India’s coal expansion and child health

Sangita Vyas, Economics & PRC, University of Texas at Austin

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Among developing countries, India is one of the largest consumers of coal. Coal comprised roughly 76% of India's electricity generation in 2016-2017, and between 2007 and 2018, India's installed coal capacity almost tripled. This represents a rapid increase in the number of coal-fired power plants in the country in recent years, and the associated increases in air pollution present potentially large negative health externalities.

This study investigates the impacts on child health that can be attributed to this dramatic expansion in coal plant capacity. Child height is an important indicator of early-life health, and recent studies suggest that exposure to air pollution is associated with child height deficits (Mishra & Retherford 2007, Goyal & Canning 2018). Coal plants have also been found to be associated with infant deaths in the US (Clay et al. 2016), and poor respiratory health in India (Gupta & Spears 2017). However, to my knowledge, no prior paper has studied the effect of coal plants on child height in India.

This study uses a dataset on coal plant capacity and India’s most recent Demographic and Health Survey (DHS) to exploit changes in exposure to coal plant capacity within villages over time. I find that exposure to each additional median sized coal plant of 1,000 MW is associated with a decrease in height-for-age z-score of 0.07 to 0.08 points. Since child height is an important economic variable predicting adult human capital, cognitive achievement, and health, India’s recent coal expansion has important consequences for human development in India.

Data and Methods

This research uses data on child health from India’s DHS 2015-2016, and a dataset on power plant openings and capacity in India from 1922 to 2017. The dependent variable in this analysis is child height, which was collected of all children under the age of five of surveyed women. Child height is standardized using the mean and standard deviation, by age and sex, of a healthy reference population identified by the World Health Organization. Data on installed coal capacity, the independent variable of interest, is obtained from the Central Electricity Authority of India’s CO_2 Baseline Database for the Indian Power Sector. Following Clay et al. (2016), villages located within 50 kilometers of a coal plant are considered exposed to the coal plant, and villages that are outside of this radius are considered unexposed. Some villages are exposed to more than one coal plant, and in these cases, coal capacity exposure is the sum of each plant’s capacity. Each child in the DHS is matched to installed coal capacity in the village-month of the child’s birth.

I exploit variation in exposure to coal plant capacity within villages over time to identify the relationship between changes in exposure to coal-fired power and changes in height-for-age through a difference-in-difference estimation strategy. Because the NFHS measured the heights of children at different ages, and child height deficits evolve over time, I also include 119 age-by-sex fixed effects. I include village and time fixed effects to control for variations in child height over space and secular changes in child height over time. Finally, I include district-month fixed effects, to control for seasonal differences within districts. This analysis answers the question: are children born at times when exposure to coal plant capacity in the village is higher shorter than children who were born at times when coal plant capacity in the same village is lower?

My analysis estimates a fixed effects regression of the following form:

$$height-for-age_{ihvdmy} = \beta capacity_{vdmy} + \mathrm{B}_{ihvdmy}\delta + H_{hvdmy}\gamma + \alpha_{my} + \mu_{vd} + \rho_{dm} + \varepsilon_{ihvdmy},$$

where *i* indexes children, *h* indexes households, *v* indexes villlages, *d* indexes districts, *m* indexes months, and *y* indexes years. The dependent variable is *height-for-age*, measured as a z-score. *capacity* is the exposure to coal plant capacity in megawatts (MW) in the village in the month of birth. To facilitate the interpretation of this coefficient, I scale this variable so that one unit represents the capacity of the median coal plant in the data, 1,000 MW. *B* represents a vector of birth characteristics, including sex-by-age dummy variables, birth order, and twin birth. *H* represents a vector of household characteristics, including mother's height, mother's literacy, religion, caste, toilet facility, cooking fuel, and electricity access. α, μ, and ρ represent time, village, and district-month fixed effects, respectively. β indicates the effect of coal plant capacity on child height. Standard errors are clustered by village.

