

Hygiene Heroes

A process evaluation of promoting hygiene practices in Tamil Nadu Schools

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May 11, 2020

Abstract

Diarrheal diseases and respiratory infections are the leading causes of illness and school absences for school-aged children. Both can be prevented by handwashing with soap. Unfortunately, at most schools in poor nations, soap and water are rarely present and, if present, rarely used. Hygiene Heroes, a project of the University of California, Berkeley and IIT Madras, had been working with the Tamil Nadu school system (Samagra Shiksha, formerly SSA) on improving the hygiene practices of school students since 2015.

Keywords:

Preventative Healthcare Measures, Tamil Nadu, Hygiene, Handwashing, Presence of Soap

Acknowledgements:

I am extremely grateful for Professor David Levine for his continuous support and dedication as my advisor. I also thank Rowan Pan, Krunal Desai, and Shankar Krishnan, for their assistance and encouragement. The description of the intervention, and literature review is all accredited to Professor Levine. All of the remaining errors with regards to the Process Evaluation are my responsibility.

1 Introduction

Dental and handwashing hygiene is crucial in preventing dental, diarrheal, and respiratory illnesses in school-aged children. This paper analyzes the “Hygiene Heroes” curriculum on improving the hygiene practices of students in the southern Indian state of Tamil Nadu. Hygiene Heroes ran a cluster-randomized trial of a school-based hygiene intervention for students in grades 3 to 5 in public schools. The 200 schools were in the Kanchipuram and Thiruvallur districts near Chennai, in southern India. They randomly selected half the schools in each district to train in handwashing. The primary outcome measure is handwashing with soap before lunch, as observed by surprise visits arriving one minute after lunch begins. Secondary outcome measures are the presence of soap in classrooms or near handwashing stations.

Table 1: Theory of change + measures

Theory of change	Measures
Teachers attend training and receive teaching supplies and soap.	Attendance sheets at training
Teachers sign up for WhatsApp group	Membership in WhatsApp group
Teachers learn the curriculum and report intention to teach it	Teacher post-test at training (not linked to schools)
Teachers remember the key lessons	Teacher survey: knowledge of key times
Teacher teach materials	Photos submitted to the WhatsApp group
Students learn the material	Student survey: Knowledge questions
Soap in classroom	Student survey: Soap presence Classroom observation
School inspectors (BRTEs) observe and report the presence of soap	BRTE checksheet
Students and teachers follow hand washing routines	Student survey: Self-reports
Students wash hands with soap before lunch	Enumerators surprise observation

Table 1: The experiment measured most (but not all) steps of the theory of change.

This paper seeks to discover the story of how the intervention operated in practice. Conclusions might be such that whether the intervention worked only when soap was present and student knowledge didn’t matter. It could also be that soap was not what mattered; it was whether the teachers had learned anything.

Thus, I will attempt to diagnose where along with our theory of change, things went according to plan and where they broke down. I will first report the levels of outcomes predicted by the theory of change at each step. I will then assess if the correlations with earlier stages of the theory of change hold. Ultimately, I intend this paper to highlight how the Tamil Nadu school system can better understand the effectiveness of a scalable school-based intervention to promote hand hygiene.

2 Literature Review

We based our intervention on a combination of hygiene theory and practice and more general theories of behavior change.

2.1 Behavior Change

Daily behavior change is difficult. Importantly, merely alerting people to a problem and explaining a solution rarely leads to daily behavior change. Familiar examples of the challenges include doctors not washing hands between patients (Handwashing Liaison Group, 1999) and people eating more and exercising less than they intend (Fjeldsoe 2011).

At the same time, a number of levers exist to promote behavior change. For example, the integrated behavior change model for water, sanitation, and hygiene (IBM-WASH, Dreifelbis 2013) unify a number of models (health behavior change, etc.) and levels of influence (person, situation, etc.).

Economics and theories of self-efficacy emphasize that people must be able to perform the behavior. Thus, people need the required skills and necessary equipment or supplies. Marketing and behavioral economics (Cialdini 2007; Heath and Heath, 2007) focus on the importance of vivid messages and communicating that behavior is normal in a community. Messages are also influential if the messenger is a role model the listener respects and/or likes. Interventions to promote handwashing and to discourage open defecation often mobilize emotions of disgust (Biran et al., 2014, on handwashing; Kamal, 2005, on open defecation). The literature on habit formation emphasizes the importance of repetition (Lally et al., 2010). If a behavior can become part of the morning and evening routine, then children do not need to “decide” whether to brush their teeth twice each day. Instead, the behavior is built into the morning and bedtime routines.

2.2 Handwashing interventions in schools

A number of high-quality randomized trials have examined interventions to promote handwashing in schools (Biran et al., 2014; Galiani et al., 2016; Bowen et al., 2007; Grover et al., 2018). Most of these interventions had higher-intensity programs than we study (Bowen et al., 2007; Biran et al., 2014), used specialists as trainers, and often involved both community and school outreach (Biran et al., 2014; Gertler et al., 2018). The use of multimedia and community interventions is desirable on many grounds. At the same time, these elements make it hard for a school system in a low-resource setting to scale these interventions. Our intervention is designed to be highly scalable, using the school system’s regular trainers to deliver the intervention.

