TECHNICAL SUMMARY

Impact of Splash's program on household WASH knowledge and behaviours in Addis Ababa, Ethiopia

Splash's partnership with the Addis Ababa government is helping to deliver safe water, sanitation, and hygiene (WASH) to thousands of school children. Ensuring access to improved WASH in schools has great potential to improve children's health and educational outomes.[1] In addition to benefiting students, school-level WASH interventions can improve WASH behaviours and health among students' family members and neighbours. Though the existing literature is mixed, there is evidence to suggest that children can act as messengers or "change agents," sharing the WASH lessons they learn in school with others.[2–5] These messages can encourage family or friends to practice behaviours they may know but do not consistently perform.[5]

While Splash's program does not explicitly promote children as change agents for their families, there is potential for message transmission to occur naturally. This study investigates if and how Splash's program is affecting student households' WASH knowledge and behaviour. The results of this exploratory research may help to inform Splash of any unintended consequences of its work and guide Splash in understanding how to expand its reach into students' communities.

JULY 2023

Research Design

RESEARCH QUESTION

How is Splash's program associated with the WASH knowledge and behaviors of the students' households (HHs)?

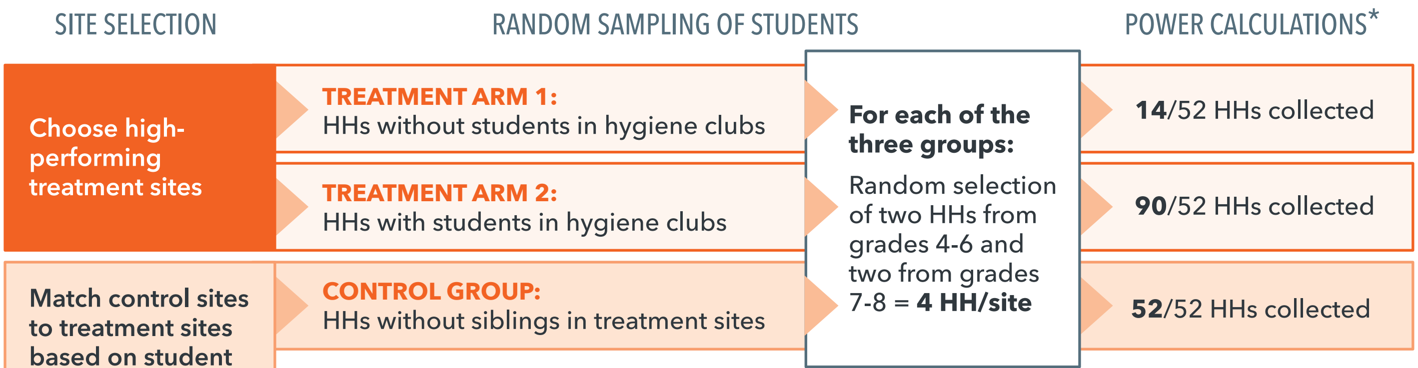
DATA COLLECTION

This study uses a cross-sectional, household-level survey design. The data were collected during September and October 2022. The study area included all sub-cities in Addis Ababa where Splash implemented its program. Treatment schools were defined as government schools that had received Splash's program and were high performing based on post-implementation survey data showing the schools as having 50%+ students handwashing with soap (HWWS), soap present at 10%+ of handwashing (HW) stations, water flowing at some or all HW stations, and monthly hygiene club meetings. Control schools were those that had not yet received Splash's program. Treatment schools and control schools were matched based on student population size and pre-implementation water availability. This matching was done to minimize bias in the treatment effect estimates.

Participants were the self-identified household heads and main caregivers of the primary child in their household. Participants are synonymous with "households" throughout the document. The primary child was defined as a child in grades 4 through 8 who attended school at the sampled school. We divided participants whose primary child attended a treatment school into two groups, or arms, based on the primary child's hygiene club participation. Treatment arm 1 consisted of participants who were the caregivers of a primary child who was not in the hygiene club, and treatment arm 2 was comprised of participants who were caregivers of a primary child who participated in the hygiene club. The control group was defined as the participants whose primary child attended school at a control school.

We performed power calculations to determine the sample size needed to detect a treatment effect. Based on our calculations 156 participants were needed: 52 treatment arm 1 participants, 52 treatment arm 2 participants, and 52 control group participants. However, the data collection firm had difficulty identifying primary children who did not participate in hygiene clubs, and only 14 treatment arm 1 households and 90 treatment arm 2 households were sampled. Figure 1 summarizes these school and participant selection processes.

FIGURE 1. **Outline of selection process for treatment and control schools and participants**



**156 HHs needed to power the study for the primary outcome (52 each across arms and control). Due to unexpectedly high hygiene club participation, data colletion yielded impbalanced treatment arms.*

OUTCOME VARIABLES

We were primarily interested in estimating treatment effects related to measure the households' handwashing with soap (HWWS) behaviour. We measured this primary outcome as the presence/absence of a handwashing station with soap and water in the household. The study was powered to detect this effect.

Secondary outcomes included in the study were households' HWWS knowledge, water behaviours and knowledge, and communication with the primary child's school - especially communication about WASH-related matters. Handwashing knowledge was measured by the number of HWWS steps completed (Splash teaches students five steps to handwashing), knowing the critical times to wash one's hands (Splash teaches pre-meal and post-toileting), and knowing the benefits of HWWS (Splash's curriculum includes germs and health benefits). Safe water behaviour was measured by self-reported water storage handling practices. Safe water knowledge was defined by the type of point-of-use water treatment and location of water storage container. Communication with the child's school was assessed by the frequency, type, and content of the communication. It is important to note the study was not designed to detect differences in these outcomes across treatment and control groups.

