2017

Sanitation Coverage, Usage and Health: A Rapid Investigation

FOR IDS SUSSEX AND WATERAID INDIA

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Abstract

It is recognised that health outcomes in people, and children in particular can be affected by improper sanitation. One in three Indian children is stunted. As India's flagship scheme works hard to achieve ambitious sanitation targets, what are the health outcomes of improving sanitation conditions? While India has focused on expanding the coverage of and access to sanitation facilities, there is evidence of partial usage from across India. A big gap in knowledge is on usage – what are usage behaviours. Moreover, there are methodological inconsistencies and wide variations in the way usage data is collected. Further, how do usage patterns affect health impacts? Given the limitations of the rural sanitation scheme, are there inferences to be made on sanitation thresholds and corresponding health impacts? There have been some studies that have demonstrated certain health impacts – such as reductions in stunting levels, or reduced rates of reinfection of certain diseases have been associated to high levels of coverage. However, while more research is required on this subject, current knowledge points to high thresholds of sanitation coverage *and* usage in order to see significant health impacts.

Toilet coverage, usage, and partial usage

I. Sanitation coverage and usage

India's sanitation schemes have focused on improved sanitation coverage, right from the Total Sanitation Campaign (TSC) to the Nirmal Bharat Abhiyan (NBA) and its current avatar, the Swachh Bharat Mission Gramin (SBM-G). Sanitation coverage has been long used a proxy for usage and only recently has there been an emerging and encouraging focus on latrine usage. Within usage, the prevalence of partial usage, or the enduring practice of open defecation despite access to a working latrine, is of concern. It belies the claims of universal toilet coverage, or open defecation free status that is the primary sanitation goal for India's villages today. Measuring coverage *and* usage is therefore critical for India to truly become open defecation free.

It is not easy to capture usage data. A close look on the few surveys that have captured usage data two comments emerge: that practices of partial usage vary widely across regions in India, and that there are methodological inconsistencies in the way usage and partial usage are captured. Methodological questions are addressed below, followed by a glimpse of the kind of usage data available.

II. The challenges of measuring usage

Households, demographic groups or individuals?

Should usage be measured at the household level, or aggregated to the sub-household level/demographic groups, or should every individual's behaviour be captured (Coffey and Spears 2014)? Usage surveys have largely tended to capture the first two categories, with only very few surveys actually investigating individual latrine use. There are reasons for this: for e.g. many have used

coverage as a proxy, or the survey design does not unpack usage fully, or the fact that individual investigations are more resource intensive and may not be feasible by all development institutions.

To start, the health surveys (NFHS, DHS etc) and the 2011 Census do not collect usage data and ask limited questions on latrine ownership. The NSS surveys and some RCTs from India offer some level of disaggregation by grouping people within the household, and only three recent large scale studies – the SQUAT surveys and one from Odisha (Barnard et al 2013), have interrogated individual behaviour.

People have different motivations for using or not using toilets (see Chambers and Myers 2016). The nature of the question determines the answer: those surveys that aggregated to the household level or by household member groups reveal lower levels of partial usage, whereas the surveys on individual latrine use found higher a higher prevalence of the same. There is a clear case for improving survey methodology on usage, and that asking about individual behaviour will perhaps reveal a more accurate picture of latrine use (see Table 1 - for example, the three studies in Puri district). Given the variations in data across the board, how do we make sense of the numbers?

Household level behaviour and behaviour by demographic groups

Subjectivity and bias. The 69th NSS round which captured water and sanitation data found that only 1.7% percent of households "had access to latrine but not using them" (NSS MOSPI 2016, p.25). The NSS-Swachhata Status report released four years later in 2016 was built on a survey that sampled households. It found that that 95.6% of households with toilets were using them, and usage of the different family members (men, women, elders etc) was all above 90%. (NSSO-MOSPI, 2016). While the report captured usage and open defecation separately, it did not capture partial usage, i.e. those households with functioning latrines still practicing some form of open defecation. The Swachh Survekshan Gramin survey 2017, conducted by Quality Council of India covered 4626 villages and found coverage to be 62.25% and 91.29% of people with access to toilets use them[1].

