CAWST

What is the evidence that HWTS is effective?

Centre for Affordable Water and Sanitation Technology

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Contents

Does HWTS reduce diarrhea?

There is substantial evidence from many studies that HWTS reduces diarrhea risk. Over the last two decades, five systematic reviews and meta-analyses (outlined below) assessed and summarized the evidence for household water treatment and safe storage (HWTS) and other WASH interventions in low and middle income countries. Reduction in diarrhea risk is the measure that is most commonly used to assess health impacts of WASH interventions. The reduction of diarrhea risk varies by HWTS technology, but in most cases is equal to or better than other WASH interventions.

1. Effectiveness of interventions to improve drinking water, sanitation, and handwashing with soap on risk of diarrhoeal disease in children in low-income and middle-income settings: a systematic review and meta-analysis, *Wolf et al. 2022*

Findings

- "Compared with untreated water from an unimproved source, ***risk of diarrhoea was reduced by up to 50% with water treated at point of use (POU): filtration (50%, 23 studies), solar treatment (37%, 13 studies), and chlorination (34%, 25 studies).***"
- Compared with an unimproved source, provision of an improved drinking water supply on premises with higher water quality reduced diarrhoea risk by 52%" (2 studies).
- "Overall, sanitation interventions reduced diarrhoea risk by 24%. Compared with unimproved sanitation, providing sewer connection reduced diarrhoea risk by 47%" (5 studies).
- "Promotion of handwashing with soap reduced diarrhoea risk by 30%."

Meta analyses are considered the highest quality of evidence because:

- They review all the relevant papers, and include only those that were published in a peer-reviewed scientific journal or meet criteria for the quality of their methodology.
- They then combine results from multiple, independent studies to produce more precise and reliable estimates of the effect of each intervention.
- They check for things that would affect the results, like the risk of bias in each study and random effects.
- The result is an estimate of the relative risk of each type of intervention, compared to a control group or a different intervention.

Note: meta analyses are only as good as the quality of the underlying studies and methodologies

Key takeaways

- **Household filtration had among the highest reductions in diarrhea risk.** The only higher reduction was the provision of improved drinking water on premises with higher water quality (of which there were only 2 studies). Chlorination and solar treatment reduce diarrhea more than handwashing or basic sanitation.
- **The evidence on the effectiveness of HWTS is clear and further study is not needed.** "We believe that additional evidence on the provision of basic WASH services, such as POU water treatment, provision of basic sanitation services, and hygiene promotion, is unlikely to change the results of this analysis to a major extent. This assumption is supported by the comparison with results from previous reviews."

2. Impact of drinking water, sanitation and handwashing with soap on childhood diarrhoeal disease: updated meta-analysis and meta-regression, *Wolf et al. 2018*

Findings

- "Point-of-use filter interventions with safe storage reduced diarrhoea risk by 61%" or 48% when adjusted for bias
- "Piped water to premises of higher quality and continuous availability reduced diarrhoea risk by 75% and 36%", respectively compared to a baseline of unimproved drinking water"
- "Sanitation interventions by 25% with evidence for greater reductions when high sanitation coverage is reached; and interventions promoting handwashing with soap by 30% vs. no intervention."

Note: these impacts do not account for compliance (i.e. the reported risk reductions include both the people who have adopted the intervention and those who are not using their POU treatment, and compliance is assumed to be low.)

Meta analyses integrate results from multiple studies to clarify apparently conflicting findings seen between different studies of WASH, as exemplified below. *(Clasen et al, 2015)*

"This may be due to the variety of alternative transmission pathways, such as ingestion of contaminated food, person-to-person contact, or direct contact with infected faeces. In addition, interventions which only target the home may fail if unsafe water is consumed at work or school. Consequently, effective programmes may require combined interventions to address not only water quality, but also water quantity and access, the proper disposal of human faeces (sanitation), and the promotion of hand washing and hygiene practices within communities.