DESIGN LIMITATION

When designing the study, we overlooked the fact that treatment and control households would be clustered geographically by subcity, given how Splash's program is rolled out. After data collection, we found that seven of the ten sub-cities in Addis Ababa had either all treatment or all control households (Table 1). As a household's location can affect its WASH conditions (e.g., municipal piped water operations can affect access and availability), subcity is a confounder between treatment and our primary and secondary outcomes (Figure 2). That subcity and treatment are related makes the confounding issue difficult to overcome. In other words, it is challenging to statistically disentangle the effects of subcity and treatment on the outcomes.

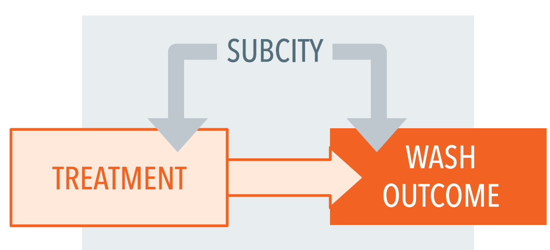
TABLE 1. Distribution of treatment and control households across subcities

	TREATMENT STATUS		PRIMARY
SUBCITY	TREATED	CONTROL	OUTCOME*
Addis Ketema	10	12	0.23
Akaki Kaliti	8		0.13
Arada		16	0.33
Bole	7		0.86
Gulelle		12	0.00
Kirkos	9		0.22
Lemi Kura	8	4	0.83
Lideta	8	8	0.31
Nifas Silk Lafto	8		0.13
Yeka	32		0.10

** mean HW station status*

FIGURE 2. Confounding by subcity

"Subcity" is a potential confounder, which means it likely influences both the treatment and outcome variables.



Analysis

Due to the small sample size for treatment arm 1, the analysis only included treatment arm 2 and the control group.

PRIMARY OUTCOME

We analysed the associations between the households' treatment status and primary outcome using bivariate techniques (i.e., bar plots) and regression models. We ran three models to test the sensitivity of our assumptions:

1. **Logistic regression controlling for subcity as a categorical variable**
2. **Logistic regression with subcity as a random intercept**
3. **Conditional logistic regression controlling for subcity as a categorical variable + conditioning on matched treatment and control schools**

Each regression model controlled for caregiver sex (referent: female), education (referent: no education), marital status (referent: not married), piped water delivery frequency (referent: one, two, or three days per week), toilet type (referent: flush), and whether or not the household shared its toilet with other households (referent: not shared/private). Most caregivers are female (82% in treatment, 83% in control), most have some education (71% in treatment, 81% in control), most are married (64% in treatment, 77% in control), most have intermittent on-premises piped water (only 17% in treatment had water seven days per week, 6% in control), some have flush toilets (50% in treatment, 17% in control), and most share their toilet (73% in treatment, 84% in control). We were unable to include an indication of household wealth, which reduces the precision of our estimates.

Due to the confounding between treatment and subcity, the matched pair schools – which are typically not in the same subcity – may not be more similar than two random schools. Therefore, we do not benefit by using a matching estimator as originally planned. However, without the matching we are less able to account for fundamental differences between treatment and control schools and between the students that attend them (e.g., differences determining a school's treatment status). We cannot rule out the possibility that underlying differences across the schools are not also acting as confounders and biasing the results.

SECONDARY OUTCOMES

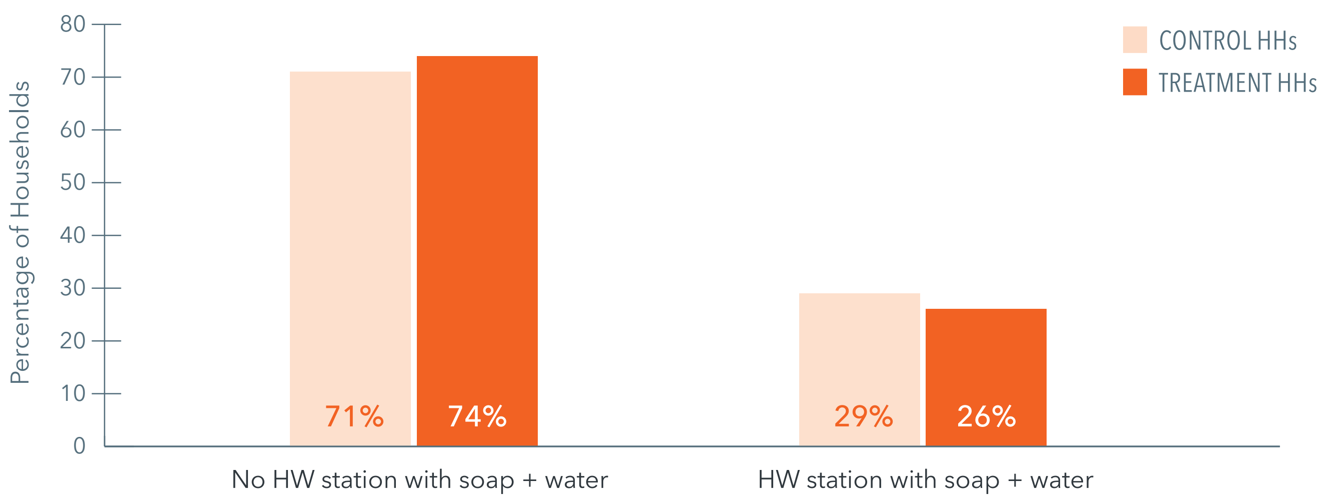
We performed identical bivariate and logistic regression analyses for six of our secondary outcomes to examine their relationships with treatment status – excluding WASH communication. As we had no reason a priori to be interested in differences across treatment and control groups for each category of each secondary outcome, we reduced our secondary outcomes to binary categories. The secondary outcomes with multiple categories included HWWS steps, HWWS times, HWWS benefits, water storage location, and water storage handling practices. The binary variables were created to compare the best WASH practices to the rest.