As Coffey and Spears (2014) point out, the 69th round NSS survey did not ask questions, but indicated options for the surveyor on access and type of latrine. Usage was arrived at by asking "whether all household members of categories specified are using latrine – yes/no/n-a" followed by the list of categories: men/women above 15 years of age, and men/women below 15 years of age. Coffey and Spears in their latest book also take a close look at the 2016 report. In it, they find that questions on access to toilets were not predefined, surveyors grouped latrine behaviour using intra-household groups (e.g. adult men, adult women) and they conclude that in all probability surveyors reached out to a few key respondents or "knowledgeable persons" (Swachhata status report as reported in Coffey and Spears 2017) in each village rather than interviewing every sampled household (ibid, p.262). Moreover, the surveyed districts were mostly better performing in terms of toilet coverage, and thus not representative. All this points to high levels of over-reporting and bias, and would explain why partial usage levels in the NSS reports are so implausibly low.

Aggregating responses. Although the three studies cited next were designed to study the health impacts of sanitation interventions (and not only usage), the manner in which levels of usage were captured and the results are interesting. The randomised control trial from Madhya Pradesh that studied the impact of the Total Sanitation Campaign (Patil et al 2014) asked respondents about open

[11] http://pib.nic.in/newsite/PrintRelease.aspx?relid=169706

defecation practices amongst men, women and children under the age of five. Questions were framed around whether open defecation practices were occasional, seasonal, daily, always or never. The trial found that despite having improved sanitation facilities within the home, 41% of those households reported adult men or women[2] still practiced daily open defecation (Patil et al 2014).

The RCT from Puri district in Odisha (Clasen et al 2014), (which also assessed the effectiveness of the Total Sanitation Campaign) used a mix of observation and behaviours of household member categories but recognised that this did not shed light on individual behaviour. Clasen and his team found that only 36% of households with toilets from the intervention sample in Puri district had signs of usage. A second study from Puri in Odisha in 2014 (again, looking at TSC) put together a set of questions to piece together household level sanitation behaviour that would peg households on a complex spectrum of behaviour ranging from full usage to only open defecation (Jenkins et al 2014). Their study found that within households with functional toilets, "27% of members still openly defecated once a day" (Jenkins et al 2014).

Surveys that looked at individual behaviour

Surveys that asked about individual behaviour reported higher partial usage levels (Coffey and Spears 2014). Barnard et al, 2013, which studied latrine usage in Odisha found that 39% of all households with functional toilets were not being used at all, and only 47% of household with latrines reported using them all the time.

The Squat survey from 2014 and its qualitative subset which covered five states in North India[3] found partial usage levels (measured as households with a working latrine but at least one member practising open defecation) to be 48% on average for the four states (UP, MP, Bihar and Rajasthan). Bihar had the highest rate of partial usage: 54.2% of households with a functioning toilet still practicing some open defecation (Coffey et al 2014). The qualitative survey – a smaller, more in depth conversation on toilets with respondents across the sample - found a higher prevalence of partial usage: 56% of households with toilets reported some open defecation.

Highly varying levels of partial usage and open defecation across India

In 2017, Public Affairs Foundation, supported by BMGF undertook a survey of SBM-G beneficiaries from select districts in Odisha and Tamil Nadu. One adult per household was questioned. On usage, the survey offered four categories: yes, all members use all the time / only some members use all the time / some members use during certain seasons / nobody uses the toilet (Public Affairs Foundation 2017).

For the six districts in Odisha[4] they found 78% of SBM-G households had members using "all the time"; in the six Tamil Nadu districts[5] 93% of households with functioning toilets used them answered "yes, all members use all the time" (Public Affairs Foundation, 2017). These levels of usage clash with the findings from the Squat survey, which reported that more than half of the houses with government latrines did not use them, but seem to match the anecdotal evidence received from that use a

[2] From the intervention set of villages
[3] Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh and Haryana
[4] Sambalpur, Angul, Dhenkanal, Ganjam, Cuttack and Baleshwar
[5] Dharmapuri, Kanyakumari, Krishnagiri, Perambalur, Tirunelveli, Tiruchirapalli

combination of CLTS and microfinance and reported 97-98% of usage in households). Clearly this requires more unpacking.

A recent but small study looked at toilet usage behaviour of 300 households from 4 villages in Jalpaiguri district in West Bengal. A little under half of the households (135) had toilets; amongst them, the study found that 56.7% of those households with toilets used them all the time, 32.6% reported "mixed usage of home toilets and open defecation" and 10.7% of the households opted for complete open defecation. Higher levels of OD were found in households with pit toilets as compared to those homes with flush toilets (Hajra and Dutta 2016). It is unclear if this data was captured at the household or individual household member level.