The effectiveness of individual water quality interventions may also vary between settings due to the varied prevalence of the organisms causing diarrhoea. For instance, ceramic filters are only marginally protective against viral illness, while chlorination may provide little protection against *Cryptosporidium*."

Key takeaways

- **Most WaSH interventions are unblinded and diarrhoea is self-reported which may lead to biased results. The authors performed an additional analysis to adjust for bias for only the hygiene and point-of-use water interventions.** This was done because it's obvious to the user that these interventions aim to improve health, whereas the aims of improvements in supply may be less apparent to users. Without this bias analysis, both POU chlorination and POU solar treatment were beneficial for unimproved sources (24% and 33% risk reductions). Filtration has a high reduction of risk with (48%) and without (61%) the bias analysis.
- **A common perception among WASH practitioners that chlorination is a more effective treatment method is not supported by this data for point-of-use interventions.** "After adjusting for bias, there was no evidence that POU chlorine treatment or POU solar treatment was beneficial [] whereas filtering of unimproved and improved sources, excluding piped water to premises, remains significantly beneficial".
- For POU filtration, **providing safe storage containers reduces the risk of diarrhea by a further 10-14%**, depending on the source - improved, unimproved, and piped (when results are not adjusted for non-blinding). Lower reductions in risk (8-9%) were reported when the risks were adjusted for non-blinding.
- This paper seems to indicate that **higher quality water reduces the risk of diarrhea more than continuous availability** (75% vs. 36% compared to an unimproved source). However, caution is urged with this interpretation because these numbers are based on a small number of studies (higher quality: 1 study, continuous availability: 2 studies). There are clearly other benefits to continuous availability, notably reductions in womens' and girls' time spent collecting water.

3. Interventions to improve water quality for preventing diarrhoea (Review), *Clasen et al. 2015*

Findings

		Pooled estimate of diarrhoea reduction	Adjusted for non-blinding
Disinfection products probably reduce diarrhea by about one quarter	Chlorination	23%	20%
	Flocculation & disinfection sachets	31%	35%
Point-of-use filtration probably reduces diarrhoea by about half	Ceramic filters	61%	All types of filtration combined 38%
	Biosand filters	53%	
	LifeStraw	31%	
	Plumbed in filters in high-income settings	19%	
Solar disinfection probably reduces diarrhoea by about one third	Plastic bottles in direct sunlight	38%	20%

- "Plumbed in filters have only been evaluated in high-income settings" showing a reduction of 19% in three trials
- "Significantly, **there were no eligible studies that investigated the impact of boiling**, even though that is by far the most common type of POU water treatment (Rosa 2010)."
- "Distribution of **improved water storage containers in settings with improved water sources showed no statistically significant effect on diarrhea**"
- **"We found no trials evaluating reliable piped-in water supplies to people's homes."**

Key Takeaways

- **Larger diarrhea reduction was seen in trials with higher adoption of HWTS practices, and those that provided a safe storage container.**

- In most cases, the **reduction in diarrhoea was evident whether or not the water sources and sanitation were improved or unimproved**.
- **Further studies are needed to assess the effects of household connections and chlorination at the point of delivery.**

The following two older systematic reviews and meta-analyses are consistent with the newer studies, so the findings are not outlined here:

4. Systematic review: Assessing the impact of drinking water and sanitation on diarrhoeal disease in low- and middle-income settings: systematic review and meta-regression, *Wolf et al. 2014*

5. Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis, *Clasen et al. 2007*

Does HWTS improve water quality?