3 Intervention

This section discusses our intervention, data collection, and statistical methods. The intervention consisted of a curriculum and a rollout procedure.

3.1 The curriculum

Professor Levine and the Hygiene Heroes team designed the intervention based on the theories described above. To ensure the ability to wash hands effectively, teachers taught how to wash hands. To improve the ability to wash hands with soap, we also provided a low-cost soapy bottle and soap refills. The cost is \$0.03 (Rs 2) per student per year.

To provide a vivid role model, we gave students illustrated stories we wrote. One was Tenali Rama gets in Trouble (Figure 3). Tenali Rama is a familiar folk tale character in southern India who gives advice to the king. They were familiar to all students. In this story, Tenali Rama arranges for the king to learn that handwashing with soap is essential because filth can be invisible and require soap to remove. A second story used Chhota Bheem, a cartoon character familiar to all of the children.

To reach parents, the team had students copy out a letter home. The letter asked parents to report if the student washed hands with soap after using the toilet and before eating. The goal of the letters was not data collection but to teach parents what their children (and they) should be doing at these key times.

To build the habit of washing hands with soap, we asked teachers to keep a star chart (Figure 6). While not valid data collection, the star chart acts as a daily reminder. By showing all of a student's peers are washing hands with soap at key times, the star chart also establishes this pattern as normative in this group.

3.2 Rolling out the curriculum

To make the intervention scalable, we used the school system's regular trainers to train teachers. Specifically, we trained BRTEs (Block Resource Trainer-Educators – the lowest level trainers and monitors in the government school system). BRTEs then trained the teachers from participating schools (Oct. 11, 2019, in Kanchipuram district and Nov. 8, 2019, in Tiruvallur). This training took two hours during a regularly scheduled teacher training. With the purpose of motivating teachers, the training also emphasized the importance of student handwashing with soap (1) for the health of the teacher and their family and (2) to avoid having a disgusting classroom covered with poop and germs. BRTEs distributed copies of the curriculum to each teacher: Lesson plans, stories, star charts for motivating students, and letters students would bring home for their parents to read and sign. BRTEs also distributed soapy bottles and refills. At the end of

the training, the intervention team created a WhatsApp group for teachers. There was a separate group for each study arm in each district. These groups permitted the intervention team to send reminders to teachers and let teachers share pictures and stories. After the training, teachers taught students. The schedule was three lessons over three weeks. We used the WhatsApp group to send out reminders twice a week for the first month (that is, during the time the teachers were scheduled to teach the three sessions). Reminders continued less frequently for the next month, encouraging teachers to have students complete the star charts. We also used the WhatsApp groups to request photos of star charts and letters home. Sharing these photos reinforced that handwashing with soap is normative behavior for schools in this area.

4 Data and Empirical Framework

4.1 Pipeline

We chose ten blocks (a group of schools) in each district so our data collection area would be more compact. We selected all schools that the Department of School Education reported had at least 80 students, yielding 228 candidate schools. Each school has a unique DISE number to identify themselves.

We tried to collect baseline surveys at all 228 schools. We failed to find six schools, and one principal declined to give informed consent, so we collected 221 baseline surveys. After the baseline, we dropped one school that had exactly 80 students (our minimum size). We then dropped 20 additional schools in order of remoteness to hit our target of 100 schools per district. [DL1] Professor Levine, who knew nothing about the schools, used Excel’s random number generator to randomize 50 schools (50%) in each district into the Handwashing Arm. The other schools received an unrelated dental hygiene intervention (see Levine et al. 2020). At each school in the Handwashing Arm, the intervention was in one classroom for each of the third, fourth, and fifth grades. If a school had more than one classroom for a grade, we chose the first class in grades 3 and 5 and the last class in grade 4. We intervened in about half the classrooms in most schools (grades 2, 3, and 4).

At each school, we carried out three rounds of data collection: baseline, midline, and endline. We surveyed nine students and two teachers per school to study knowledge of handwashing and self-reported handwashing behaviors. We are missing 15% of baseline observations of handwashing before lunch, largely because of challenges finding schools (so the observer arrived after lunch began) or HMs delaying the enumerator to enter the school (due to lack of familiarity with our project). In addition, schools in Tamil Nadu closed abruptly due to COVID-19 on March 13, 2020. Thus, we did not complete the endline survey and school observations for 40 schools (20%).

Non temporal Datasets Collapsed by Wave and DISE Number

*In brackets are the missing observations in each wave for each dataset

	Baseline	Midline	Endline	Total Size	Tot Mid Obs	Tot End Obs
Classroom Observations (Presence of Soap)	99 (20)	100 (22)	78 (17)	277	78	61
Student Survey (Self report Handwashing)	99	98	79	276	98	79
Rapid Observations (Enumerators surprise observation handwashing)	99	100	79	294	100	95

Table 2: Total Observations per Dataset at school level per wave

The above table shows the number of schools (identified by the DISE number) per wave . Note how we are missing 22% of our observations at Endline. In addition, as shown by the brackets we are missing a significant portion of class room observation of soap by the enumerators.