Results

Figure 1: Time trends in exposure to coal plant capacity and height-for-age z-score in villages near and far from coal plants

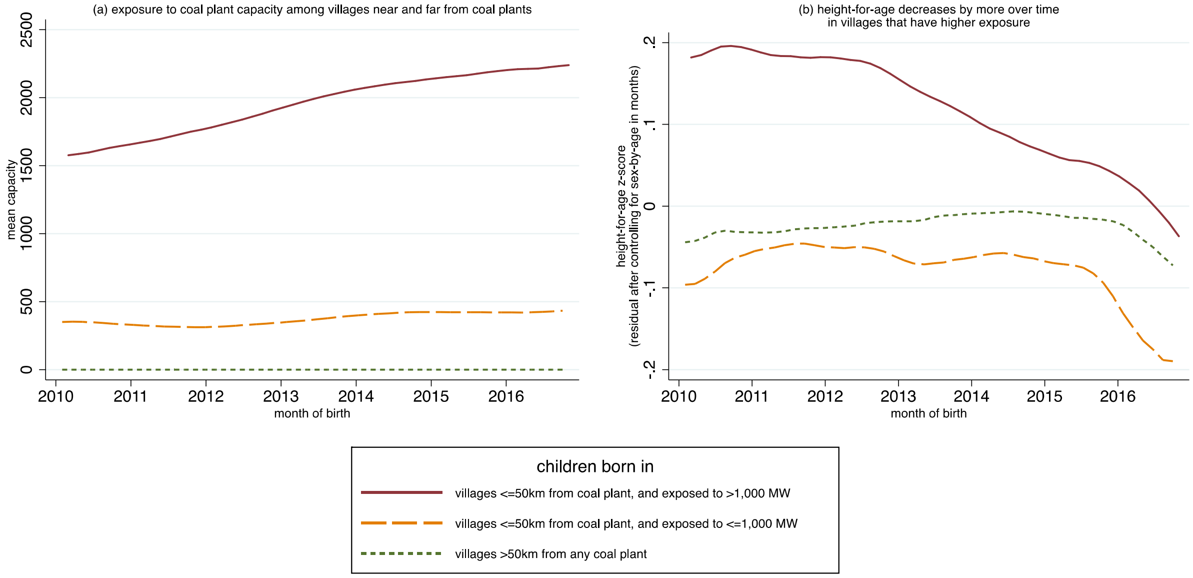

Figure 1 depicts the evolution of the exposure to coal plant capacity and child height over time separately for villages with varying degrees of coal plant exposure. Most children are born in villages that are not near a coal plant. However, among villages that either have or get a coal plant nearby, there is variation in the evolution of capacity over time. Panel (a) of Figure 1 separates children by the type of village they live in: villages that never get a coal plant nearby, villages that are exposed to >1,000 MW in capacity, and villages exposed to <= 1,000 MW in capacity. In villages that have low exposure, exposure stayed relatively constant over the study period, while in villages with high exposure, exposure increased by about 750 MW on average over the study period. Panel (b) shows the associated evolution of height-for-age in villages with varying levels of exposure. The vertical axis in panel (b) is the residual height-for-age after controlling for 119 age-by-sex indicators. This figure shows that residual height-for-age decreased by more over time in villages with greater exposure to coal plant capacity, compared to villages with less exposure.

Regression results are presented in Table 1. I add fixed effects and controls in stages to show that the main coefficient of interest, that on capacity, is robust to respecification of the model. Column 1 regresses height-for-age z-score on coal plant capacity and includes age-by-sex, village, and month-year, fixed effects. The coefficient on capacity indicates that each additional median-sized coal plant of 1,000 MW is associated with a decrease in height-for-age z-score of 0.08 points. Column 2 adds birth order, twin birth, and mother's height. Column 3 adds religion, caste, toilet facility, cooking fuel, and mother's literacy. Column 4 limits the sample to villages that are within 150 kilometers of a coal plant. What is notable in this table is that the coefficient on capacity remains relatively constant, at between -0.07 and -0.08 z-score points.

Table 1: Children born exposed to more coal plant capacity are shorter

dependent variable:	height-for-age z-score				
	(1)	(2)	(3)	(4)	(5)
coal plant capacity/1,000 MW	-0.0801**	-0.0786**	-0.0767**	-0.0727**	-0.0748**
	(0.0179)	(0.0182)	(0.0181)	(0.0184)	(0.0185)
n (children under age 5)	198,250	198,241	197,731	191,248	165,376
adj. R-squared	0.196	0.196	0.225	0.232	0.233
sample	full	full	full	full	villages <=150km
fixed effects					
age-by-sex	✓	✓	✓	✓	✓
month-year	✓	✓	✓	✓	✓
village	✓	✓	✓	✓	✓
district-month		✓	✓	✓	✓
birth characteristics			✓	✓	✓
household characteristics				✓	✓

Standard errors clustered by village in parentheses. *** p<0.01, ** p<0.05, * p<0.1

References

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