



# Disease externalities and net nutrition: Evidence from changes in sanitation and child height in Cambodia, 2005–2010



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## ABSTRACT

Child height is an important indicator of human capital and human development, in large part because early life health and net nutrition shape both child height and adult economic productivity and health. Between 2005 and 2010, the average height of children under 5 in Cambodia significantly increased. What contributed to this improvement? Recent evidence suggests that exposure to poor sanitation – and specifically to widespread open defecation – can pose a critical threat to child growth. We closely analyze the sanitation height gradient in Cambodia in these two years. Decomposition analysis, in the spirit of Blinder-Oaxaca, suggests that the reduction in children's exposure to open defecation can statistically account for much or all of the increase in average child height between 2005 and 2010. In particular, we see evidence of externalities, indicating an important role for public policy: it is the sanitation behavior of a child's neighbors that matters more for child height rather than the household's sanitation behavior by itself. Moving from an area in which 100% of households defecate in the open to an area in which no households defecate in the open is associated with an average increase in height-for-age z-score of between 0.3 and 0.5. Our estimates are quantitatively robust and comparable with other estimates in the literature.

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## 1. Introduction

Child height is an important indicator of human capital and human development, in large part because of its importance for adult economic productivity and health (Currie, 2009; Vogl, 2014). This is chiefly because height is determined by health and net nutrition in the first few years of life, a critical period for cognitive development (Case and Paxson, 2008). In poor countries, the disease environment to which children are exposed and income are important indicators for adult height (Bozzoli et al., 2009). The importance for height and child development of early-life health, relative to genetics, is even greater in these countries compared to richer countries (Martorell et al., 1977; Spears, 2012b). Recent econometric evidence suggests that exposure to germs from open defecation is an important determinant of child height in developing countries (World Bank, 2008; Spears, 2013), and epidemiological evidence suggests that potential mechanisms for

this relationship include diarrhea, intestinal parasites, and environmental enteropathy, a disease of the small intestine. It is therefore important to better understand the relationship among sanitation, the early-life disease environment, and subsequent child health and human capital outcomes, especially in countries where practicing open defecation is widespread.

We study the relationship between open defecation and child height in Cambodia, where 77% of households defecated in the open in 2005 and 63% in 2010. The primary contribution of this paper is to document what accounts for Cambodian children growing taller between 2005 and 2010. We show that much of the increase in child height over this period of time can be statistically accounted for by the increase in sanitation coverage over the same period.

In studying Cambodia, this paper makes three important contributions to the literature. First, in Cambodia open defecation is particularly common, representing an enduring development challenge and an unusually threatening disease environment for children. Second, although the country remains far from eliminating open defecation or child stunting, Cambodia saw an improvement in child height from 2005 to 2010, coupled with a decrease in open defecation. This improvement, which was unusually rapid

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among developing countries, gives us the opportunity to study any association that may exist between the two.<sup>1</sup> Third, we use decomposition techniques to examine whether the change in sanitation can statistically account for the improvement in child height over this period of time.

The empirical analysis in this paper is in two parts. The main question we seek to answer is how much of the increase in child height from 2005 to 2010 can be statistically accounted for by the reduction in open defecation. We apply three complementary decomposition techniques: regression analysis to examine whether controlling for local open defecation eliminates the statistical importance of the indicator for survey year, a standard linear Blinder-Oaxaca decomposition, and a non-parametric decomposition. Although open defecation remains common in Cambodia, we find that its decline over the period studied can account for most or all of the increase in child height.

Before computing decompositions, we first explore the association between exposure to open defecation and child height over time by combining the two most recent Demographic and Health Surveys in Cambodia and using panel data methods. This analysis provides support for the association between sanitation and stunting on which we rely for computing decompositions. Using urban and rural province part fixed effects, which isolates the variation within province parts, we find that the geographic areas in which open defecation decreased by more saw a greater improvement in child height, on average. In particular, we document negative externalities of open defecation: the rate of open defecation in the child's locality is more important for child height than the sanitation practices of the child's own household, indicating an important role for policy as households' own private demand for latrines may be too low.

This preliminary result is robust to a range of specifications. We test the mechanisms through which we expect open defecation to affect child height. We show that the association between open defecation and child height is steeper in urban areas, which is consistent with greater exposure to fecal pathogens when open defecation occurs in higher density areas, and that there is also an association between open defecation and child weight, consistent with mechanisms that affect child growth. We also perform two robustness checks: estimating our model by isolating the variation within regions in a particular year, and including data from the Demographic and Health Survey conducted in 2000.