Results

PRIMARY OUTCOME

We did not find evidence of a statistically significant relationship between treatment and household HW station status. Figure 3 displays the primary outcome across aggregated treatment and control groups (i.e., ignoring matching). The figure suggests both the treatment and control groups have a similar distribution of households with HW stations (30%) and without HW stations (70%). Our regression models did not show a statistically significant difference between the treatment and control groups (results not shown).

FIGURE 3. **Primary outcome: Absence versus presence of a household HW station with soap and water**



SECONDARY OUTCOMES

Secondary outcomes for handwashing

We did not find evidence of associations between the three secondary handwashing outcomes (i.e., HWWS steps, HWWS critical times, and HWWS benefits) and treatment status. Figures 4a-4c display the results in aggregate. Most households in the treatment (68%) and control (79%) demonstrated fewer than five HW steps. Sixty-five percent of control households and 67% of treatment households knew to wash their hands before eating and post-toileting. Motivations for HW were similar across treatment status, with approximately 65% of households in both groups citing good health plus an aesthetic reason (i.e., either appearance or smell).

Interestingly, though not every household had a HW station (Figure 3), all households could demonstrate HW (Figure 4a). The data collection team observed that participants retrieved HW materials when asked to demonstrate HW steps.

FIGURE 4a. Secondary outcome HWWS knowledge: Five steps

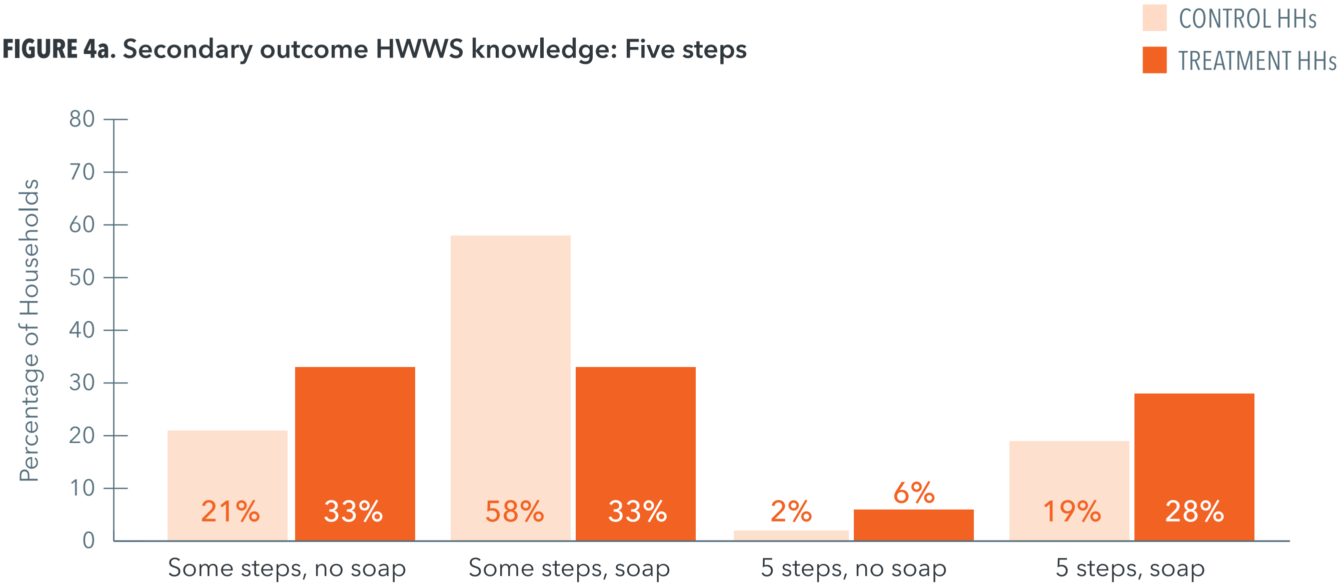


FIGURE 4b. Secondary outcome HWWS knowledge: Critical times

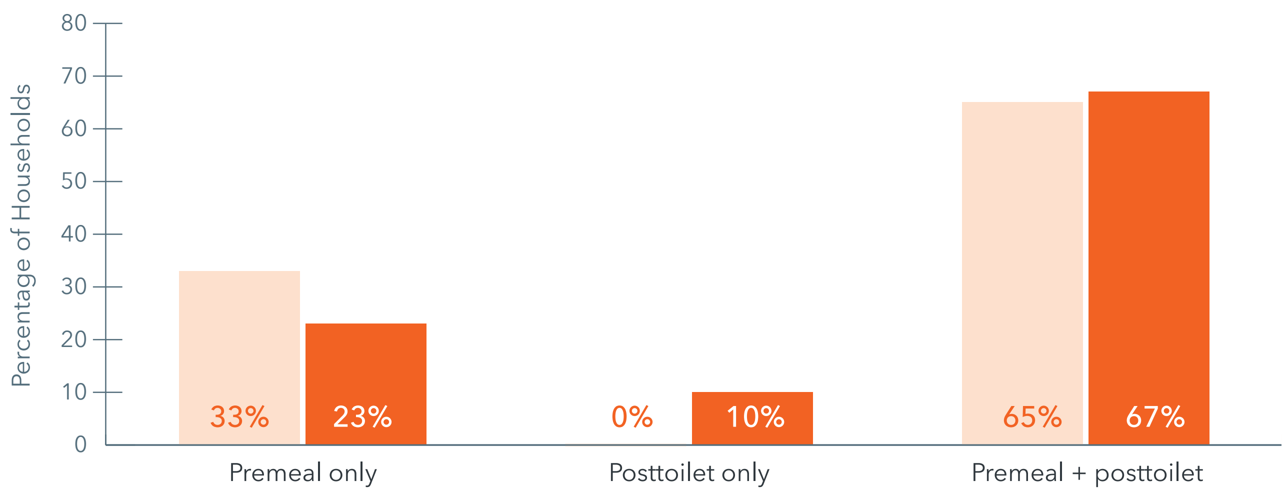
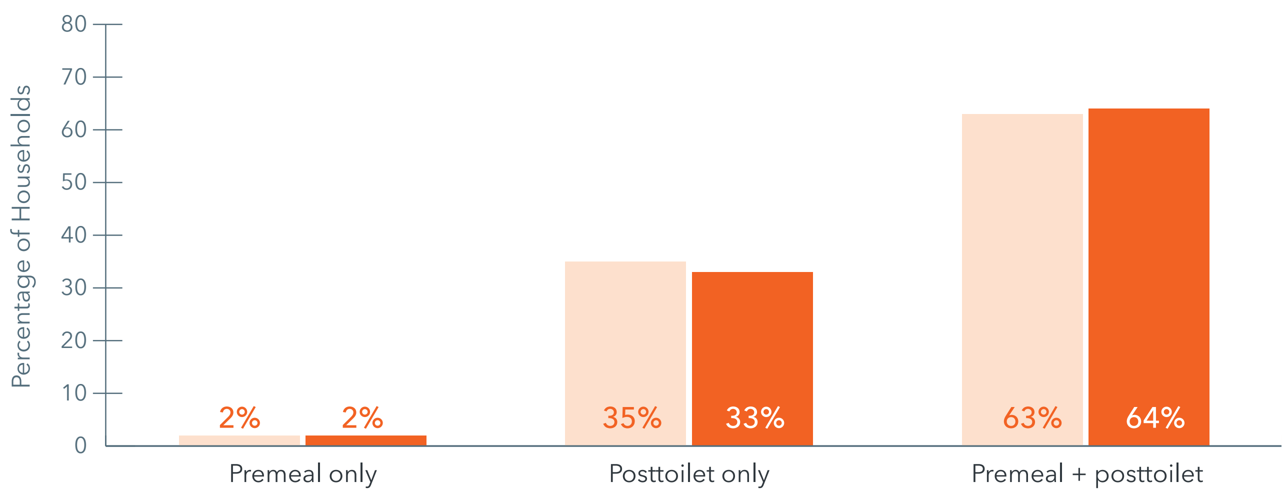


FIGURE 4c. Secondary outcome HWWS knowledge: Benefits of HW



Secondary outcomes for water

There may be a relationship between treatment status and households' water treatment and storage practices, but this result was not robust across model specifications. Water storage handling practices were unrelated to treatment status. Figures 5a-5c display the bivariate results for secondary outcomes related to water treatment and storage (statistically significant model estimates not shown). Treatment households were more likely than control households to treat and safely store their water covered and on the ground. Figure 5a shows that 76% of control households and 70% of treatment households do not treat their water; the remainder either boil, filter, or add chlorine to their water prior to drinking. According to Figure 5b approximately 76% of control households and 77% of treatment households store their drinking water in covered containers on the ground. Figure 5c indicates that among those in the treatment and control groups who store water, 65% of treatment households and 59% of control households pour water from the storage container. These figures report the percentages out of those households that store water, which is 85% of the total sample.

