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Childhood Health and Prenatal Exposure to Seasonal Food Scarcity in Ethiopia

RAY MILLER*

Harvard Center for Population and Development Studies, Cambridge, USA

Abstract. — There is growing empirical support that poor maternal nutrition during pregnancy can lead to permanent fetal adaptations that affect health throughout a child's life. Most of the evidence stems from evaluating the impact of extreme prenatal deprivations due to atypical events such as droughts or floods. However, less is known about the magnitude of effects due to more normal variations in food availability. This study estimates the impact of prenatal exposure to seasonal food scarcity on the evolution of childhood health for a cohort of Ethiopian children born in 2001–02. A novel measure of seasonal exposure was constructed based on reported months of relative food scarcity in the local community collected shortly after birth. While exposure was found to have little effect on child height at age one, a larger and statistically significant negative impact emerges by age eight and strengthens by age twelve. Effects in early childhood also appear to be latent from the view of parents with little evidence of remedial investments in exposed children after birth. We conclude that mild prenatal nutritional deprivations could have significant impacts on long-term health and well-being even if effects are small or unobserved in early childhood. This implies caution against the common use of birth and early-life outcomes as the sole evaluation tools for mild prenatal insults or interventions. Overall, results highlight that in addition to the effects of severe famine conditions identified in many studies, more typical variation in prenatal food availability can have lasting impacts on health in the developing world.

Key words — health, nutrition, Africa, Ethiopia, prenatal, seasonal

1. INTRODUCTION

There is growing support in the biomedical literature for the hypothesis that poor maternal nutrition during pregnancy can lead to permanent fetal adaptations that affect health throughout a child's life (Gluckman & Hanson, 2005). This 'fetal origins' hypothesis has recently garnered interest among economists, who have attempted to establish and quantify the casual impact of such a mechanism. [1] These studies have often used uncommon and arguably exogenous events such as famine or disease epidemic to identify the causal effects of prenatal nutritional environment. While many find significant effects from such environmental shocks, less is known about the magnitude of effects due to more normal variations in food availability.

In this paper, we use a unique longitudinal data set to examine the effects of prenatal exposure to seasonal variations in food scarcity on childhood health in Ethiopia. Despite a long history of attempts to address food security, an estimated 40% of households in Ethiopia are still classified as food energy deficient by the World Food Programme (2014). A heavy reliance on small-scale rain-fed agriculture combined with highly localized agricultural markets make Ethiopia's erratic climatic conditions a significant source of food uncertainty. Moreover, even in years of fairly typical seasonal patterns of cultivation, lack of storage capacity and costly transport can lead to measurable differences in food availability over the agricultural cycle (FAO, 2004; WFP, 2014). While seasonal changes in nutritional intake may be mild in comparison to more extreme weather phenomenon (e.g., drought, flood, monsoon), theory and recent empirical evidence suggest it could still have a substantial impact during vulnerable stages of human development (e.g., Almond & Mazumder, 2011).

Many studies across a variety of disciplines have found month or season of birth to be robustly correlated with health outcomes such as birth weight, life expectancy, and height in developed countries (e.g., Doblhammer & Vaupel, 2001; Kihlbom & Johansson, 2004; Tanaka et al., 2007; Muñoz-Tudurí & García-Moro, 2008; Strand, Barnett, & Tong, 2011). A smaller but growing body of literature has established similar patterns in the developing world (e.g., Moore et al., 1999; Moore, Fulford, Streatfield, Persson, & Prentice, 2004; Rayco-Solon, Fulford, & Prentice, 2005; McEniry, 2011; Lokshin & Radyakin, 2012). Researchers have most commonly argued that prevalence of disease, seasonal maternal labor supply, or nutritional intake associated with agricultural output as likely channels through which calendar time of birth may affect health outcomes. While much of the season of birth literature suggests that the timing of birth in relation to the agricultural cycle is important, it is difficult to disentangle prenatal nutritional effects from exposure to disease or other seasonal factors.

A growing body of related literature examines the effects of early exposure to observed weather fluctuations (e.g., Maccini & Yang, 2009; Yamauchi, 2012; Skoufias & Vinha, 2012;

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Rocha & Soares, 2015; Cornwell & Inder, 2015; Andalón, Azevedo, Rodríguez-Castelán, Sanfelice, & Valderrama-González, 2016; Trudeau, Conway, & Menclova, 2016; Groppo & Kraehnert, 2016; Mulmi, Block, Shively, & Masters, 2016). These studies have most commonly relied on changes in rainfall or ambient temperature patterns as exogenous sources of variation. While this literature arguably implements stronger identification strategies than the season of birth literature, it still has trouble isolating the relevant mechanisms at work. Maccini and Yang (2009), for example, found higher rainfall in early life was associated with better health outcomes for Indonesian women, but not for men. They attributed the positive association to the influence of rainfall on increased agricultural output and lower food prices. Rocha and Soares (2015), on the other hand, attributed a positive relationship between rainfall and birth outcomes in Brazil to increased access to safe drinking water and consequently lower prevalence of disease. Still other studies have found that increased rainfall early in life can have negative consequences for later outcomes due to the disease environment, increased maternal labor supply, inaccessible healthcare, or a negative impact of excessive rain on agricultural production (e.g., Skoufias & Vinha, 2012; Cornwell & Inder, 2015; Adhvaryu & Nyshadham, 2015).

