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Detailed Review of a Recent Publication: Improved sanitation results in taller children in Mali

Pickering, A.J. et al., 2015. Effect of a community-led sanitation intervention on child diarrhoea and child growth in rural Mali: A cluster-randomised controlled trial. The Lancet Global Health, 3(11), pp.e701–e711.

Historically, the most commonly used indicator of health impact of WaSH interventions has been childhood diarrhea (Esrey et al. 1991, Fewtrell et al. 2005). Though widely used, this measure has drawbacks: it is hard to measure objectively because it is hard to define precisely or recall, and it often varies seasonally. There are many causes of diarrhea, not all of them WaSH-related.

Pickering et al. have recently published the results of an impact evaluation of a sanitation program in Mali. The intervention was implemented by the Government of Mali (Direction Nationale de l'Assainissement) with technical support from UNICEF, and used a demand-creation approach to eliminating the practice of open defecation known as Community-Led Total Sanitation (CLTS—see box). Among the outcomes studied were episodes of diarrhea (which showed no change), and child stunting (which did). This study thus adds to a growing body of evidence of the link between sanitation and nutritional outcomes.

The evaluation was a randomized controlled trial (RCT), a study design providing credible results when done correctly. The trial compared outcomes between 60 villages that received a CLTS program and 61 villages that did not. The CLTS program was implemented in one entire village at a time (called a "cluster") and selecting who would get the CLTS program and who would not was done by randomly selecting villages (not families).

Outcomes of interest were measured at baseline in April-June 2011. The CLTS intervention was carried out from September 2011 to June 2012. The endline data were collected in April-June 2013. The intervention followed a fairly standard CLTS approach, whereby villages were "triggered" through a series of group activities to raise awareness of the dangers and externalities of open defecation (e.g. the flies go from anyone's feces to anyone's food), and to make public commitments to end open defecation. The program differed somewhat from other CLTS interventions in terms of intensity: follow up with the communities was frequent, and commitments were videotaped and later shared with other communities. Open-defecation free status was publicly awarded to a village once each household had a private latrine (with water and ash or soap for handwashing) and no open defecation remained.

Key Policy and Programmatic Takeaways

- **Well-implemented Community Led Total Sanitation can increase latrine use**: A sanitation program in Mali led to the construction and use of latrines that were affordable and acceptable to the users.
- **Sanitation improvements decrease stunting**: The intervention resulted in reductions in stunting among children, measured by height and weight data.
- **Stunting can be considered a useful measure of health impact**: Use of height and weight data demonstrated health impacts not shown by diarrhea data alone.

The authors report that the CLTS intervention in Mali increased ownership and use of latrines, reduced self-reported open defecation, and improved the quality of latrines. At the endline survey, use of a private latrine was 65% in CLTS villages (up from 33% at baseline) and 35% in control villages.

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Community Led Total Sanitation - CLTS

Communities are triggered to stop the practice of open defecation following a "transect walk", pointing out the presence of human feces in the community. The walk takes place after one or more meetings at which villagers identify places of open defecation and discuss negative impacts from the practice under guidance of a skilled facilitator. The primary focus is thus behavior change, not latrine construction, and one of the primary drivers of change is disgust. The assumption is that the collective decision by community members to stop open defecation establishes a new social norm in the community (strengthened by sanctions) that supports sustained behavior. Where new norms are not effectively established, "slippage" (i.e., people returning to the practice of OD over time) is likely.

The government implementing agency declared 97% of the intervention communities open defecation-free (ODF), even though not all households in ODF communities had a private toilet. (Note that accurately measuring ODF status is difficult, and there are no generally accepted methods for doing it. It is common for ODF figures to be overestimated.) Self-reported open defecation rates fell from 32.5% in control villages to about 9.5% among women and men in CLTS villages. Open defecation by children aged between five and ten dropped by 49% and among those younger than five it decreased by 51%. Self-reported data can be unreliable, but similar improvements were also documented through direct observation: latrines showed signs of regular use and in intervention villages they were three times more likely to have soap, five times more likely to have water, more than twice as likely to have a covered pit, and 31% less likely to have flies present. However, fecal contamination in drinking water sources and in water stored by households was not significantly different between control households and CLTS households.