The WHO Scheme to Evaluate Household Water Treatment Technologies has established the effectiveness of many HWTS technologies in controlled lab settings (Part A below). However, it is known that many technologies perform differently in the real world, that high removal efficacy does not necessarily result in greater health impacts, and most importantly that consistent use is critical for health impacts (Part B below). The largest sources of data on water quality in actual use is from the water quality module of the WHO/UNICEF Joint Monitoring Programme (Part C below).
It shows smaller than expected improvements in water quality, with many samples still containing *E. Coli* at the point of use. This may be because households self-reported treating their water (which is known to be less reliable), and there was no assessment if whether use was correct and consistent.
Part A - Lab Testing

Part A
Lab Testing

Over the last 15 years, the World Health Organization has supported a voluntary process to test HWTS products under controlled conditions in lab settings. The scheme tested the removal of bacteria, viruses and protozoa in test waters that have specified turbidity, pH, temperature, total dissolved solids, etc. Only technologies that were submitted by their manufacturers/developers were tested. The results to date are summarized in the following table.

Findings

Water treatment effectiveness	Type of technology	Name of product
Comprehensive protection ★★★ Removes at least 4 $\log_{10}$ of bacteria, at least 5 $\log_{10}$ of viruses and at least 4 $\log_{10}$ of protozoa	Solar disinfection	AquaPark SolarBag
	Membrane filtration	Grifaid Family Filter LifeStraw Community LifeStraw Family 1.0 ORISA

Water treatment effectiveness	Type of technology	Name of product
Comprehensive protection ★★ Removes at least 2 $\log_{10}$ of bacteria, at least 3 $\log_{10}$ of viruses and at least 2 $\log_{10}$ of protozoa	Flocculation-disinfection	AquaSure Tab10 P&G Purifier of Water
	Flocculation-disinfection-filtration	DayOne Waterbag PuriBag
	Membrane filtration	LifeStraw Family 2.0 ROAMfilter Plus Sydney 905 Purifier
	Solar disinfection	JAMEBI Solar Water Pasteurizer
	UV disinfection	Waterlogic Hybrid/Edge Purifier
	UV disinfection and membrane filtration	Drop2Drink Unit
Targeted protection ★ Meets the performance targets for at least two-star (★★) for only two classes of pathogens	Membrane filtration	BluAct Drinking Water Faucet (All in One Water Purifier) Katadyn First Response BeFree NanoFilter Sydney 905 Filter UZima Filter UZ-1 VF100 Home Filter
	Ceramic filtration	Katadyn Rapidyn Water Filter Kit Nazava Water Filters SPOUTS Water Purifaaya Filter Tulip Table Top Water Filter
	Solar disinfection	SaWa WADI
	UV disinfection	Mesita Azul Solageo Better Water Maker Water Elephant
	Chemical disinfection	Aquatabs Aquatabs Flo Biox Aqua 20 H2gO Purifier Oasis Water Purification Tablets WATA-Standard

Water treatment effectiveness	Type of technology	Name of product
	Flocculation-disinfection	Bishan Gari Water Purifier Rubicon-Micro WaterMaker Plus Water Purification Sachets
	Flocculation-biofiltration	BlueQ Two-Stage
	Diatomaceous earth filtration	MINCH Household Water Filter
	Carbon and membrane filtration	VF100 Home Filter + VF200 Pre-Filter
Doesn't meet WHO performance criteria	Membrane filtration	GrifAid M3 LifeFilta LFJC Jerrycan with backwash
	Chemical disinfection	AquaCare BioCool CleanWater Chloritard Germisep 0.5g Silverdyne
	Ceramic filtration	TEMBO Filter Pot

Source: *https://www.who.int/tools/international-scheme-to-evaluate-household-water-treatment-technologies/products-evaluated*

Part B
Modeling studies

Three modeling studies explored the relationship between the effectiveness of HWTS technologies in lab studies (like the WHO Scheme) and how consistently they are used in real world applications:

> **Selecting Household Water Treatment Options on the Basis of World Health Organization Performance Testing Protocols,** Bivins et al. 2019
>
> **Linking Decision Theory and Quantitative Microbial Risk Assessment: Tradeoffs Between Compliance and Efficacy for Waterborne Disease Interventions,** *Hayashi et al. 2019*
>
> **The joint effects of efficacy and compliance: A study of household water treatment effectiveness against childhood diarrhea,** *Engels et al. 2013*