### 1.1. Open defecation and child stunting

According to [WHO and UNICEF Joint Monitoring Program \(JMP\) statistics for 2015](#), 13% of people in the world defecate in the open. Of these roughly one billion people, about 7.5 million live in Cambodia, representing 48% of the country's population.<sup>2</sup> Among developing countries, open defecation is particularly common in Cambodia, notably more common than in the rest of Southeast Asia, where 10% defecate in the open, sub-Saharan Africa, where 23% do, and South Asia, where 34% do.

Poor sanitation has important implications for the health and nutritional status of children, and a sizeable body of evidence in the fields of medicine and epidemiology demonstrates this link through a combination of three or more possible mechanisms, the

importance of each of which may differ across contexts. These mechanisms include diarrhea, intestinal parasites, and environmental enteropathy. [Checkley et al. \(2004\)](#) used a cohort study in Peru to show that safe water and sanitation practices, which reduced fecal-oral contamination, were associated with fewer diarrheal episodes and better nutritional outcomes, as measured by height-for-age, in children. A meta-analysis conducted by [Esrey \(1996\)](#) has shown an effect of sanitation on intestinal parasites.

More recently, researchers have investigated the role of environmental enteropathy (EE) as another, and perhaps more important, mechanism linking fecal-oral contamination to malnutrition ([Humphrey, 2009](#)). EE is a largely subclinical condition that is demonstrated by damage to the walls of the small intestine thereby reducing its absorptive capacity. There is substantial evidence linking markers of EE to lower height-for-age z-scores ([Kosek et al., 2013](#); [Goto et al., 2009](#); [Campbell et al., 2003](#); [Lunn et al., 1991](#)), and there is now a growing literature linking the sanitation environment to markers of EE. One recent observational study finds that indicators of EE and malnutrition are higher among children who live in "dirtier" households, where they are exposed to more fecal pathogens ([Lin et al., 2013](#)). EE may even be at play when clinical conditions like diarrhea are absent. A recent study in Mali found an effect on child height, but not on diarrhea, of a randomly assigned Community-Led Total Sanitation program ([Pickering et al., 2015](#)).

This paper joins a growing econometric literature documenting effects of open defecation on child height. [Gertler et al. \(2015\)](#) use experimentally-induced variation in open defecation from four randomized controlled trials (RCT) of independently conducted sanitation programs in different countries to find a causal relationship between village open defecation and child height. An RCT in Indonesia, one of the experiments studied in Gertler et al.'s meta analysis, shows that a Total Sanitation and Sanitation Marketing project increased average height of children living in households without access to sanitation at baseline ([Cameron et al., 2013](#)). Another RCT, conducted in Maharashtra, finds that improvements in sanitation brought about by the Indian government sanitation program increased average child height ([Hammer and Spears, 2015](#)). In India in particular, econometric studies of a government sanitation program document a link between sanitation and infant mortality ([Spears, 2012a](#)), child height (*ibid.*), cognitive achievement ([Spears and Lamba, 2015](#)), and adult wages ([Lawson and Spears, 2016](#)). In the vein of the analysis we conduct in this paper, [Headey \(2015\)](#) applies econometric methods to Demographic and Health Surveys in Ethiopia to identify an effect of improved sanitation on child height, and [Spears \(2013\)](#) investigates the difference in child height between India and Africa and documents that cross-country variation in sanitation can statistically explain a large fraction of international height differences.

Several studies of sanitation programs, however, document no health impacts. [Clasen et al. \(2014\)](#), for instance, find no significant health impact in an RCT studying a government sanitation program in Orissa. [Patil et al. \(2014\)](#) similarly find no impact in a sanitation study conducted in Madhya Pradesh. The authors of both studies note, though, that the absence of an impact on health may have been because latrine use remained low despite large increases in latrine coverage.<sup>3</sup>

<sup>1</sup> In Cambodia, open defecation rates fell by 14 percentage points over the five-year period studied. According to WHO-UNICEF Joint Monitoring Program data, Cambodia's decline in open defecation over this period was in the 96th percentile of all countries in the world.

<sup>2</sup> The JMP compiles data from multiple sources including DHS and country censuses, and makes projections for years in between using a linear trend. For this reason, estimates from the JMP often differ from DHS data, on which this paper relies.

<sup>3</sup> The authors of the Orissa study write: "insufficient coverage and use of latrines seem to be the most likely causes for the absence of effect" ([Clasen et al., 2014](#)). Similarly, the authors of the Madhya Pradesh study state: "the less than universal or very high levels of IHL coverage in the intervention villages combined with relatively small behavior changes are consistent with our finding of no improvements in child health outcomes" ([Patil et al., 2014](#)).

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