In terms of health outcomes, the study did not find a change in the number of self-reported cases of diarrhea present in control communities vs. intervention communities. However, in addition to diarrhea, the study also measured the height-for-age and the weight-for-age of children under five. Children under five years old were taller in the intervention villages than in the control villages, and they were 13% less likely to be stunted, measured by comparing actual height at a given age to a reference height for the population (See the accompanying literature review for a definition of stunting and its effects).

Although the CLTS program in Mali did not achieve universal sanitation coverage, and many latrines constructed did not meet the definition of an "improved sanitation facility" as defined by the WHO-UNICEF Joint Monitoring Program, there was an increase in coverage and use of toilets, without the use of hardware subsidies. Latrines were constructed using local and available materials in the same way as village houses, which meant that they were low cost and acceptable to the users.

The fact that there was no change in the prevalence of diarrhea is not necessarily surprising as there are many pathways of infection and removing one may not be enough to reduce diarrhea; the fact that the study found no improvement in water quality indicates that at least some of the pathways of infection remained. At the same time, interpretation of the diarrhea data must be done with care: it was self-reported, and was only measured at one point in the dry season.

There are fewer such concerns with the height and weight scores. These are objectively measurable indicators, and their use in this study allowed the authors to demonstrate real impact on children's health as a result of the program; a fact that would have remained hidden if only diarrheal disease had been considered. But use of height and weight data comes at a cost. Collecting the data is harder and more time consuming (measuring and weighing children is more complicated than asking their caregiver whether they have had diarrhea recently). It also takes time to demonstrate that children in villages where most people use a latrine are actually growing taller, on average, than those in villages where most people don't.

It is important to note that there is still the possibility of bias when measuring child length or height; Wood et al. (2007) demonstrated that measurement bias can be demonstrated when a study is not blinded (i.e. the researcher doing the measuring does not know whether the subject received the intervention or not). Pickering et al. report that data collectors in this study were blinded as to which communities received the intervention and which ones did not, but they could have observed the newly constructed toilets and drawn their own conclusions. So we cannot completely exclude the possibility of bias, or measurement error. Nonetheless, the results of this impact evaluation suggest that measuring children's height and weight should be seriously considered for studies that seek to measure the health impact of WaSH interventions.

What does this article tell us about ways to measure program effectiveness? The study described in the article raises five important issues:

1. Results from a study such as this are influenced strongly by the quality of implementation of the intervention. In this particular example, sanitation coverage went up from 35% on average to 65% on average. Use of the toilets was very high, in both control and intervention villages (over 94% of people with access to a toilet used it), but presence of water or soap in the latrines was very low (25% and 15% respectively).

2. The use of a randomized control trial (RCT) allows the authors to say with a great degree of certainty that any differences we see between the control communities and the intervention communities are caused by the intervention itself (constructing and using toilets), not anything else.

3. It is difficult to say anything about trends over time. The fact that the researchers allowed one year to pass between

the baseline measurement and the endline measurement is – by and large– a strong point of the study; any positive impact from consistent latrine use would be expected to be established and measurable. But we must be aware that there was only one round of data collection after completion of the CLTS program.

4. There are questions regarding both what is measured and how it is measured. Stunting may be a better indicator of health impact than self-reported cases of diarrhea, but it is not perfect.

5. The study only looked at the health impact of sanitation. Additional study arms (measuring the impact of combined improvements in water supply, sanitation and hygiene for example) would likely have been meaningful. However, the evidence base for health impact of sanitation interventions in developing countries is weak, so this study adds significantly to our understanding.

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Literature review: Sanitation and Nutrition

Low height for age, or stunting[1], affects almost 165 million children under 5 years of age worldwide (Black et al. 2013). Irreversible growth faltering can begin before a child is born, and becomes apparent during the first two years of life. Long-term effects include impaired cognitive development, poorer educational achievement, and reduced economic productivity (Victora et al. 2010; Dewey and Begum 2011). Further, stunting also has inter-generational implications as recent evidence suggests stunted mothers are more likely to give birth to children that are stunted (Prendergast and Humphrey 2014).