Key Takeaways of the modeling studies

1. **Removal effectiveness in the lab is not the same as in real world use**

"The effectiveness of household water treatment (HWT) at reducing diarrheal disease is related to the efficacy of the HWT method at removing pathogens, how people comply with HWT, and the relative contributions of other pathogen exposure routes." *Enger et al. 2013*

"Notably, the WHO guidelines assume perfect compliance with the treatment method. However,

technological adoption is seldom complete (*Rogers, 2010*). HWT uptake in particular is variable but rarely widespread in lower-income regions (Rosa & Clasen, 2010; Shaheed et al., 2018). More recently, the WHO international scheme to evaluate HWT technologies has begun to include usability considerations, but remains primarily focused on the microbiological performance of HWT technologies (World Health Organization, 2016)." *Hayashi et al. 2019*

"our analysis suggests that the middle tier of efficacy, ★★, is likely to yield comparable health gains to the highest tier of performance under actual implementation conditions. Second, the model output suggests that technologies at the lowest tier of performance (★) may yield health gains similar to the middle tier (★★) under certain conditions." *Bivins et al. 2019*

2. **Higher removal effectiveness does not necessarily result in greater health improvements**

"the efficacy of an HWT method does not capture its actual capacity to reduce the burden of disease, as a more efficacious treatment device may induce lower compliance and therefore be less effective than a less efficacious but more appealing intervention." *Hayashi et al 2019*

"It is commonly assumed that greater microbiological efficacy for water treatment options, generally measured by LRVs across pathogen classes, should yield proportionally greater health gains among users, though, to our knowledge, this has never been measured directly in controlled health impact trials comparing multiple water treatment technologies across ranges of performance. Alternatively, our analysis suggests that technologies that have been shown to meet basic efficacy criteria and are likely to be used exclusively, or nearly so, are likely to be more effective in preventing waterborne infections and subsequent disease." *Bivins et al, 2019*

"Notably, we find that improving compliance from low to moderate levels can provide significant health gains (Fig. 2). Conversely, even a small level of noncompliance with a high LRV treatment method can still result in a significant loss in health gains when drinking water is sufficiently contaminated (Fig. 2). This suggests that once the microbiological efficacy of a device is "good enough," focusing on improving compliance may be at least as important as increasing a device's LRV." *Hayashi et al. 2019*

3. **Correct and consistent use (also called adherence or compliance) is the recommended criterion in choosing treatment technologies**

"Adherence must be near 100% (exclusive use) to realize maximum health gains across all tiers of performance, and adherence is especially important where waterborne disease risk is high. Therefore, the likelihood that a given water treatment technology is used consistently, correctly, and over long periods (i.e., high adherence) is the central factor in treatment technology selection once the "comprehensive protection" performance tier has been met." *Bivins et al. 2019*

"For most situations, HWT interventions that trade lower efficacy (i.e., remove less pathogens) for higher compliance (i.e., better usability) contribute substantial reductions in diarrheal disease risk compared to devices meeting current World Health Organization efficacy guidelines. Recommendations that take into account both the behavioral and microbiological properties of treatment devices are likely to be more effective at reducing the burden of diarrheal disease than current standards that only consider efficacy." *Hayashi et al. 2019*

Part C
Joint Monitoring Program, Multiple Indicator Cluster Surveys, Water Quality Module

The SDG definition of safely managed drinking water includes a criterion about being free from faecal and priority chemical contamination. A new water quality module for household surveys was implemented in Multiple Indicator Cluster Surveys from 2013-present. Portable equipment was used to measure *E. coli* at the point of collection and at the point of use. Households were asked about the availability and accessibility of drinking water. They were also asked questions about whether they do anything to make the water safer to drink, and what they usually do to make the water safer (boiling, adding bleach/chlorine, straining it through a cloth, using a water filter, solar disinfection, and letting the water stand and settle plus anything else). They were not asked about adherence/consistency i.e. whether they treat all the water they consume. The water quality testing questionnaire included specific questions on the source of the glass of drinking water and an observation of water storage practices. The data from these surveys in 27 countries was presented and analyzed in this paper *Bain et al. 2021*.