Accountability Initiative in Delhi ran a process survey[6] on SBM in a sample of north Indian districts in 2016 and looked into partial usage[7]. They found varying levels for "households with fully constructed toilets where at least one member defecates in the open": 26% in Udaipur district, 17% in Sagar district, 13% in Nalanda district, 2% each in Satara, Jhalawar and Purnea districts and 1% each in Kangra and Solan districts.

The most recent data received comes from Chhattisgarh and Uttar Pradesh. Investigations and verifications by Wateraid in Chhatisgarh districts found that 56% of households with toilets has at least one member practicing open defecation in Korba district, the same was 15% in Durg district and 1% in Kanker district[8]. These are surprisingly low figures!

Open defecation despite being declared open defecation free

While the following figures are not usage figures, they are nevertheless relevant. In Uttar Pradesh, a rapid survey of ODF declared villages conducted in September 2017 found that 30% of villages in Bijnor district did not qualify, i.e. the open defecation claim was rejected upon verification. These figures were compared to 60% of Amroha villages, 50% of Moradabad district villages and 74% of villages in Sambhal district[9].

[6] How Swachh is Bharat two years on? *Accountability Initiative.* 04 October 2016. Retrieved from http://www.accountabilityindia.in/how-swachh-bharat-two-years and http://accountabilityindia.in/sites/default/files/pdf_files/SBMG_Spt%2020%20%28Final%29.pdf
[7] Defined as "households with fully constructed toilets where at least one member defecates in the open".
[8] 2017, survey conducted by Wateraid
[9] 2017, as told to IDS in September 2017.

Table 1: Consolidated table of partial usage data

% of rural households with functioning toilets not being used by any member of the household[J] - 2013		*Barnard et al 2013*
Puri- Odisha	39%	
% of members still openly defecating once a day in rural households* with functional toilets / *2014		*Jenkins et al 2014*
Puri- Odisha	27%	
% of rural households with functioning toilets with signs of usage[\] - 2014		*Clasen et al 2014*
Puri[\] - Odisha	37%	
% of rural households with improved sanitation facilities reporting daily open defecation by adult men or women[&] - 2014		*Patil et al 2014*
Dhar and Khargone[&] - Madhya Pradesh	41%	
% of rural households with working latrine but at least one member practising open defecation* - 2014		*Coffey and Spears 2014*
Rajasthan[*]	66.2%	
Bihar[*]	54.2%	
Uttar Pradesh[*]	42.5%	
Madhya Pradesh[*]	40.8%	
SQUAT (Qualitative) North India	56%	
% of rural households with functioning toilets with "mixed usage of home toilets and open defecation" ^ - 2016		*Hajra and Dutta 2016*
Jalpaiguri[^] - West Bengal	32.6%	
% of rural households with fully constructed toilets where at least one member defecates in the open – 2016[$]		*Aiyar et al 2016*
Udaipur[$]- Rajasthan	26%	
Sagar[$]- Madhya Pradesh	17%	
Nalanda[$]- Bihar	13%	

Satara[$]- Maharashtra	2%
Jhalawar[$]- Rajasthan	2%
Purnea[$]- Bihar	1%
Kangra[$] - Himachal Pradesh	1%
Udaipur[$]- Rajasthan	26%
Solan[$] - Himachal Pradesh	1%

% partial usage in households with SBM-G toilets (see below for categories. HH with complete usage are not included) [>] ***– 2017***

Public Affairs Foundation 2017

	Some members use all the time	Some members use during certain seasons	Nobody uses the toilet
Dhenkanal[>] - Odisha	12%	5%	16%
Sambalpur[>] - Odisha	4%	6%	17%
Baleshwar[>] - Odisha	14%	3%	3%
Angul[>] - Odisha	12%	4%	7%
Ganjam[>] - Odisha	14%	2%	3%
Cuttack[>] - Odisha	7%	2%	2%
Dharmapuri[>] - Tamil Nadu	4%	1%	7%
Krishnagiri[>] - Tamil Nadu	4%	1%	3%
Perambalur[>] - Tamil Nadu	4%	1%	2%
Tiruchirapalli[>] - Tamil Nadu	2%	2%	2%
Tirunelveli[>]- Tamil Nadu	1%	0%	0%
Kanyakumari[>]- Tamil Nadu	0%	0%	0%

% of rural households with toilets has at least one member practicing open defecation - 2017[#] *Wateraid 2017*