FIGURE 5a. Secondary outcome safe water knowledge: Water treatment

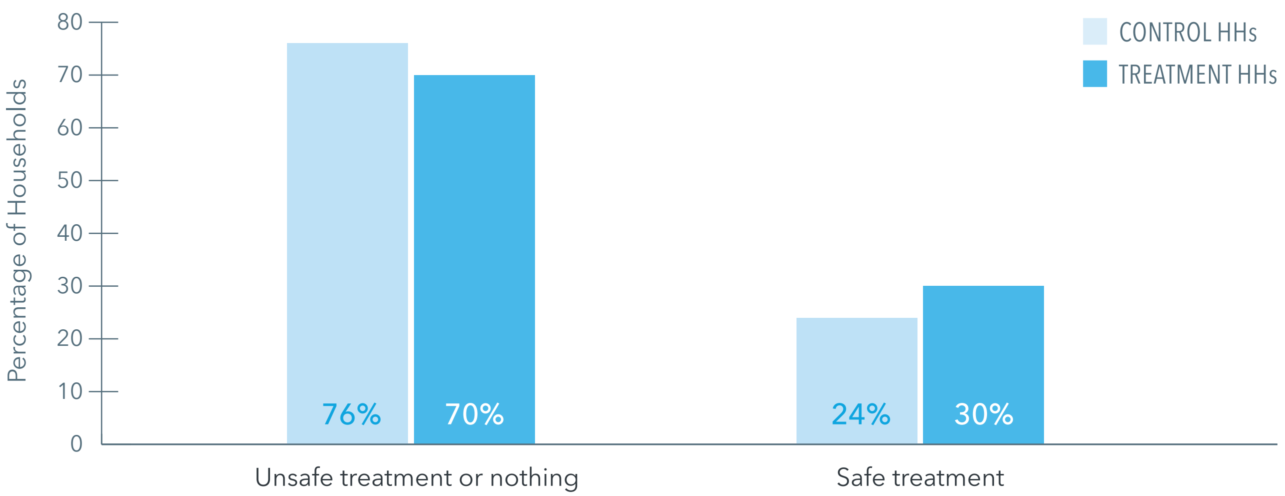


FIGURE 5b. **Secondary outcome safe water behaviors: Water storage handling**

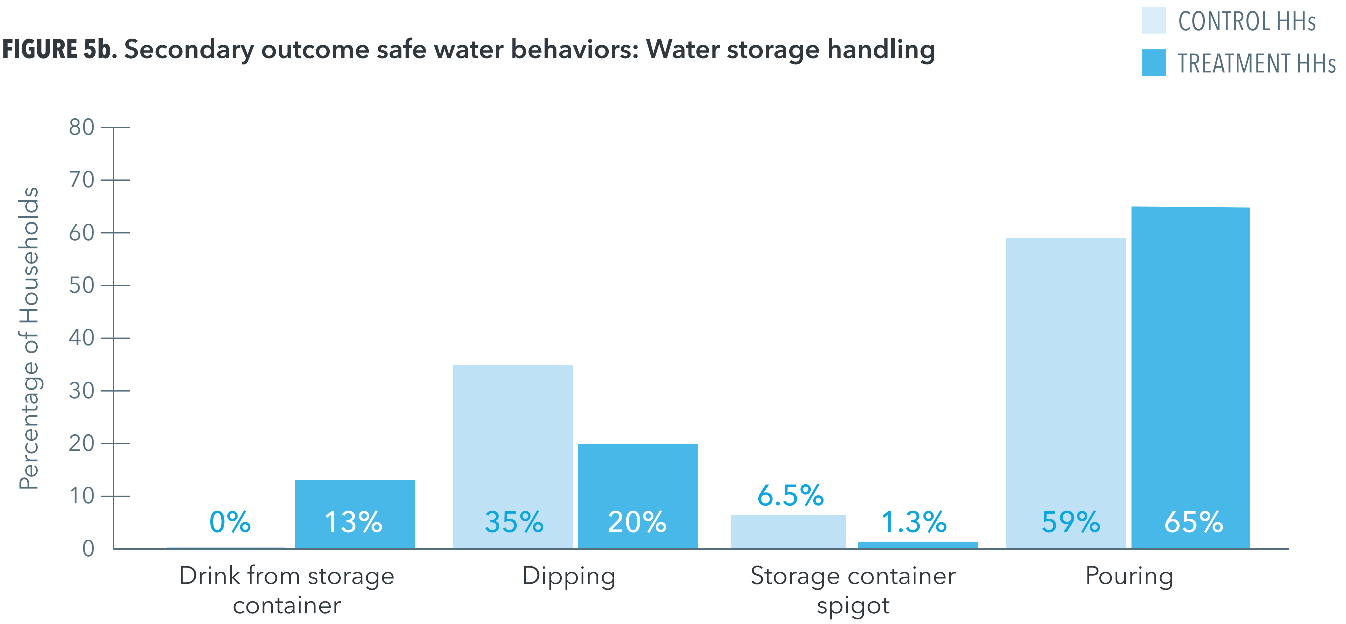
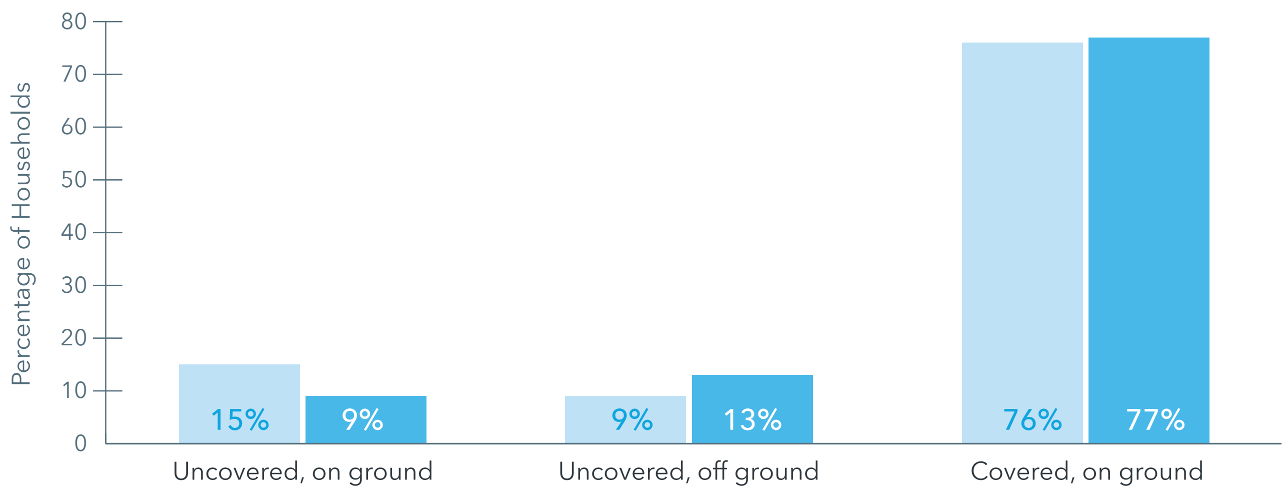