Findings

- Large proportions of the population in low and middle income countries are exposed to very high levels of E. coli, and this is true for all different types of water systems.
- There is significant re-contamination of water between the point of collection and point of use in almost all types of water systems.
- In many countries, households store water prior to consumption.
- "Self-reported appropriate household water treatment practices were relatively uncommon except in Kiribati and Mongolia. Our analysis suggests that self-reported household water treatment may provide limited protection, and that many households reporting these practices are still exposed to *E. coli* contamination at the PoU. These findings may be attributable to a lack of correct and consistent water treatment practices, ineffective treatment technologies, or self-reporting bias (which has been documented in other countries)."

- "Self-reported household water treatment was significantly associated with a lower prevalence of any *E. coli* at the PoU in Lao PDR, Mongolia, Nepal, and Suriname, and Zimbabwe and a lower prevalence of very high risk water in Lao PDR, Mongolia, and Sierra Leone".
- Risk factors for re-contamination vary widely between countries.
- Accessible and available sources are NOT more likely to be free from *E. coli* contamination.

Key Takeaways

- When the researchers only looked at households that had contamination at the point of collection, self-reported water treatment reduced the risk of *E. coli* contamination by 8%.
- Because water quality tests were only done at the point of collection and the point of use, it is not possible to know whether self-reported water treatment was ineffective, not happening at all (despite being reported by the household), or being recontaminated during handling and storage.
- Self-reported water treatment did reduce the risk of *E. coli* contamination in some countries, and the amount of reduction was quite variable from one country to another. This may indicate that household water treatment practices were more effective in some countries, or self-reporting was more accurate in some countries.
- Because all self-reported water treatment options were grouped together in this analysis, it is not possible to know which options may have been more or less effective, nor which were more or less common.

Part D
Randomized Controlled Trial

Randomized controlled trials (RCTs) are experiments to evaluate the effectiveness of an intervention. RCTs

- Randomly assign participants into an experimental group (which receives the intervention) and a control group (which doesn't) and then compare the two
- Are considered the best type of research because they minimize bias, and can establish whether the intervention caused the outcome
- Are time consuming and expensive
- Are not generalizable – an RCT proves that a particular intervention caused that outcome in that specific situation, it doesn't necessarily apply to other populations, settings and times

Effects of Single and Combined Water, Sanitation and Handwashing Interventions on Fecal Contamination in the Domestic Environment: A Cluster-Randomized Controlled Trial in Rural Bangladesh, *Ercumen et al. 2018*

A randomized controlled trial in rural Bangladesh included a chlorination intervention and a combined WASH intervention (chlorination, improved latrines and hand washing), along with other interventions such as nutrition. Among households receiving the water treatment intervention, 90% of households reported chlorinating their drinking water, and of these, 80% had detectable free chlorine residual at the 1 year and 2-year follow-ups. Stored drinking water in the water treatment intervention was approximately 50% less likely to contain any E. coli and there was approximately 90% less E. coli in the samples at both 1 year and 2 years. The combined WASH intervention had similar reductions in E. coli but was more likely to have E. Coli in stored water and be more contaminated. “Chlorine and safe storage effectively reduced E. coli in stored water, consistent with prior evidence.”

Note: this is the same trial as the one in Part B of the section on stunting (more details below), but this is a different paper that analyzes different data.

Does HWTS reduce stunting in children?

Stunting is reduced growth and development, particularly in children under five. Stunting is related to chronic undernutrition and influenced by several other factors, including WASH. The burden of undernutrition that can be attributed to WASH is estimated at 10% (*Wolf et al. 2023*).

