



Why Sanitation Matters for Nutrition

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SUMMARY Water, sanitation, and hygiene can have a profound effect on health and nutrition. A growing base of evidence on the link between sanitation, child height, and well-being has come at an opportune time, when the issue of sanitation and nutrition in developing countries has moved to the top of the post-2015 development agenda.

THE YEAR 2014 WAS AN EXCITING TIME FOR NUTRITION RESEARCH and policy action related to water, sanitation, and hygiene, or WASH. In terms of research, during the past year, a wide range of studies began to converge on evidence that WASH can be critical in shaping key nutrition outcomes, such as child height, one of the most important measures of a population's well-being. The evidence regarding the nutritional consequences of sanitation was particularly strong,¹ especially for open defecation without using a toilet or latrine, which is the focus of this chapter.

The importance of WASH for nutrition should come as no surprise. Researchers have long known that nutritional outcomes reflect “net nutrition”: the nutritional resources that, after what is consumed by activity or disease, are absorbed and available to the body to support growth. Poor sanitation, and deficient WASH more generally, expose growing children to germs that cause disease and prevent children's bodies from putting their diets to the best possible use. This is why WASH has long been part of the United Nations Children's Fund (UNICEF) conceptual model of child nutrition.

In 2014, the issue of sanitation and nutrition also moved to the front of the development policy agenda. Sanitation now seems to be a global priority: ending open defecation is near the top of the world's post-2015 goals for sustainable development. This is particularly true for India—a country where half of all children are stunted² and a country home to half of the world's population of the one billion people worldwide who, according to UNICEF-World Health Organization (WHO) statistics, defecate in the open. India has made the rapid elimination of open defecation a policy priority.

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While open defecation has declined only very slowly in India, other countries have experienced faster improvements in WASH, which has sometimes contributed to improvements in child nutrition. Below, we review new evidence from such periods of rapid improvement in sanitation and highlight emerging biological research that is helping researchers better understand the mechanisms of the nutritional effects of WASH. We will especially focus on evidence that has emerged in the past year.

The chapter particularly focuses on the links between WASH and child height. A child's height reflects her health and nutrition in her first few years of life, including *in utero*. This is because children with a healthier start in life come closer to achieving their genetic potential height. Height is a marker for the development of bodies, brains, and skills—all of which are influenced by health and nutrition. On average, children who have the early health that allows them to grow taller are also likely to grow into healthier, more productive, and longer-lived adults. The average size of children predicts the health and human capital of the next generation of workers and parents.³ Thus, the impacts of WASH on child height are critical.

JUSTIFICATION FOR ACTION

The evidence base is now sufficient for policymakers to invest in improving WASH in contexts where exposure to fecal pathogens is an important threat to child nutritional outcomes. Much of this evidence comes from studies of entire populations—including both the current experiences of modern developing countries and the sanitary history of developed countries. This is appropriate because the effects of sanitation are population-level processes, where neighbors influence neighbors. Demographers, epidemiologists, and historians first documented the importance of fecal germs by studying urbanizing Europe.⁴ A new analysis of more than a century of adult male heights in 15 European countries found that the most important cause of the historical increase in European height was improvement in the disease environment.⁵

Disease still matters for nutritional outcomes in developing-country populations today. Preliminary research suggests that during the past 40 years,

improvements in water and sanitation have been one of the key drivers in reductions in child stunting across 116 countries.⁶ However, many countries still face a threatening disease environment. Demographic and Health Survey data show that differences in exposure to open defecation can statistically explain more than half of the variation in average child height across developing countries.⁷ Moreover, new research suggests that the longstanding puzzle of the “Asian enigma”—that children in India are shorter, on average, than much poorer children in Africa south of the Sahara—can be entirely statistically accounted for by the much greater density of open defecation to which children are exposed in India.⁸

Evidence from Changes in Bangladesh

Open defecation has fallen dramatically in Bangladesh over recent decades—from 34 percent of people defecating in the open in 1990 to 2.5 percent in 2012, according to data provided jointly by UNICEF and WHO. This important change has provided researchers with a special opportunity to investigate the nutritional consequences of changes in exposure to poor sanitation.