Korba[#] - Chhattisgarh	56%
Durg[#]- Chhattisgarh	15%
Kanker[#]- Chhattisgarh	1%

% of open defecation villages despite ODF declared status (rounded off)	
Sambhal˜- Uttar Pradesh	60%
Amroha˜ - Uttar Pradesh	60%
Moradabad˜ - Uttar Pradesh	50%
Bijnor˜ - Uttar Pradesh	30%

volunteer verification - 2017

Sources: ˜Volunteer verifications as informed in IDS interviews and field investigations; #Wateraid Verification Survey 2017; $Aiyar et al 2016 / Accountability Initiative; >Public Affairs Foundation,2017; ^Hajra and Dutta, 2016; *Coffey et al, 2014; \Clasen et al 2014; /Jenkins et al 2014; &Patil et al 2014;)Barnard et al 2013. Not included in the table are anecdotal figures received between 20-25% of partial usage in North Karnataka districts / 97% in Tamil Nadu and findings from the QCI Swachh Survekshan Gramin report 2017.

III. Summing up: some pointers for investigating usage

Asking the usage question. The most common way of investigating usage has been through self-reporting. It is also common to ask generally about household toilet behaviour (e.g. how many members use the toilet) rather than the individual behaviour of each householder. This is easy and involves few straight forward questions, but can tend towards bias as people tend to overestimate, or have difficulty recalling. We also lose valuable information on the frequency and consistency of individual behaviour.

Usage surveys also ask people about their 'usual behaviour', which, as recent studies have found, tends to be unreliable when it comes to latrine use. A study from Odisha compared reported responses with data coming from passive latrine use monitors (PLUMs) installed in rural Puri district in Odisha (Sinha et al, 2017). The results were not surprising: reported use was significantly higher than the PLUM data. When asked about their 'usual' daily usage, respondents tended to over-estimate. There were fewer discrepancies when respondents were asked about their latrine use every day (for e.g. for a period of seven to fourteen days). It is probably more accurate to ask people to report on their usage patterns in very recent past than asking them about their 'usual behaviour'.

Framing an appropriate question. r.i.c.e. opines that questions on usage need "to be balanced – asking about both open defecation and latrine use"[10] and every person in the household needs to be questioned. Surveyors need to make respondents comfortable, and not hint that they *expect* an answer. Asking questions to a few 'knowledgeable persons' in the village could elicit *expected* answers. Moreover, questions tend to focus on use of toilets only, rather than asking about open defecation practices, latrine ownership *and* the frequency of toilet usage. Questions shouldn't be binary (yes/no), but should be balanced. For example, questions like "all the time/some of the time/ none of the time" could be better answered if framed around the time of day, or if there were issues of seasonality, and as pointed out above, if respondents are asked about their toilet usage in the recent past or within a specific time frame that can be accurately recalled. (Coffey and Spears, 2014).

When's a good time to survey? Through the course of investigations with field practitioners and sanitation NGOs[11], a common point that comes up is that transitioning from open defecation to latrine usage takes time. Occasionally this may not be the case, but it is well known that individual toilet behaviours vary by gender, by age, by disability, by occupation and even by the location of the household within the village[12]. Individual members have different reasons for not using toilets and a number of groups questioned estimated that moving a household to complete usage can take between three to six months, and even up to a year[13]. This brings up a number of questions:

- When should the state declare a village or a district open defecation free? Is it when coverage is 100%, or when usage and coverage are 100%?
- Secondly, when is the right time to survey usage?

Many NGOs also do not capture usage data. One reason they offer, apart from the fact that measuring usage is complex, is that they function 'in project mode', and after construction they

[10] Conversations with Sangita Vyas in September 2017
[11] This point came up when speaking to NGOs.
[12] For e.g. the usage baseline conducted by Arghyam in 2012 found that people living on the periphery and closer to the fields were more likely to practice open defecation than those at the heart of the village.
[13] Interviews with NGOs in September 2017

have limited bandwidth both in terms of staff and finances to study usage, which may require a longer time frame.

IV. What's working when it comes to usage?

Access to water as an entry point

From conversations and investigations with practitioners and NGOs on the ground, water seems to emerge as an important factor, and some NGOs[14] in India use water as an entry point into the sanitation space. For example, NGOs working in remote, difficult, or sparsely populated regions, or in areas with poorer communities who do not have water or sanitation facilities, securing water access is often a higher priority for the community than sanitation. The study of SBM-G toilets in Odisha and Tamil Nadu also pointed out that access to water was an important factor in the adoption of household latrines (Public Affairs Foundation 2017).

