PDRI Policy Brief 4: The Asian Games, air pollution and birth outcomes in South China

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Key takeaways:

- This study is a contribution to the causal literature on the impact of air-pollution exposure on adverse birth outcomes. It exploits a natural experiment provided by air-quality-control policies implemented during the 2010 Guangzhou Asian Games. These stringent policies reduced air-pollution in the region. The reduction was significantly greater in Guangzhou than in neighboring Shenzhen, which serves as a control in this study.

- Birth-certificate data with about half a million observations from the two cities provide information on prematurity, birthweight and low birthweight, which have been linked to life-cycle outcomes ranging from schooling attainment to adolescent behaviors to adult earnings. Daily observations of concentrations of three monitored air pollutants' (NO_2, PM_{10} and SO_2) from local environmental bureaus are employed to measure prenatal exposure based on pregnancy timing.

- 10 μg/m^3 increases in PM_{10}, NO_2, and SO_2 are found to significantly decrease mean birthweight by around 14, 9 and 18-20g, respectively, and significantly increase preterm risk by 0.45-0.65%, 0.33-0.38%, and 0.76-0.83%, respectively, depending on specifications. The authors also address heterogeneous effects, finding that: (1) in terms of average birthweight, males are more vulnerable to PM_{10} and SO_2, while females to NO_2; (2) babies of mothers over 35 years also suffer more from air pollution in terms of lower average birthweight, with NO_2 having the greatest harm; and (3) late pregnancy is also found to be a more sensitive period to PM_{10} exposure.

- The greater magnitudes of effects reported in this study compared to studies from high-income countries suggest the possibility of a threshold effect--that high concentrations of air pollutants such as those characteristic of this area a decade ago may have particularly pernicious implications for birth outcomes.

Background:

 Most of the world's population faces levels of air pollution that exceed World Health Organization (WHO) guidelines, with the most extreme concentrations of pollutants being in China, India, Pakistan and Bangladesh. Previous studies have shown associations between air pollution and birth outcomes, and theWHO has estimated 4.2 million premature deaths every year are linked to ambient air pollution.

The study summarized in this policy brief provides causal estimates of such impacts through the analysis of a policy that exogenously improved air quality in an area of extreme concentration of air pollutants--south China. On the occasion of the 2010 Guangzhou Asian Games, the Guangdong government implemented a series of interventions to improve air quality in the key area of the Pearl River Delta (PRD) Metropolitan Region, where the two cities of Guangzhou and Shenzhen are situated. Several measures were implemented during the years preceding the Games, but the strictest policies were put in place during the Games period (between October and December 2010). This included temporary production shutdowns for plants that did not meet emission standards and traffic controls. The study shows that the main host city for the Games, Guangzhou, saw much more substantial decreases in air pollutants as compared to Shenzhen, which represents a control city.

Research design:

The study uses a unique birth-certificate dataset (with around half a million observations) and daily air-pollution data from local environmental bureaus from two cities that are comparable in terms of climate and social and economic development, but different in air pollution levels thanks to the air-quality-control measures implemented during the Guangzhou Asian Games.

A difference-in-difference approach is used to verify that Guangzhou's air quality was significantly improved as compared to Shenzhen's. Furthermore, the duration of exposure to the Asian Games during the expected pregnancy period is used as an instrumental variable (IV) for prenatal air-pollution exposure, allowing researchers to identify the impact of air pollution on birth outcomes (birthweight, low birthweight and prematurity risk), separately from other factors including socioeconomic characteristics, which may determine the location in which one lives and therefore usual air-pollution exposure.

Due to high correlations among pollutants, regressions are estimated for each pollutant separately. The regressions employed include controls for individual characteristics of mothers (i.e. age, schooling) and children (i.e. sex), meteorological conditions during pregnancy, conception-year fixed effects, city-specific conception-quarter fixed effects, and city fixed effects. The study design of exploiting a natural experiment also allows for disentangling meteorological factors from air pollution, despite their high correlation.

Results:

The three air pollutants' levels were found to be significantly reduced in Guangzhou during the games, and reduced more than in Shenzhen. Moreover, IV estimates show that a 10 µg/m^3 increase in PM_{10} reduces average birthweight by around 14g and increases the risk of preterm births by 0.45-0.65%. The estimated impact of a 10 µg/m^3 increase in SO_2 is the most alarming, corresponding to a reduction of average birthweight by 18-20g and an increase in the preterm birth rate by around 0.76-0.83%. Among the three pollutants, NO_2, in contrast, shows the smallest effect, amounting to a reduction of average birthweight by 8.7-9.3 g and an increase in the preterm birth rate by 0.33-0.38% for an increase of 10 µg/m^3.

Further analyses show the impacts of air pollutants by trimester: while exposures in the first and second trimester to PM_{10} do not seem to have significant effects, the third trimester seems to show more vulnerability with regards to average birthweight, with a reduction of 13-15g caused by an increase of 10 µg/m^3. With regards to preterm birth risks, the results by trimester are sensitive to controls, and have lower significance. The other pollutants do not show strong impacts by trimester.

Heterogeneity of effects is investigated in terms of infants' sex and maternal age. Males seem to be more vulnerable to PM_{10} in terms of average birthweight, but not for other outcomes. Maternal age seems to play some role in the impact of air pollutants. In particular, an increase of 10 µg/m^3 in PM_{10} exposure lowers birthweight of babies whose mothers are aged at least 35 by an additional 17.3g, compared to mothers under 35 years old; there are no significant findings for other outcomes. Similar patterns are found for SO_2, but different ones are estimated for the case of NO_2. In this case, female fetuses seem to be more sensitive. Moreover, babies of mothers aged over 35 experience a worrisome estimated 77.6g extra lower average birthweight when exposed to 10 µg/m^3 of NO_2. Other outcomes are found to be not significantly affected.

Policy Implications:

This paper shows a causal and significant adverse impact of prenatal air-pollution exposure on relevant birth outcomes such as birthweight and premature birth risk, which in turn are found by an extensive literature to be associated with fundamental aspects of the life cycle such as schooling attainment, adolescent behaviors and adult earnings. The estimates of this study appear to differ compared to previous causal studies from low- and middle-income countries in finding larger effects on birth outcomes. The very

high concentration of air pollutants characterizing the investigated context may play an important role in accounting for these differences. This study adds an important factor to consider among the different benefits of air-quality control measures, namely birth outcomes, particularly in areas with very high air pollution. More generally, the paper offers novel evidence to the body of knowledge around the importance of environmentally-friendly policies, showing a clear impact of air pollution on the health of children and potentially implying further negative effects during their life cycles.

Read full study

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