The fast improvement in child height in Bangladesh over recent years has been called the “other Asian enigma.” Particularly given that nutritional improvements in neighboring India have been so slow, why have children in Bangladesh grown so much taller so quickly?⁹ Data suggest that, alongside improvements in overall economic well-being and in parents' education, a reduction in the amount of open defecation to which children are exposed is among the important factors that can account for the improvement over time in average child height.¹⁰

Other recent research on Bangladesh uses Geographic Information System data to study differences in child height within small geographic areas. These studies pay special attention to an interaction between sanitation and population density because open defecation matters more for infant mortality and child height where population density is greater.¹¹ Bangladesh is relevant because population density is extremely high, and open defecation has declined dramatically. Evidence points to a strong association between reductions in the density of open defecation and improvements in child height.

Finally, one can learn from comparing children in Bangladesh with a very similar population of children: those just across the Indian border, in the neighboring state of West Bengal.¹² Children in West Bengal come from much richer households, on average, than Bangladeshi children, but are not much taller; indeed, at the same level of economic wealth, children in West Bengal are *shorter* than children in Bangladesh. Much lower levels of open defecation in Bangladesh are a key reason for this difference.

Environmental Enteropathy: An Emerging Biomedical Picture

Several biological mechanisms could link exposure to fecal germs to poorer net nutrition in children. Some of these, such as diarrhea and parasitic infections, have a long history in the biomedical literature. Another hypothesized mechanism called “environmental enteropathy” (EE) has been receiving increased attention recently, including from newly published studies and ongoing field experiments.

EE is a complex disorder of the intestines caused by an inflammatory response to ingestion of large quantities of fecal germs.¹³ EE could be an important cause of poor nutritional outcomes by reducing the ability of a child’s intestines to absorb nutrients—possibly without a child ever appearing to suffer from obvious illness, such as diarrhea. Although EE may prove to be an important cause of malnutrition globally, it is currently unclear exactly what causes EE and how it can be treated or prevented.¹⁴

In comparing children in Bangladesh exposed to better and worse WASH conditions, a new analysis found that poor WASH is associated both with biological markers of EE and with reduced child height.¹⁵ This study thus provides early evidence of a link throughout the biological pathway from WASH to EE to nutritional outcomes. Another large-scale study of children in eight developing-country settings worldwide similarly found that children who show measurable signs of EE go on to grow less tall over subsequent months.¹⁶ Finally, a third study found that EE is associated with stunting among infants in Zimbabwe and that effects may begin *in utero*.¹⁷ These observational studies all point toward an important role for EE in linking poor WASH to child stunting.

CLUES TO GUIDE ACTION

If WASH matters for nutritional outcomes, can programs designed to improve WASH also lead to better nutrition? Several ongoing randomized controlled trials are designed to estimate the effects of particular WASH interventions on nutritional outcomes, especially the SHINE (Sanitation, Hygiene, Infant Nutrition Efficacy) trial in Zimbabwe and the WASH Benefits trial in Bangladesh and Kenya.

Another experimental study that recently released preliminary results was a cluster-randomized controlled trial of a community-level campaign to promote latrine use that was implemented by the government of Mali with the support of UNICEF. This study showed that the program caused children under the age of five to be taller and less likely to be stunted.¹⁸ Although it may be surprising that improved sanitation had a detectible effect on child height in a country with such a low population density, the improvement in sanitation coverage was quite large, relative to other experimental studies of sanitation.¹⁹

Three other cluster-randomized field experiments have been led by the World Bank Water and Sanitation Program (WSP). One is a randomized intervention of the Indian government’s Total Sanitation Campaign in rural Madhya Pradesh, a state in central India.²⁰ Unfortunately, open defecation proved difficult to change: “the intervention led to modest increases in the availability of individual household latrines and even more modest reductions in open defecation.” Additionally, many treated villages received latrines only a few months before the follow-up survey. Therefore, the outcomes did not detect any effects on child height.²¹ Similar challenges emerged in a 2004 experimental implementation of the campaign by WSP and the government of Maharashtra.²² The experiment was only implemented in one of three intended districts, and the effect on latrine coverage was reported to be small. Because randomization occurred within districts, the study was able to identify a positive average effect of the program on child height in the implemented district; however, that district was the most developed of the originally identified three, and an econometric model suggests that the program would have had a much smaller effect if implemented in the other two districts.