FIGURE 5c. **Secondary outcome safe water behaviors: Water storage location**



Due to our study design, it is possible these results are spurious. In other words, the difference between 76% of control and 77% of treatment households storing water in covered containers (Figure 5c) may be due to randomness, rather than true differences between treatment and control. Nevertheless, the findings may signal that Splash's interventions influence water treatment and storage. This should be investigated further.

CHILDREN AS CHANGE AGENTS

This section explores the possibility of children acting as natural change agents in their households. It only includes findings on knowledge transfer for treatment households (n = 90) due to the way the survey was administered.

Figure 6 sketches this potential process of message exposure among children and/or caregivers, message retention among children and/or caregivers, and behavior change among children and/or caregivers. We explore message transmission from schools to caregivers in the next section.

It is important to remember that of Splash's program is not designed to reinforce the child being a change agent at home per se, and we did not have any expectations or formal hypotheses about children's role as change agents at the start of the study. Without formal hypotheses we are careful to not "fish around" for statistically significant results and have refrained from conducting tests and calculating statistical significance for every relationship

FIGURE 6. Simplified chain of learning model from school to household

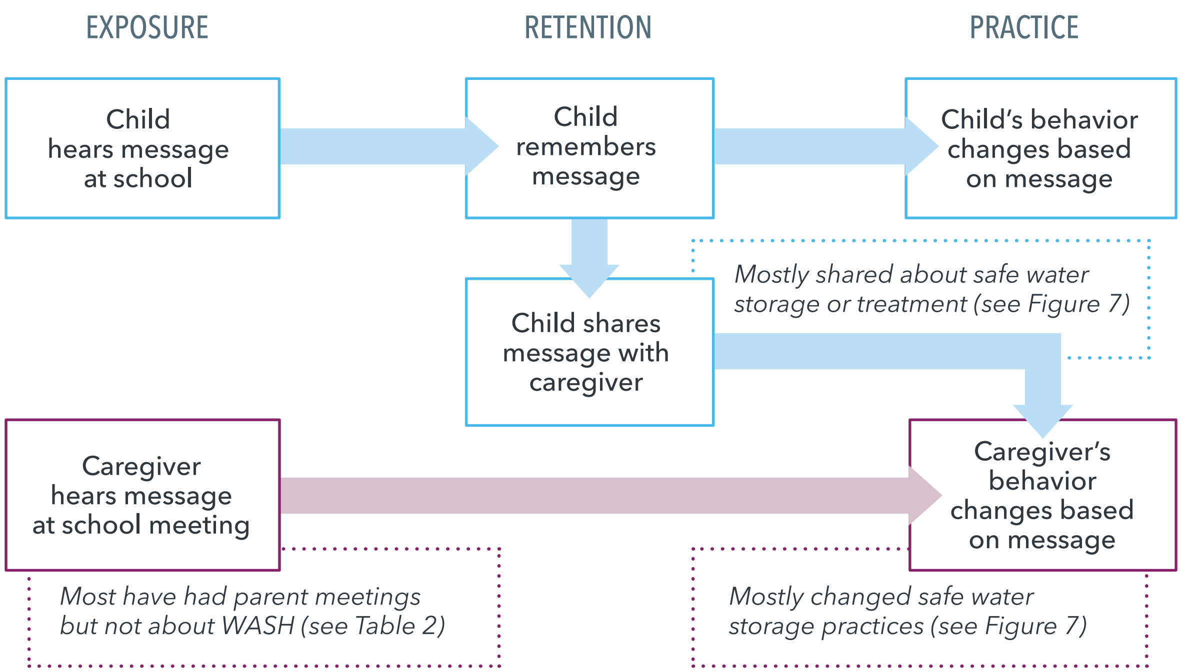


Figure 7 displays the most common information children were bringing home to their caregivers. It is most common for children to speak to their caregivers about water-related work being done by Splash at their school. The water storage and treatment messaging may suggest further that those two outcomes are due to Splash's interventions, and this should be investigated further.

FIGURE 7. Knowledge transfer and behavior change

WATER

HHs learned something about Splash's safe water work from children
(n=54/90 or 60%)

Top messages from children:

Water storage
(n=35/54 or 65%)

and treatment
(n=31/54 or 57%)

Top behavior change:

Water storage practices
(n=25/35 or 71%)

SANITATION

HHs learned something about Splash's sanitation work from children
(n=24/90 or 27%)

Top messages from children:

Toilet cleaning practices
(n=22/24 or 92%)

and toilet use
(n=15/24 or 63%)

Top behavior change:

Toilet cleaning
(n=13/22 or 59%)

and toilet use
(n=11/22 or 50%)

HYGIENE

HHs learned something about Splash's hygiene curriculum from children
(n=39/90 or 43%)

Top messages from children:

Critical times
(n=33/39 or 85%)

and HW steps
(n=27/39 or 69%)

Top behavior change:

Question not asked

Who shares messages with their caregivers?