Nutritional interventions alone have failed to improve child growth and undernutrition in the first two years of life to the extent predicted, shifting focus to complementing nutrition interventions with improvements in health care, housing conditions and water, sanitation and hygiene (Dewey and Adu-Afarwuah 2008).

Improved WaSH can complement nutrition interventions and impact children's growth through several biological mechanisms. Improved sanitation reduces environmental fecal contamination and improved hygiene and water quality reduce other means of exposure, decreasing risk of enteric infections (Wagner and Lanoix 1958). In addition to links between diarrhea and stunting (Checkley et al. 2008), research suggests that repeat enteric infections[2] of any type—both asymptomatic and diarrheal—may contribute to stunting through a condition known as "environmental enteric dysfunction" (EED)[3] (Prendergast and Humphrey 2015). Among other effects, EED leads to poor absorption of nutrients, and therefore contributes to poor nutrition and stunting.

Studies have shown an association between poor sanitation and child stunting at the community level. For example, Spears (2013) found country- and state-wide associations between open defecation and child height globally, and specifically in India (Spears et al. 2013), which is home to over 550 million people who practice open defecation (WHO and UNICEF 2015). Similarly, Fuller et al. (2016) showed that rural Ecuadorian children in areas of 100% sanitation coverage had 67% lower prevalence of stunting compared to those in areas with no coverage; studies in Nepal and Cambodia have similar findings (Coffey and Geruso 2015, Kov et al. 2013). While the literature suggests there is a strong association between community-level sanitation coverage and nutritional outcomes, a specific level of sanitation coverage necessary to reduce stunting has not been identified.

Despite these community level associations, evaluations of specific sanitation programs have yielded inconsistent results related to the impact of sanitation programs on diarrheal disease reduction and stunting. For example, a cluster-randomized control trial of an Indonesian rural sanitation campaign showed improved growth and reduced diarrhea in children previously lacking household sanitation. However, the impact was observed only among the wealthiest 80%, with no effect amongst the poorest (Cameron et al. 2013). An evaluation of India's Total Sanitation Campaign reported less open defecation, but no measurable effect on diarrhea or stunting (Patil et al. 2015), similar to results from Odisha (Clasen et al. 2014). An impact evaluation in Mali, reviewed in the first part of this Digest, suggested possible improvements in child height and a decrease in stunting (14% lower prevalence of stunting) following improvements in sanitation despite no differences in diarrhea (Pickering et al. 2015). These conflicting findings, and in particular those of the article highlighted in the first part of this digest, suggest that enteric infections—and not simply diarrhea—may be the mechanism through which sanitation impacts child stunting; however, more evidence is needed.

Currently, neither sanitation nor nutrition interventions alone have resulted in consistent reductions in stunting. Biologically, it follows that combining sanitation and nutrition interventions may yield synergistic effects on child growth and long-term development, as improved sanitation can reduce the burden of enteric infections, and not only diarrhea, that drives development of EED. However, the mechanisms by which enteric infections affect child growth needs to be better understood and multiple ongoing trials of concurrent sanitation and nutritional interventions should

1 Moderate (or severe) stunting is defined as height for age Z scores (HAZs) of more than 2 (or 3) standard deviations below the median of the reference population (WHO and UNICEF 2016).

2 Defined as any infection affecting the gut

3 Formerly known as "environmental enteropathy" (EE) or "tropical enteropathy"

further explain these links (Brown 2016; The Sanitation Hygiene Infant Nutrition Efficacy (SHINE) Trial Team 2015; Arnold et al. 2013). In the meantime, however, efforts to combat child stunting from the WaSH and nutrition communities are likely to require cooperative—rather than isolated—efforts, building on previous failures in both fields to identify effective solutions.

This literature review was prepared by David Berendes, Post-doctoral Fellow/Research Associate and Joe Brown, Assistant Professor, School of Civil and Environmental Engineering, Georgia Institute of Technology

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