Several systematic reviews have found a correlation between improved WASH and childhood stunting as outlined below. Note: correlation does not prove that the intervention caused that effect. Sanitation conditions had the largest, most consistent association with stunting. Although these reviews did not find studies on HWTS specifically, they did find that insufficient water supply and poor water quality were both associated with stunting. Three large randomized controlled trials (RCTs) found no effect on child growth and stunting from WASH interventions. The results of RCTs are not generalizable to other situations and there are concerns that the design of these particular WASH interventions affected the results. These trials did find other benefits of WASH such as cognitive development, reduction in *E. Coli* in stored drinking water, reduction in diarrhea, parasites, and mortality. A clinical trial is currently underway to assess whether HWTS (a silver impregnated ceramic disk, another water filter, and safe storage only) reduce stunting – results were not yet available at the time this summary was published.

Part A
Systematic reviews

A systematic review is a research method that is comprehensive and unbiased. It involves:

- Conducting a comprehensive search for studies that address a specific question
- Including only the studies that meet the defined criteria
- Assessing the quality of each included study
- Summarizing and analyzing the results of the included studies

The Relationship of Water, Sanitation, and Hygiene on Stunting in Children Under Five: A Systematic Review, *Amelia et al., 2025*

A systematic review identified 14 studies published between 2019 and 2024 looking at the correlation between WASH and stunting. The studies include diverse populations from 8 countries, with various incomes, social factors, environmental conditions and diets. For water, they found the following aspects were correlated with stunting of children under 5:

- Water sources – children drinking from unimproved sources or contaminated supplies were more likely to experience stunting
- Household drinking water service - limited and poor quality household services were correlated to stunting
- Water storage is correlated with stunting
- Water quality – one study showed that clean water is related to stunting, whereas 2 studies showed that water quality and water purification were not correlated, "suggesting that other factors, such as contamination during storage or handling, might influence outcomes"
- Distance to fetch water – longer distances were associated with higher stunting prevalance
- Knowledge and awareness of WASH practices were associated with reduced stunting

Water, Sanitation and Hygiene (WASH) and its Association with Stunting in Developing Countries in Asia: A Systematic Review, *Rizaldi et al, 2025*

This systematic review identified 5 studies between 2014-2024 in developing countries in Asia, primarily in rural areas. Three of the studies focused only on sanitation or hygiene; the water related findings were:

- One study found consuming unsafe water had a statistically significant correlation with stunting and wasting
- One study found an association between drinking water access and nutritional status and cognitive performance

Water, sanitation, and hygiene vulnerability in child stunting in developing countries: a systematic review with meta-analysis, *Silva et al, 2023*

The systematic review identified 14 studies of which 8 were included in the meta-analysis. The studies occurred between 1992-2021 in 8 countries. The water related findings were:

- Children >5 with less access to WASH were shorter
- One study found that children who used surface water were much more likely to be stunted than those who used tap water
- "Some studies found that a better water source alone did not provide complete health benefits. Children from households with access to piped water without adequate sanitation were 1.8 cm shorter than children in households with sewerage."

Part B
Randomized Controlled Trials

Three large, high-quality, randomized controlled trials (RCTs) of water, sanitation and hygiene (WASH) were published in 2018-2019: *WASH-Benefits Bangladesh*, *WASH-Benefits Kenya*, and *SHINE in Zimbabwe*.
The interventions were to increase point-of-use chlorination of drinking water, access to and use of improved pit latrines (including the safe disposal of child feces), and handwashing with soap (by providing handwashing stations). The trials studied the effects of these interventions on childhood diarrhea and growth, independently and when combined with nutrition interventions. Each was conducted in a low-income rural area where stunting is common. The trials provided free soap and chlorine and conducted regular home visits that included behavior change communications.

Findings

- All three studies found no effect of any WASH intervention on child linear growth and stunting and no additional benefit of adding WASH interventions to nutrient supplementation.
- The effects on diarrhea were mixed. No reduction in diarrhea was observed in Kenya and Zimbabwe, whereas a 40% relative risk reduction for diarrhea was observed in Bangladesh – where diarrhea was much less common before the interventions.
- In Bangladesh, a separate comparison of the prevalence of giardiasis showed a substantial reduction in infections among all WASH interventions except water chlorination (which makes sense because giardia is resistant to chlorine).
- The studies found improvements in other measures such as prevention of hookworm and cognitive development.