A further randomized evaluation studied WSP's Total Sanitation and Sanitation Marketing program in rural East Java, Indonesia.²³ Like the findings in the other field experiments, the effect on open defecation was found to be small: the program was claimed to have caused an approximately 2 percentage point decline in open defecation overall, and a 5.8 percentage point decline among participants without sanitation facilities before the experiment. With such a small effect on sanitation, the experimenters could find improvements in child weight and height only among nonpoor households without sanitation at baseline, but not in the full sample.

The Difficulty of Estimating the Effect of Sanitation on Child Height from an Experiment

Researchers and policymakers often talk about “the” effect of an input or an intervention, such as the effect of open defecation on child height. Yet effects are, in fact, different in different contexts. This variation across places, programs, and populations means that the set of effect sizes available from experimental evidence will always be shaped by the contexts in which experiments can and do happen.

One important recent review surveyed impact evaluations of WASH interventions, focusing on the effects on child nutritional outcomes.²⁴ By design, the review excluded both population-level observational studies and indeed any research that did not study an intervention. Therefore, its view of the effects of WASH on child height was shaped by the interventions studied in the literature, and by the ability of those interventions to change WASH behaviors. The review identified 14 eligible studies, including interventions targeting solar disinfection of drinking water and hand hygiene. Yet the only studies pooled in a meta-analysis were the five studies that were randomized. The reviewers concluded that the studies collectively are suggestive of a benefit of these WASH interventions for child height, although they also cautioned the reader regarding the methodological quality of the reviewed studies.

The ability of intervention studies to illuminate the effect of sanitation on child height (stage 2 in Figure 1) will always depend upon the ability of available interventions to change sanitation behavior (stage 1 in Figure 1). For an extreme example, it

would clearly not be possible to learn about the effect of open defecation on child height from an intervention that does not reduce open defecation at all. This is a matter of practical concern: we have seen several examples of large-scale intervention studies that achieved only very small improvements in sanitation behavior.

Because 60 percent of the people worldwide who defecate in the open live in India, it is perhaps the context where understanding the effect of sanitation on nutrition would be most relevant. A recent survey of rural households in five north Indian states highlights a deep-seated, socially embedded aversion to latrine use.²⁵ Many people in rural north India believe that open defecation is part of a wholesome rural way of life. Perhaps more important, latrine use is discouraged by social notions of purity and pollution. As a result, many people living in households with working latrines do not use them, even in instances where another family member does. In a special challenge for sanitation policy, most people who live in a household with a government constructed latrine still defecate in the open.

There is every reason to expect that the effect of sanitation improvements on nutritional outcomes is not the same worldwide. For example, studies suggest that the effect on neighbors' health of moving from open defecation to latrine use might be greater than the effect of moving from simple latrines to better toilets.²⁶ We have seen evidence that population density interacts with sanitation to shape child health: open defecation seems to matter more where people live more closely together. All of these factors suggest that the effect of sanitation on child height may be especially large in densely populated India, where resistance to sanitation behavior change is strong.

PRIORITIES FOR RESEARCH

The initial priority is to address first-stage problems by improving the programmatic and policy tools available to change sanitation behavior. Indeed, even if we were not concerned with improving intervention studies of the nutritional consequences of WASH, learning how to be more effective at changing open defecation behavior into latrine use, particularly in India, would be a top priority for further

FIGURE 1 Evaluating WASH interventions



Source: Authors' schematic.

research. Similarly, much more research is needed on exactly how fecal germs contaminate children's environments. Which are the most important pathways, and how can they be interrupted?