We investigated the relationship between age, sex, and knowledge transfer by calculating the relative percentages of households who learned something about WASH across sex and age. Neither boys nor girls appear to be systematically sharing more than the other sex. Similarly, no age group seems to be sharing more than any other, except potentially 13-year-olds sharing about "Splash's water work at school" (Exact survey question: Has your child told you about safe water work at his/her school?). A total of 16 out of the 21 households with 13-year-olds reported hearing something about Splash's water work from their child.

OTHER WASH MESSAGING TO HOUSEHOLD

What wash knowledge have caregivers learned at school parent meetings?

This section reports on the messages caregivers have learned at meetings held by their primary child's school. The findings are reported as percentages of households in the treatment and control groups learning a particular WASH message. None of the percentages is statistically significantly different across treatment status. It would not best practice to test for statistical significance here, as we did not hypothesize that there would be differences in school communication across treatment status.

Many households had a child who attended a school that held parent meetings. More specifically, 77 out of 90 treatment schools (86%) and 49 out of 52 (94%) control schools reported their schools holding parent meetings. However, only 12 treatment households and 9 control households reported learning about WASH at these meetings. Interestingly, a higher percentage of control households are learning about WASH in parent meetings (9/49 = 18% of control schools versus 12/77 = 16% of treatment schools).

TABLE 2. Content of WASH communication from schools

LEARNED ABOUT...	TREATMENT	CONTROL
HWWS	10 HHs (83%)	3 HHs (33%)
HW steps	9 HHs (75%)	6 HHs (67%)
Germs	1 HH (8%)	2 HHs (22%)
Disease	5 HHs (42%)	6 HHs (67%)
Toilet use and cleaning	6 HHs (50%)	2 HHs (22%)
Safe drinking water practices	3 HHs (25%)	2 HHs (22%)

Overall, there is less sharing around theoretical concepts related to WASH, such as germs, as opposed to practical aspects of WASH – from students to caregivers and from schools to caregivers.

Extra-school hygiene communication

It may be informative to Splash to know what other WASH communication households in Addis Ababa may receive. We found that 15 of the 90 treatment households (17%) lived in communities that had hygiene campaigns led by a church, mosque, or health extension workers. However, these campaigns do not seem to be effective in teaching handwashing. Only 6% of these households reported their child has learned HW from them. Most children (59%) are learning to HW at home, with 33% learning at school.

Twenty-five of the 52 control households (48%) lived in communities that had hygiene campaigns led by a church, mosque, or health extension workers. Similarly, only 4% of households reported their child as having learned HW from them. Most children learned to HW at home (71%), with 25% learning at school.

Key takeaways

Due to the study design and the issue of subcity confounding, we were unable to rigorously answer our original research question: How is Splash's program associated with the WASH knowledge and behaviors of the students' households? In other words, based on our results we cannot ascertain whether or not Splash's program is having an impact on households. We instead interpret any evidence of associations between Splash's program and households' WASH as possible indications of areas for further investigation or intervention. We discuss these and other takeaways below.

PRIMARY OUTCOME

We did not find evidence of a relationship between the presence of a HW station with soap and water and households' treatment status, though this result does not necessarily mean Splash's program is having no effect on household-level hygiene given we werehindered in our ability to accurately estimate the association between treatment and HW station status.

SECONDARY OUTCOMES

We found some evidence of relationships between treatment status and the secondary outcome of safe water storage location and drinking water treatment practices. HWWS knowledge (HWWS steps, critical times, and benefits) and safe water handling were unrelated to treatment status, with our models and in our dataset. Similarly to the primary outcome, the confounding by subcity means that we are not confident that our results are accurate and unbiased; it is unlikely that we successfully isolated the effect of treatment from the effect of subcity. We again recommend Splash regard these secondary outcome results not as evidence on their program's impact but rather as indications of behaviors to research in the future. The low prevalence of point-of-use water treatment (e.g., 30% of treatment group) and high prevalence of water storage (85% of total sample) suggest opportunities for intervention.

CHILDREN AS CHANGE AGENTS

We found evidence to suggest that children may be relaying information about Splash's water-related interventions from school to their homes (60% of treatment households), especially as it relates to safe water treatment and storage. While we do not know the exact content of their messages, and despite not having control households to which to compare, our results may suggest that Splash's program is improving caregivers' safe water storage practices. In addition to our secondary outcome regression results, these findings may support further research and programming on water storage and treatment practices. We did not find evidence of change agency potential being associated with age or sex.

We also observed most of the WASH messaging from students to their caregivers was more practical than theoretical. Specifically, there is a lack of discussion of germs transferring to the home. It would be worth exploring why students are not sharing this piece of Splash's curriculum?

OTHER WASH MESSAGING TO HOUSEHOLDS

Based on our analysis, there may be opportunities to improve WASH communication to households, either at the community or school level. Only 16% of treatment households and 18% of control households reported receiving WASH information from their schools at parent meetings. Community hygiene campaigns seem to have little effect on households' HW behaviour.