Part C
Responses to these RCTs

These findings have caused confusion and doubt in the WASH and nutrition sectors. Several prominent WASH experts and organizations wrote responses to the findings.

Implications of WASH Benefits trials for water and sanitation, *The Lancet, 2018*

Implications of recent WASH and nutrition studies for WASH policy and practice, *WHO & UNICEF, 2019*

WaterAid's reflections on the results of the WASH Benefits Trials – Kenya and Bangladesh, *WaterAid February 2018*

These responses identified details about the WASH interventions that may explain the results, a few of which are summarized below:

1. In both WASH-Benefits trials, most participants already had access to an improved drinking water source and basic latrines, plus rates of open defecation were low.
    - These WASH interventions might have a much greater effect in places where open defecation and poor water supply are common.
2. Access to sanitation was improved on the compounds of participants but not in the wider community. In Bangladesh, this meant only 10% of the village population gained access to improved pit latrines.
    - Improvements from sanitation do not come from improved household sanitation, but from high community coverage. This intervention may not have improved environmental conditions around the enrolled children. Previous research showing an effect of sanitation on linear growth adopted community-wide approaches where conditions were improved across the entire village.
3. In Bangladesh, environmental measurements showed widespread faecal contamination related to the presence of animals and their faeces. Food hygiene practices and the likelihood of ingesting contaminants through food were not studied.
    - The interventions did not aim to reduce these transmission pathways in a substantial way. Exposure to animal faeces and contaminated food could be significant transmission pathways.
4. Both Kenya and Bangladesh included chlorination only intervention arms, where bacterial contamination of stored drinking water was reduced, but there was no reduction in diarrhea.
    - This could be due to the resistance of certain pathogens to chlorine, e.g. Cryptosporidium which is known to be common globally and Giardia which was common in at least the Bangladesh study area. It could also be because pathogens were primarily transmitted through other routes (food, hand hygiene, etc.)

5. The studies used the presence of infrastructure and supplies as indicators of uptake. Other behaviours such as safe disposal of child faeces were self-reported.

   - Presence of infrastructure and supplies does not indicate consistent use and correct behavior. Self-reporting has previously been shown to be inaccurate.

The following article includes comments that may help us understand the results of these RCTs:

The implications of three major new trials for the effect of water, sanitation and hygiene on childhood diarrhea and stunting: a consensus statement, *Cumming et al, 2019*

- "As pointed out by numerous researchers over the decades, different environmental settings require different WASH interventions, and the same interventions may even have different effects on health in the same settings at different times. In grossly contaminated environments, where childhood exposure to a variety of enteric pathogens occurs through multiple environmental pathways, partial or even absolute elimination of a single pathway may yield no health benefit. At the same time, under different conditions, small incremental gains may, in some cases, prove catalytic."

- "Historically, large, population-level gains in child health have not been achieved without significant improvements in WASH services: [...] Typically, these changes took place over decades. For example, in Victorian Britain, while the great municipal water reforms began in the 1840s, it was not until the 1870s that major investments in sewered household connections began in most cities. Changes in diarrheal disease mortality followed slowly. In London, for example, infantile diarrheal disease mortality was still rising in 1900. In fact, trends in child and infant mortality suggest that benefits accrue from incremental and progressive steps over time, and that major health dividends may come late in that process, as was the case in England and Wales (1900–1920) or in the USA (1920–1930).

- "WASH trials often produce heterogenous results, reflecting the inherent complexity of interventions combining infrastructure and behavior, and which interact strongly with specific, local environmental and social systems. Indeed, the mixed results for diarrheal disease reported across these three trials of very similar interventions bear witness to this."