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Weather Shocks and Health at Birth in Colombia

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Summary. — This paper investigates the relationship between health outcomes at birth and fetal exposure to temperature shocks in rural Colombia during 1999–2008. We overcome a limitation of previous studies, confined by small samples and restricted areas, by using records on nearly 1.5 million births. We exploit variations in exposure to temperature shocks by municipality and by year and month of conception in a fixed effects model. We find that exposure to moderate heat waves during the third trimester of pregnancy reduces the birthweight of the infant by about 4.1 g. Furthermore, exposure to moderate cold shocks during the first and second trimesters of pregnancy reduces the length at birth by 0.014–0.018 cm. We also find evidence of the negative effects of heat weaves in Apgar tests at a magnitude of −0.2 to −0.6 percentage points of the normal Apgar score.

Key words — weather shocks, birth health, Latin America, Colombia

1. INTRODUCTION

Shocks that are beyond the control of pregnant women can severely affect the health at birth of the offspring of these women. Severe but relatively infrequent aggregate shocks, such as conflict-related deaths in west Gaza, landmine explosions in Colombia, hurricanes in Texas, and the 2005 earthquake in Chile, have all been found to exert detrimental effects on health at birth as measured by weight, gestational length, or abnormal conditions among the newborn (Camacho, 2008; Currie & Rossin-Slater, 2013; Mansour & Rees, 2012; Torche, 2011). However, less is known about the effects on health at birth of intrauterine exposure to more commonly encountered aggregate shocks. For example, one of the few studies analyzing recurrent shocks has found that exposure to Ramadan among pregnant Arab women reduces the birthweight of their newborns (Almond & Mazumder, 2011). A better understanding of the effects of exposure to more frequent aggregate events (such as changes in weather) on health at birth is desirable because the effects of such events are more amenable to policy interventions and because health at birth has been linked to better long-term positive socioeconomic outcomes, particularly educational attainment, health, and labor earnings in the subsequent years of the lives of the newborns (Behrman & Rosenzweig, 2004; Case & Paxson, 2008; Case & Paxson, 2010; Currie, 2009; Oreopoulos, Stabile, Walld, & Roos, 2008). [1]

This paper investigates the effects of severe temperature shocks on health at birth in rural Colombia. With climate change, weather events such as extreme high temperature and heavy precipitation are increasingly frequent yet largely unpredictable far in advance (IPCC, 2014). The exposure to weather shocks among pregnant mothers can affect their offspring's health at birth through three potential mechanisms. First, weather shocks can generate a disproportionate amount of stress (Dunkel Schetter, 2011; Maida, Gordon, Steinberg, & Gordon, 1989; Shore, Tatum, & Vollmer, 1986), which could affect the duration of pregnancy and fetal maturation (Hobel & Culhane, 2003; Wadhwa, Sandman, Porto, Dunkel Schetter, & Garite, 1993). Second, these shocks could also affect the incidence of infectious diseases because they determine the survival and reproduction of vectors, pathogens and hosts (Patz *et al.*, 2003). Finally, weather shocks can lead to more prolific or lean harvests; the associated changes in prices and profits potentially affect household real incomes and, consequently, the consumption of food and other health inputs (Hoddinott, 2006; Skoufias & Vinha, 2013). The net impact of weather shocks on health is an interplay among the direct impact on the mother's stress and health, the indirect impact on income and consumption and the ex ante and ex post coping mechanisms available to the household.

Colombia is severely affected by weather events. In 2010, it ranked third, behind only Pakistan and Guatemala, among the countries most affected by the impacts of weather-related events (storms, floods, heat waves, etc.), according to the Global Climate Risk Index (Harmeling, 2011). Among the countries most affected, the best available data for conducting such an analysis are the data available on Colombia. Moreover, the number of disaster events registered in Colombia in the first decade of the 2000s increased more than 60% with respect to the number in 1970–99 (Campos *et al.*, 2011). Colombia is particularly affected by rainfall and temperature shocks, such as droughts, floods, and heat and cold waves. These events are caused by the warm (El Niño) and cold (La Niña) extremes of the El Niño Southern Oscillation, a weather event that takes place every two to seven years because of temperature changes in the Pacific Ocean. [2] Because of climate change, the El Niño and La Niña phenomena and the associated weather-related events (droughts, floods, and heat and

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cold waves) will become even more frequent and intense. They are expected to affect 80% of the residents of Colombia who live in areas highly vulnerable to climate change (Catarious & Espach, 2009).[3] We focus especially on rural areas in Colombia because weather shocks are among the most important risk factors faced by rural households (Giné, Townsend, & Vickery, 2008). Rural residents suffer appreciably more because of the potentially harmful effects of weather shocks on the agricultural activities on which rural households generally rely for additional food and for livelihoods and because, relative to urban dwellers, rural residents typically have fewer effective coping mechanisms to mitigate these effects (Skoufias & Vinha, 2013), which allows for a better identification of the effects on health at birth.