Interestingly, WASH messaging from schools to caregivers was also more practical than theoretical. How might Splash encourage schools to communicate more with caregivers about theoretical concepts such as germs?

The so-what, now-what

What do these takeaways mean for Splash?

One interpretation is that in a sense, they may confirm what Splash already knows: Improved knowledge, behavior change, and infrastructure are all necessary ingredients to promoting safe WASH, but none is sufficient by itself to do so. Based on our results, practical WASH knowledge may be present (even if the theory is not), but limited infrastructure may be hindering households from using this knowledge to change their behaviors.

What kind of knowledge and behaviors are present?

Recall that we found that both treatment and control households demonstrated knowledge of the benefits of HWWS, critical times to HWWS, how to properly handle stored water, and where to safely store water. Children from treatment schools seem to be carrying home messages about water storage and treatment, and caregivers reported changing their water storage practices as a result. Most households do not treat their water at point-of-use, though relatively more treatment households treat their water than control households, which may be associated with Splash's program, but we cannot be sure from our findings.

How is infrastructure a limiting factor?

Households may be more readily able to modify behaviors such as water storage and treatment because changing these practices does not depend on large household or extra-household (e.g., subcity) infrastructure changes. Putting HW knowledge into practice, however, would likely involve more infrastructure changes given how few households have a fixed HW station. Physical infrastructure constraints such as intermittent piped water and shared sanitation may interfere with their ability to construct a reliable, convenient HW station. These types of infrastructure conditions are one reason to care about the subcity confounding issue when interpreting the findings.

Now what?

If Splash wants to expand its reach into students' communities, it might begin by targeting knowledge and behaviors that require minimal infrastructure intervention. Splash could focus on message transfer through children, school meetings for caregivers, and/or community health campaigns. In addition to water storage and treatment, Splash may consider targeting sanitation behaviors such as toilet cleaning and use; encouragingly, in some treatment household's sanitation knowledge transfer from children to caregivers and caregiver behavior change are reportedly already happening. Effectively improving HW behaviors, however, would require water and hygiene infrastructure investments at the household and subcity levels, in addition to a greater emphasis on teaching the five HWWS steps. Such large-scale investments would require new government partnerships and a significant widening of Splash's horizon beyond school-based WASH.

Limitations and implications for future research

We have already discussed the issue of confounding by subcity throughout this document. We recognize the way Splash rolls out its program makes it difficult to avoid the issue of subcity confounding. Nevertheless, if Splash wanted to conduct another household survey, we recommend using schools as their own controls; this method would also avoid the need for matching and minimize the confounding issues associated with the non-random allocation of the intervention. Using schools as their own controls would require surveying households at each school before and after Splash's program implementation.

Our measurement of HW behavior is another important limitation of the study. While our decision to use a fixed HW station as our primary outcome was based on the literature,[6] we found after our study was complete that fixed HW stations were not common among the sampled households. HW materials were brought out when participants were asked to demonstrate HW. It is therefore difficult to say how well a fixed HW station indicator reflects true HW behavior. We recognize that no single indicator may be able to provide a holistic picture of household hygiene behaviors.[7] Splash may consider using multiple indicators in future household hygiene studies. For example, a recent HW study used script based covert HW recall as one measure of HW in southern Ethiopia, in addition to self-reported HW, HW station presence, and HW observations.[8]

REFERENCES

1. McMichael C. Water, Sanitation and Hygiene (WASH) in Schools in Low-Income Countries: A Review of Evidence of Impact. *International Journal of Environmental Research and Public Health*. 2019;16(3):359. doi:10.3390/ijerph16030359

2. Bresee S, Caruso BA, Sales J, Lupele J, Freeman MC. 'A child is also a teacher': exploring the potential for children as change agents in the context of a school-based WASH intervention in rural Eastern Zambia. *Health Education Research*. 2016;31(4):521-534. doi:10.1093/her/cyw022

3. Onyango-Ouma W, Aagaard-Hansen J, Jensen BB. The potential of schoolchildren as health change agents in rural western Kenya. *Social Science & Medicine*. 2005;61(8):1711-1722. doi:10.1016/j.socscimed.2005.03.041

4. O'Reilly CE, Freeman MC, Ravani M, et al. The impact of a school-based safe water and hygiene programme on knowledge and practices of students and their parents: Nyanza Province, western Kenya, 2006. *Epidemiol Infect*. 2008;136(1):80-91. doi:10.1017/S0950268807008060

5. Winter JC, Darmstadt GL, Lee SJ, Davis J. The potential of school-based WASH programming to support children as agents of change in rural Zambian households. *BMC Public Health*. 2021;21(1):1812. doi:10.1186/s12889-021-11824-3

6. Luby SP, Rahman M, Arnold BF, et al. Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Bangladesh: a cluster randomised controlled trial. *The Lancet Global Health*. 2018;6(3):e302-e315. doi:10.1016/S2214-109X(17)30490-4

7. Moffa M, Cronk R, Fleming L, Tidwell JB. Measuring household hygiene access and handwashing behaviors: Findings from 14 low- and middle-income countries. *International Journal of Hygiene and Environmental Health*. 2021;237:113810. doi:10.1016/j.ijheh.2021.113810

8. Contzen N, Pasquale SD, Mosler HJ. Over-Reporting in Handwashing Self-Reports: Potential Explanatory Factors and Alternative Measurements. *PLOS ONE*. 2015;10(8):e0136445. doi:10.1371/journal.pone.0136445