This point is bolstered by some evidence and experiences from the field. One NGO that works with marginalised communities in Kutch, Gujarat and some districts in Chhattisgarh (Mungeli, Bilaspur, Kawardha). Both regions offer distinct problems. Villages in Kutch where they work face acute water scarcity. In Chhattisgarh it's a problem of water access as villages rely on remote springs, where access and collection is difficult. In both cases, This NGO found using water as an entry point useful in improving sanitation conditions and getting people to use toilets. Once the water source is secured – either through gravity fed systems or rainwater harvesting, people are far more amenable to using toilets. Rainwater harvesting is a common entry point as well.

While integrated water and sanitation interventions can achieve high levels of coverage and usage and consequently positive health outcomes as in the case of Gram Vikas' interventions in Odisha (Duflo et al 2015), there can be challenges in their deployment and scaling.

Inter personal communication and ownership

One NGO that works in Maharashtra and Karnataka uses a mix of CLTS and financial support (water or sanitation loans) in their sanitation interventions. Measurement of usage is quite limited across most NGOs. However, since they go back regularly within the first year of construction for repayments, they are able to monitor the toilet usage and use IPC to encourage families to use. They did not have official usage numbers, but peg usage levels at 75-80% in north Karnataka. Gramalaya too finds working via a local village committee (including for routing finances) increases ownership of the asset, which encourages usage.

Explaining the causes of undernutrition (teaching about faecally transmitted infections and their transmission pathways, and talking about nutrition related aspects – availability and access to food, absorption, antibodies and allopathogens) through IPC or IEC messaging are also important triggers. In Saharanpur, Uttar Pradesh, WSSCC successfully used stunting photographs to explain to families that sanitation (and not just nutrition) is a factor in stunting (Mishra and Singh 2017). In one NGO's experience in North Karnataka, mothers take infant diarrhoea for granted, and tend to think it's part of the toddler teething process. Dispelling this myth was an integral to the triggering process. Other

[14] Interviews with NGOs in September 2017

examples have been the use of 'paternal responsibility' to trigger toilet construction in Davangere district of Karnataka.

On usage specifically, early projects in 2012 funded by Arghyam and designed by Final Mile looked at behaviour change and nudges to improve usage. However the intervention that was rolled out in Davangere district in Karnataka (other partners were the district administration and Final Mile, a behavioural architecture firm) did not proceed beyond pilot stage, and focused more on IEC/IPC activities on dispelling common myths associated with the toilet (early pit filling etc). 3ie with r.i.c.e has recently launched a program to evaluate interventions that promote latrine use across eight Indian states: Bihar, Odisha, Tamil Nadu, Uttar Pradesh, Karnataka, Telangana and Rajasthan.

V. Sanitation and health: indicators, evidence and issues.

Health outcomes in people, and children in particular can be affected by improper sanitation. Poor WASH is one of the leading causes of diarrhoea, many neglected tropical diseases (like trachoma), parasitic infections and soil transmitted helminth infections, not to mention stunting, which in turn leads to lower economic productivity and human capital (Prüss- Üstün et al 2008, Spears 2013). India alone accounts for a third of the world's people without access to improved sanitation (WHO/UNICEF 2015). WHO estimates state that 842,000 deaths from diarrhoea related diseases could be saved through WASH interventions[15], and that WASH could prevent over 5% of the child mortality under the age of 5 (Prüss-Üstün et al., 2014). Yet despite this clear connection between good sanitation-child health, gaps and contestations remain in clearly establishing the linkages between sanitation interventions in practice and their health outcomes.

Stunting and undernutrition

One of the most common cited health outcomes associated with sanitation - and the preferred indicator for undernutrition - is stunting (low height for age). Stunting, and early life circumstances are important determinants of future economic productivity and health[16]. Improper sanitation has been found to be the second largest risk factor in stunting after foetal growth risk, followed by diarrhoea[17], and in south Asia, environmental risks (and unimproved sanitation is the biggest) had a higher impact, ahead of nutritional risks (Danaei et al, 2016).

Asia is home to over half of the world's stunting (UNICEF-WHO, 2012). South Asia is a particular hotspot: 45% of children are stunted in Pakistan, 39% in India, 37% in Nepal and 36% in Bangladesh[18]. One in three of the world's stunted children under the age of five live in India[19]. Apart from being a critical risk factor for stunting itself, over half (54%) of the country level-variations in stunting can be explained by sanitation, and if population density is factored in, then 65% of the variation can be attributed to or is accounted for by to sanitation (Spears 2013). In India, inter-district variations in open defecation accounted for between 35-55% of corresponding variations in district level stunting

[15] Ibid #1
[16] http://www.who.int/nutrition/healthygrowthproj/en/index1.html
[17] http://www.healthychilddev.sph.harvard.edu/
[18] Retrieved from https://data.unicef.org/country/
[19] https://data.unicef.org/resources/joint-child-malnutrition-estimates-2017-edition/

numbers. What this means is that there is an overwhelming body of evidence that links sanitation to height.