If open defecation in rural India is indeed embedded in longstanding social forces, it may prove difficult to change. But this would be all the more reason to strive to better understand how to do so. Studies from a diversity of methodological approaches—from quantitative intervention experiments to qualitative fieldwork—are urgently needed to improve policy tools to eliminate open defecation.

Although clear evidence now links sanitation to child nutrition, another important open question asks about the effects of WASH on maternal nutrition. Maternal nutrition is a critical determinant of a child's birth weight, of neonatal mortality, and of subsequent nutritional and developmental outcomes. How much less do pregnant mothers weigh when they live in an environment of fecal germs, and what are the consequences for children?

POLICY IMPLICATIONS

A growing base of evidence supports the inclusion of improving sanitation—and particularly reducing open defecation—among nutrition-supporting policy priorities. This is especially true in places, such as rural India, where open defecation remains common amid high population density, leading growing children

to be especially likely to be exposed to fecal germs. Reducing open defecation requires urgent investments in learning *how* to reduce this practice. We must better understand how to change behavior and promote latrine use, especially in societies where open defecation is widespread and latrine use is resisted.

The importance of WASH for nutritional outcomes may or may not imply that WASH and nutritional programs should directly work together. Whether this is the case depends on two types of interactions: biological and pragmatic. Biologically, ongoing field experiments will provide evidence on whether certain ideally implemented nutritional and WASH interventions work best when implemented together. However, even if such a biological synergy exists, governance arrangements may be either improved or worsened by an attempt to converge WASH and nutrition programs.

This uncertainty illustrates the broader importance of governance constraints and limited state capacity. In some contexts where demand for latrine use is high, such as Bangladesh and Cambodia, sanitation has improved as households have purchased latrines from private suppliers. However, households are unlikely to purchase latrines from markets where demand for latrine use is low. In places such as rural India, building demand for latrine use is likely to require public action. Although the challenge is great, the benefits for improved child nutrition could be just as substantial. ■

NOTES

CHAPTER 3

- 1 Epidemiologists describe an “F-model” of the links from fecal pathogens to child health: children are contaminated from fecal germs through fingers, feet, food, fluids, and flies. Hand hygiene and improved water can break some of these pathways, but safe and sanitary containment of excreta is necessary to break them all.
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- 8 Ibid.
- 9 D. D. Headey, J.F. Hoddinott, D. Ali, T. Roman, and M. Dereje, *The Other Asian Enigma*, IFPRI Discussion Paper 1358 (Washington, DC: International Food Policy Research Institute, 2014).
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- 17 A. J. Prendergast et al., “Stunting Is Characterized by Chronic Inflammation in Zimbabwean Infants,” *PLOS ONE* 9 no. 2 (2013): e86928.
- 18 M. L. Alzua et al., *Impact Evaluation of Community-led Total Sanitation (CLTS) In Rural Mali*, CEDLAS Working Paper (La Plata, Argentina: Universidad Nacional de La Plata, 2014).
- 19 Their report of an effect of 0.16 standard deviations on child height and of a 30 percentage point difference in sanitation coverage can be used to construct an instrumental variables estimate of 0.53 for the effect of the fraction defecating in the open on child height for age. This is consistent with estimates around 0.5 (or slightly greater in high population density contexts) found by Spears, *How Much International Variation in Child Height Can Sanitation Explain?*; Lin et al., “Household Environmental Conditions Are Associated with Enteropathy and Impaired Growth in Rural Bangladesh”; and Kov et al., *Growing Taller among Toilets: Evidence from Changes in Sanitation and Child Height in Cambodia*.
- 20 S. R. Patil et al., “The Effect of India’s Total Sanitation Campaign on Defecation Behaviors and Child Health in Rural Madhya Pradesh: A Cluster Randomized Controlled Trial,” *PLOS Medicine* 11, no. 8 (2014).
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