Our prenatal food scarcity measure was derived by combining individual date of birth with survey data collected shortly after birth at the local community level. Importantly, the survey contained explicit data on months when food becomes harder to obtain or more expensive within each community. Identification relies on the assumption that prenatal exposure to reported months of food scarcity, conditional on community and month of birth fixed effects, was uncorrelated with any unobserved determinants of examined child health outcomes. Under this assumption, we were able to identify the impact of *in utero* exposure to reported seasonal food scarcity on health outcomes and subsequent parental investments measured at age one, five, eight, and twelve for a cohort of Ethiopian children born between May 2001 and May 2002.

In addition to providing effect estimates in the Ethiopian context, this paper makes three main contributions to the existing literature. First, we isolate the impact of seasonal changes in prenatal nutrition on health outcomes using a treatment measure that is both localized and explicitly based on exposure to food scarcity. A complication with using environmental shocks for identification is the presence of multiple channels through which weather changes have been argued to effect health outcomes. Moreover, even when weather patterns are convincingly linked to changes in agricultural production, it is not inherently clear how effects travel through the supply chain and ultimately impact food availability and/or prices. We used an explicit measure of food scarcity to circumvent the ambiguity surrounding the use of environmental shocks, such as rainfall or temperature, as instruments for nutritional deprivation. This is also one of the few studies to use a localized instrument to examine how season of gestation impacts later health outcomes. Localization of the measure allowed us to control for seasonal trends that occurred at the country level but were unrelated to food availability.

Second, having health outcomes collected repeatedly over an extended period of rapid physical growth adds novel evidence on how the effects of prenatal nutritional deprivation evolve over the life course. While studies have linked prenatal shocks to changes in birth weight or other early-life health outcomes, these may not be particularly comprehensive or sensitive measures (Almond & Currie, 2011). The fetal origins hypothesis suggests that prenatal insults may lead to latent physiological adaptations that have significant effects later in life. It is not clear when such latent health effects may manifest as consequential and/or perceptible adverse health outcomes. We add to the literature by documenting the longitudinal effects of a mild prenatal nutritional shock on widely used objective measures (height and body mass) that have been linked to long-term health and economic well-being (e.g., Kedir, 2009; Tesfaye, Byass, & Wall, 2009; Yimer & Fantaw, 2011; Awoke, Awoke, Alemu, & Megabiaw, 2012; Gudina, Michael, & Assegid, 2013).

Finally, we examine the impact of exposure to prenatal seasonal food scarcity on parental perceptions of child health and subsequent investments over childhood. Evidence suggests that parents in many countries alter investments in children in response to health endowments at birth (Almond & Mazumder, 2013; Adhvaryu & Nyshadham, 2016). Ayalew (2005) found that parents in Ethiopia compensated less healthy children with additional health investments as they aged. Porter (2010) also documented partial catch-up growth among rural Ethiopian children who were malnourished under age five. However, given the potential latency of effects from prenatal nutritional deprivations, it is unclear if and when parents respond to such shocks. Our longitudinal data analysis provides a unique opportunity to identify changing effects of prenatal exposure on parental perceptions and investments as children age. This adds to our knowledge of the 'biological' versus 'social' effects of the prenatal nutritional environment (Almond & Currie, 2011).

2. DATA AND METHODS

(a) *Data*

We used data from the Young Lives Study (YLS), which conducted surveys for a cohort of 2,000 children born between May 2001 and May 2002 in twenty sites across Ethiopia. Data were available from four rounds of surveys conducted in 2002, 2006, 2009, and 2013—when children were approximately one, five, eight, and twelve years old. The study collected detailed information on household and child characteristics including anthropometric markers. In addition, a community-level survey was conducted during each wave of data collection. These data on a variety of topics were obtained through interviews with key community leaders such as government officials, municipal leaders, and village headmen.

(i) *A measure of prenatal exposure to seasonal food scarcity*

Relevant data collected at the local community level were used to construct our measure of prenatal exposure to seasonal food scarcity. While poor and food-poor areas were oversampled by the study, the communities span Ethiopia geographically and are contained in the regions where almost 97% of the population reside. Specifically, communities were sampled from the capital city of Addis Ababa and the regional states of Amhara, Oromia, Tigray, and the Southern Nations, Nationalities, and Peoples' Region (SNNPR).

Our exposure measure was constructed on the basis of the following community survey question collected during the first wave, when children were 6–18 months old:

> *In which months of the year does food become harder to obtain / more expensive?*

Data collectors recorded responses to this question by ticking 'yes' or 'no' for each month of the year. We used the survey responses for 22 of the 23 local communities, with the last

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