Mills and Cumming, 2016 identify three principal pathways for WASH to affect undernutrition: through soil transmitted helminths infections such as hookworm or roundworm, environmental enteric dysfunction and diarrhoeal disease. There are other pathways – liverfluke, gardia, zoonotic infections, tapeworm etc – and in fact pathways tend to be chronically underestimated and underreported. The status of knowledge on some pertinent to the Indian context will be examined a little further down.

Usage, health and the question of thresholds

Establishing attribution levels between coverage, usage and health outcomes is a complex problem, as health outcomes are a combination of socio-economic, environmental and biological mechanisms. Further, there can be underreporting of health outcomes (for example, diarrhoea is often underreported as many cases are treated within the home and do not reach the attention of hospital and healthcare providers or facilities). Many health outcomes also require longer time frames than many studies allow (Patil et al 2014).

All or almost all studies point out that more investigation is required, to understand specific transmission pathways for diseases, on the role of WASH in broader disease control interventions or integrated vaccine programmes, even whether gender disparities affect the prevalence of diseases (Mills and Cumming 2016).

There are three ongoing studies that attempt to fill some of these gaps: PROVIDE, an RCT studying effects of EED and malnutrition on oral polio and rotavirus vaccine effectiveness in Dhaka and Kolkata. The MAL-ED study is examining enteric infections and their impact on infant development. In India, CMC Vellore is the lead institution. Neither study look at sanitation directly, but examine EED and malnutrition. The SHINE trial from Zimbabwe is looking at impacts of WASH interventions on infant nutrition and stunting.

The question of universal access and indirect benefits of sanitation.

This is where the question of thresholds comes in. Given the difficulties in attribution, is there a threshold for sanitation coverage and usage that can help eliminate the health risks of sanitation?

In light of the lack of enough data to identify thresholds below 100% coverage or 100% usage, studies advocate for very high thresholds. Sanitation is a public good, and often interventions capture the direct benefits of sanitation, missing out on the indirect ones: they improve environmental conditions, and reduce the risk of contamination in community spaces. Some studies argue that much like deworming or vaccination, 'herd protection' can lower the risk of infection overall, benefiting both those who received the intervention, and those who do not (Fuller 2016, Fuller and Eisenberg 2016). Therefore, it could be inferred that there is an argument to be made for (high) thresholds of coverage and usage. If toilets are used by nearly *everyone,* then everybody seems to benefit.

Esther Duflo's publication on Gram Vikas' model in Odisha looked at universal coverage, and found that five years on, instances of diarrhoea reduced in their villages by between a third to half (30-50%), and to some extent, malaria and fever as well (Duflo et al 2015). The Gram Vikas model is perhaps an

outlier from amongst the other interventions, as it targets a 100% coverage and is not easy to replicate.

Similarly, examples from rural Ecuador show how sanitation coverage is strongly associated with child height (communities with 100% coverage has a 67% lower prevalence of stunting as compared to 0% coverage.) (Fuller et al 2016). r.i.c.e. researchers' study of Cambodia also attributes nearly all of the sharp increase in child height between 2005 and 2010 to improvements in sanitation, and specifically reduced child exposure to open defecation (associating a move from 100% OD to 0% with an average increase in height for age z-score between 0.3 and 0.5) (Vyas et al, 2016).

Andres et al 2014's study of DLHS data from rural north India makes a case for high thresholds, pointing out that when it comes to diarrhoea, the data showed that half the health outcomes are reached at 75% coverage, and that three fourths of the benefit of sanitation infrastructure was indirect, i.e. attributable to the overall levels of sanitation coverage in the village (Andres 2017). Hunter and Pruss-Ustun's now retracted article from 2016, also posited that child mortality rates tend to fall as coverage increases up to 20%, but between 20-70% toilet coverage the impacts were minimal.

