control method^{2 3 4} was employed. This method was used to construct a “counterfactual scenario”, of the air pollution levels that would have been expected in the absence of the Games, whilst considering other changes, using corresponding concentration data from 16 air quality monitoring stations across other UK cities. Differences between the ‘de-weathered’ Games period pollutant concentrations and the “synthetic” levels show the causal impact of the Games.

Figure 1 shows the deviation from the “synthetic” levels for NO₂ and PM_{2.5} at the BAQS and Birmingham Ladywood urban background sites. During the Games period (shown by vertical dotted lines) the deviation from the expected concentration (average treatment effect) for NO₂ was 0.45 and -0.15 ppb at BAQS and Birmingham Ladywood, respectively. For PM_{2.5} the average treatment effect was -0.05 and 0.07 ppb at BAQS and Birmingham Ladywood, respectively. This indicates that the Games had no significant impact on background NO₂ and PM_{2.5} concentrations at the Ladywood site in central Birmingham. At BAQS, the Games had no significant impact on PM_{2.5} concentrations and a very small impact on NO₂ concentrations.

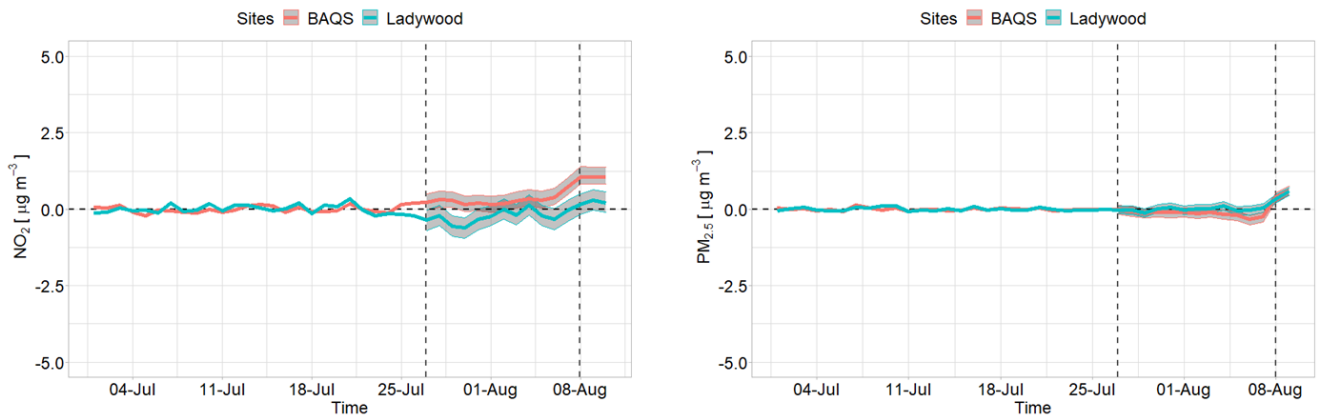


Figure 1: Deviation of de-weathered NO₂ (left) and PM_{2.5} (right) concentrations from a synthetic control (horizontal dotted line) at BAQS and Ladywood measurement stations.

For a mega-event such as the Commonwealth Games to have little or no impact on background air quality in the city is a positive outcome. The Commonwealth Games Organising Committee undertook actions primarily aimed at reducing carbon emissions, for example promoting active travel and public transport options⁵, which are likely to have delivered co-benefits to local air quality. The Birmingham 2022 Commonwealth Games demonstrate that a large-scale event involving the transport of over 1 million spectators can be delivered without a detrimental impact on regional air quality.

² Cole, M. A., Elliott, R. J., & Liu, B. (2020). The impact of the Wuhan Covid-19 lockdown on air pollution and health: a machine learning and augmented synthetic control approach. *Environmental and Resource Economics*, 76(4), 553-580.

³ Shi, Z., Song, C., Liu, B., Lu, G., Xu, J., Van Vu, T., ... & Harrison, R. M. (2021). Abrupt but smaller than expected changes in surface air quality attributable to COVID-19 lockdowns. *Science advances*, 7(3), eabd6696.

⁴ Shi, Z., Liu, B., Cheng, K., Elliot, R., Cole, M., & Bryson, J. R. (2022). Quantifying the impact of clean air policy interventions for air quality management.

⁵ Commonwealth Games Organising Committee (2022). Birmingham 2022 Commonwealth Games Sustainability Report, Birmingham, UK.