Our study contributes to the growing literature on the effects on health at birth of exposure during pregnancy to aggregate shocks, such as natural disasters and conflict. In particular, it adds to the thin body of evidence linking more commonly encountered events such as severe weather events and the health of newborns. Two relevant studies have shown that weight at birth and gestational age are positively affected by exposure to a positive rainfall shock one year before birth in the semiarid region of northeastern Brazil (Rocha & Soares, 2015) and negatively affected by exposure to extreme hot temperatures during the second and third trimester of pregnancy in the United States (Deschênes, Greenstone, & Guryan, 2009). Our paper provides the first evidence on the impacts of temperature shocks on health at birth in a developing country that is highly affected by weather shocks where this issue is understudied. We contribute to the existing literature by analyzing the effects of varying intensities of cold and heat waves and by extending the analysis to a broad range of health outcomes. Moreover, our paper overcomes a limitation of previous studies, circumscribed to small samples and specific geographical areas, by using administrative records that cover all births in Colombia, which enhances the external validity of our findings.

The empirical analysis combines rich and relatively unexploited datasets. We use data from the national registry of live births; registry is mandatory in Colombia. The analysis uses the nearly 1.5 million births that occurred in rural and semirural areas during 1999–2008 (approximately 20% of the 7.2 million births in the country).[4] This dataset provides us with our health variables, which include weight and gestational age, length and the Apgar score recorded five minutes after each birth. The Apgar score is a summary measure based on a newborn's appearance, pulse, grimace, activity, and respiration that is reflective of the baby's overall health and predictive of survival and neurological abnormalities at one year of age (Apgar, 1966; Chase & Greenberg, 1965). The national birth data contain information on the municipality of usual residence of the mother and the exact date of birth and gestational age, which we use to determine the exposure to weather shocks in each trimester of each mother's pregnancy. The weather data are taken from the Climate Research Unit of the University of East Anglia (Harris, Jones, Osborn, & Lister, 2014; UEA CRU, Jones, & Harris, 2013); they consist of monthly high-frequency gridded information of temperature and rainfall from 1901 to 2008, with which we construct a municipality-by-month weather dataset. This dataset is then combined with the data on national births based on each mother's municipality of residence and each baby's date of conception. We normalized weather event measures based on the historical (1901–97) month- and municipality-specific mean and standard deviations (SDs). Our baseline specification includes one indicator for each weather shock (heat and cold waves), indicating whether the temperature in any month during pregnancy is above (or below) 0.7 SDs from the historic long-term mean. We then allow for flexibility in the definition of weather shocks by including a set of dummy variables indicating the degree of intensity of each weather shock (0.7–1.0 SDs, 1.0–1.5 SDs, 1.5–2.0 SDs and 2.0 or more SDs). Finally, we analyze the effects of exposure to different intensities of local severe temperature shocks during each trimester of pregnancy (first, second, or third trimester).

Our fixed effects design allows us to disentangle weather effects from seasonal effects on health and from common, unobserved confounders that simultaneously affect weather shocks and health at birth. Moreover, within each municipality, we compare, over many years, the births of children who were unexpectedly exposed to temperature shocks *in utero* with those who were not so exposed, which allows us to construct an intent-to-treat effect. Our identification strategy relies on the assumption that temporary, unpredictable temperature deviations from the historical average in a mother's municipality of residence while the child is *in utero* are uncorrelated with latent determinants of health at birth. We provide evidence in favor of this assumption.

We find that the effects of temperature shocks on birth health outcomes are robust. In particular, we find that exposure to moderate low-temperature shocks (between 0.7 and 1.5 SDs from the historical mean) during the first and second trimesters of pregnancy reduces the length at birth by between 0.014 and 0.018 cm while exposure to moderate heat waves (between 1.0 and 1.5 SDs from the historical mean) during the third trimester of pregnancy reduces the weight of the infant at birth by about 4.1 g. Although of lower magnitude, these two findings are consistent with the results of Deschênes *et al.* (2009). We also find evidence of the negative effects of heat weaves in Apgar tests with a magnitude between −0.2 and −0.6 percentage points of the normal Apgar score. However, we cannot benchmark this result because we are not aware of any other paper that has studied the association between *in utero* exposure to weather shocks and Apgar scores. Our estimates can only be considered lower bounds given two of the main limitations of our study: (1) we cannot control for or measure the magnitude of the effect of potential coping strategies that are aimed at protecting pregnant women in the presence of weather shocks and that should have positive effects on health at birth, and (2) we do not observe information on selective mortality, and, thus, the population of surviving newborns in our data are positively selected, which may, in turn, also have a positive effect on health at birth.

2. PAST RESEARCH AND EXPECTED EFFECTS

Our paper is part of the economics literature analyzing the effects of a range of fetal shocks on outcomes later in life. This work expands on the fetal origins hypothesis of Barker (1998), which posits that nutritional deprivation *in utero* can have long-lasting impacts by reducing adult body size and increasing the incidence of future disease. Economists have found that prenatal shocks and other conditions affect not only health later on in life, but also a wealth of later-life outcomes including test scores, educational attainment, and income (Almond & Currie, 2011). For example, individuals who had been exposed *in utero* to the 1918 pandemic had greater rates of physical disability and lower educational attainment, income, and socioeconomic status later in life (Almond, 2006). Intrauterine exposure to civil conflict in Peru in the 1980s and 1990s had long-lasting impacts on height, but no