Garn et al, 2017 undertake a systematic review of sanitation interventions between 1950 and 2015 on toilet coverage and use; seven interventions from India were included. They conclude that the definition and measurement of usage across all interventions studied varied widely, and usage was most often self-reported. Moreover, most captured 'initial impacts' and did not capture the longer-term impacts or their sustainability. Further, research into the extent of coverage and usage has not been significant enough to establish the relationships *beyond a point* (Garn et al 2017). Carter 2017 looks at the question of thresholds, assessing findings from many of the interventions cited here, and concluding that health impacts are generally seen after over 60-70%+ of coverage and not below with rural communities (Carter 2017).

A note of caution when it comes to thresholds – health outcomes are complex and dependent on a basket of drivers. If anything, it should be retained that indicative thresholds are like denominators, levels beyond which health impacts *begin* to be seen and only increase and not as upper limits. *Finally,* threshold figure varies depending on the diseases considered.

The evidence on thresholds for particular diseases

Stunting

While the association between stunting and poor sanitation has been established, the evidence supporting WASH interventions and improvements to stunting or nutritional levels is less, and of poor quality (Dangour et al 2013). One study of note is the randomized control from rural Mali that examined the effects of a CLTS intervention to increase toilet coverage. It found improvements on stunting rates: in intervention villages where household latrine coverage was 65%, stunting rates were 35% as compared to 41% in control villages, where private/household latrine coverage was 35%. There were no discernible impacts on reported cases of diarrhoea (Pickering et al 2015).

Diarrhoea

The impact of toilet coverage and usage on diarrhoea is complex. It is accepted that poor sanitation results in higher morbidity, particularly caused by diarrhoea. A systematic review of diarrhoea and WASH related studies found that the health gains are higher when water and sanitation interventions are combined (access to clean drinking water + improved sanitation). The review also showed that access to high-quality water resulted in the highest reductions in diarrhoea (Wolf et al 2014).

Both the RCTs from Madhya Pradesh (Patil et al 2014) and Odisha (Clasen et al 2014) found little or no impact on diarrhoea, despite increasing coverage (by 51% to 63% in Odisha, and by 18% to 41% in Madhya Pradesh), but in both, the changes in usage levels achieved were lower than the increases in coverage. The Odisha study also found no evidence of impact on soil transmitted helminth infection rates, or child malnutrition. However, a study of DLHS data on rural north India found that up until 30% coverage there were no discernible changes to diarrhoea prevalence, and that "half of the potential total gains are only reached when coverage is approximately 75 percent" (Andres et al 2017, p3).

Trachoma

India is not a known endemic region for trachoma, but recent studies have shown interesting results in linking it to poor sanitation. Are there other neglected tropical diseases common to India, that merit a deeper study? Or the combination of sanitation interventions with mass drug programmes?

A recent study on trachoma (a leading cause of blindness) from Ethiopia and sanitation coverage found a lower prevalence of trachoma within villages where the proportion of households with a working latrine was high (here measures as 60-80% of households or higher, as compared to less than 20% coverage of households using latrines) (Oswald et al 2017). An RCT from 2008 that measured the effectiveness of latrine promotion in preventing the re-emergence of ocular trachomatis on communities that had been a mass drug administration (of azithromycin), found no significant link between the two. However, a secondary study within the same sample that looked at latrine *usage*, and the drug distribution found a 2% decrease in the prevalence of ocular trachomatis for every 10% increase in coverage and usage of these latrines for a year. The study noted "the proportion of households using a latrine was a significant predictor of the change in ocular chlamydial infection over the subsequent year" (Haile et al 2013). Although small in size, this study points to a strong association between the use of improved sanitation facilities and prevalence of trachoma, requiring more investigation.

Soil helminth infections, schistosomiasis and EED

Many districts in India manifest a high prevalence of soil helminth infections (STH), caused by hookworm, roundworm and whipworm and transmitted via soil contaminated by faeces. STH are common infections worldwide, and can affect child nutrition, cognitive development (Jukes et al., 2007) and even pose risks to maternal and foetal health (Brooker et al, 2008). A 2012 systemic review found that latrine access and use reduced the risk of STH infections by nearly half (50%) (Ziegelbauer et al, 2012). A subsequent review two years later in 2014 found reduced odds as well (Strunz et al, 2014). WASH interventions can also reduce the incidence of Schistosomiasis, another helminth disease caused by exposure to contaminated water and faecal matter (Grimes et al, 2014).

Given the association between open defecation and improper waste disposal with STH, can STH be good short-term markers of the prevalence open defecation[20]? Sanitation interventions are also cheaper than current strategies to manage STH such as drug administration, and offer prevention rather than treatment. More research is required to assess the quantum of benefit from WASH interventions, ranging from the benefits of household toilets versus community toilets to whether WASH interventions reduce the strength of the infection (Mills and Cumming 2016).

VI. Interpreting sanitation beyond toilets: concluding with a broader perspective

Nearly one out of five of all maternal deaths in the world take place in India (190 deaths per 100,000 live births) and 13% of these are caused by infections that could be completely avoidable[21]. There is a strong case for improving water, sanitation and hygiene practices in healthcare centres which requires a mix of infrastructure improvements, IPC and IEC to change behaviours and improved monitoring systems (WSSCC 2014) and to mitigate the alarming rise of anti-microbial resistance. The use to antibiotics to treat diseases like diarrhoea, pneumonia, tuberculosis and cholera is widespread. For e.g. nearly 494 million cases of diarrhoea in Brazil, Indonesia, India and Nigeria are treated through drugs, but 60% of drug used to treat diarrhoea could be done away with by addressing water and sanitation issues (Macintyre et al 2017).

Finally, a part of the puzzle that is largely unexplored, but is equally important, goes beyond household toilets and infrastructure, advocating for understanding interactions between the household, the rural environment and human-animal interactions. As SARS, Avian Influenza and even Zika virus become more prevalent, approaches like the One Health approach are important.

VII. Building sanitation frameworks for health outcomes

Using health outcomes to measure effectiveness of sanitation programs is tricky given the complexity and multiplicity of factors that affect health outcomes. WASH practitioners[22] advocate using comprehensive models that link outcomes to a broader theory of change rather than the impact of intervention. So for example, achieving levels of proper sanitation should contribute to achieving certain health outcomes, not just assessing the extent of health outcomes themselves. Governments should look at health trends over longer periods of time and develop more sophisticated conceptual frameworks that include all determinants of positive health outcomes: health, sanitation, nutrition etc. NGOs are not really looking at measuring health outcomes of sanitation interventions.

For example, to understand the effectiveness of latrine coverage and usage some policy and practice actions could be:

- Improve convergence between health, sanitation and nutrition interventions. The recently released National Nutrition Strategy points towards this, although much more can be done to integrate the water and sanitation ministry. For example, including water and sanitation data to identify critical districts.
- Invest in a robust usage survey that measures individual behaviour, frequency and consistency. Questions should ask about open defecation and latrine use. Surveys should also establish when to measure coverage and usage.

[20] Interview with Dr Sunderrajan Krishnan, September 2017
[21] http://soapboxcollaborative.org/?post_projects=india
[22] Conversations with Y. Velleman, Wateraid, Dr Sunderrajan Krishnan, INREM and r.i.c.e

- IEC and IPC to improve usage: establish the link between sanitation and adverse health outcomes (such as using triggers like stunting)
- Use other health markers to identify poor sanitation, particularly rates of reinfection
- Focus on maternal and child health centres: improve WASH conditions in primary healthcare facilities, with a particular focus on maternal and neonatal health centres

Conclusion

There is clear evidence linking the prevalence of stunting to poor access of improved sanitation facilities. This is a serious problem in India, given that as population density increases, so do the levels of attribution.

In sanitation, while much of the effort has been on improving the coverage of improved sanitation facilities, the high rates of partial usage across India indicate that coverage cannot be taken as a proxy for usage. Yet, measuring partial usage has been a challenge. The most accurate estimates of usage are from surveys dedicated to unpacking sanitation behaviours and preferences, and that investigate individual usage preferences.

While there are many variables and multiple factors that affect health outcomes, extensive research points to the fact that WASH – and sanitation interventions in particular – play critical preventive roles in health risk prevention and elimination.

More work is required to firmly establish sanitation-health links and sanitation threshold levels for health impacts. Nevertheless, given the positive externalities of safe and improved sanitation, there is a case to be made for as high thresholds as possible, and while existing studies show that threshold levels vary from one disease to another, they point to high thresholds of >70-80% to see significant health impacts (and very high for diarrhoea). Health outcomes are nevertheless complex outcomes, determined by a basket of indicators, and therefore should not be seen as definitive upper limits, but as indicative denominators beyond which health impacts are seen. High levels of coverage without complementing levels of usage may not be sufficient to see health impacts (particularly with neglected tropical diseases, or STH). With stunting, as mentioned above there is a strong association with low rates of coverage, and one study (Pickering et al 2015) showed improvements in stunting rates with two-thirds of the community having access to toilets.

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