Datasets Collapsed by DISE

	Total Size	Missing School Observations	Total Observations
BRTE (Checksheet for Handwashing)	62	0	62
WhatsApp (No of photos/members)	100	0	100
Classroom Observations (Presence of Soap)	100	10	90
Rapid Observations (Enumerators surprise observation handwashing)	100	0	100
Student Survey (Self report Handwashing/ Presence of Soap))	100	0	100

Table 3: Total Observations per Dataset at school level

The above table discusses the total number of schools which had observations for each specific variable regardless of wave. Note BRTE's and Classroom observations are the only two variables which have school observations lower than 100. Thus, merging the tables together for certain regressions led to a drop in sample sizes within the process evaluation segment.

5 Data Description

5.1 Curriculum Uptake Variables:

The experiment uses WhatsApp variables in measuring the direct uptake of the healthcare curriculum by teachers.

Number of Members on Whatsapp Group: Measure of how many teachers joined a whatsapp group which distributed the curriculum material. Measures how teachers direct uptake of learning the hygiene curriculum.

Photos teachers shared on WhatsApp: As noted above, we requested teachers send us photos of star charts and letters home. They shared photos using the WhatsApp groups we set up for each study arm in each district.

5.2 Presence of Soap in Classroom Variables:

Our secondary outcome is an observation of soap in three classrooms and by the handwashing stations. This outcome variable was measured separately by Students, Enumerators and BRTEs.

Student Survey Presence of soap: As part of the experiment, students were given a survey that asked to address the presence of soap

Enumerator observation: Enumerators rated soap as present if soap or a soapy bottle was by the toilet or in classrooms. We gave partial credit at schools where soap or a soapy bottle was present in one or 2 of the three classrooms we observed. Enumerators observed soap or soapy bottles in 38% of control schools and 34% of treatments at baseline (difference not statistically significant). The share more than doubled to 91% at treatment schools at the midline. The share also rose to 61% at controls (difference between study arms $P_i < 0.01$). There was a slight convergence between the study arms at the endline, with 88% of treatments and 65% of controls having soap.

BRTE reports: With the approval of the state school system, we requested the BRTEs (Block Resource Trainer Educators) in the handwashing arm to monitor soap. BRTEs sent us reports for 62 of the 100 handwashing schools. We do not know if BRTEs never observed our metrics at the other 38 schools. Another possibility is if they were loath to report poor results or some other explanation for non-response. In 89% (55/62) of schools with reports, BRTEs reported soap or soapy bottles in classrooms, and in 65% (=40/62) BRTEs reported soap or soapy bottles by the handwashing station. In 92% (57 / 62) schools, BRTEs reported seeing star charts in the school.

5.3 Handwashing:

Handwashing before Lunch: Our primary outcome is a surprise observation of students handwashing before lunch by the enumerators. Thus, our primary measure of success is having the majority of students wash hands with soap before lunch. Our analysis sample only includes visits where the enumerator arrived a minute or two after the lunch period began, so the visit was a surprise.

Hygiene knowledge: To determine the impact of the curriculum, we seek to measure the hygiene knowledge of both students and teachers. Thus, allowing us to interpret any causal relationship with the primary outcome of handwashing. We asked both teachers (and students) the key times for washing hands with soap. We gave one point for saying “after using the toilet” and one point for “before eating.” There were six other possible replies (after eating, after playing, etc.). We subtracted 1/6 point for each additional reply so that giving no replies or giving all possible replies gives a score of zero.

These rates are upper bounds for several reasons. First, the checklist asked school-level metrics, but some classrooms may have lacked soap and/or star charts. Second, BRTEs may not report problems, in part because they trained these teachers. Finally, these rates fall significantly if we assume all missing observations did not have the target behavior (to 55% of schools with soap in classrooms, 40% with soap at handwashing stations, and 57% with star charts).

6 Results and Interpretations

6.1 Baseline Characteristics

We studied 200 schools in the Kanchipuram and Tiruvallur districts near Chennai, in southern India. These districts range from urban areas adjacent to Chennai (a city of 7 million) to rural and somewhat isolated regions (see Figure 9). Most students in government schools in Tamil Nadu are from low-income families and many are from Scheduled Castes (formerly called “untouchable” castes). The outcomes we would like to interpret is the students and teacher’s knowledge of hygiene, and handwashing before launch, Note: Please see 4.2 Data Description to understand the variable names listed in below tables.

6.2 Pre/Post Intervention Summary Statistics

Looking at the baseline statistics, we see that the whatsapp variables were 1 per school, which explains the 100 observations. For students we are assuming around 7-9 per classroom with approximately 2-3 classrooms per school. Likewise 2-3 teachers per school were surveyed for teacher knowledge of curriculum .

Table 4: Descriptive Statistics

	Observations	Mean	Standard Deviation	Minimum	Maximum
Members in Whatsapp	100	2.44	0.64	1	4
Number of Photos in Whatsapp	100	1.94	1.895	0	6
Student Knowledge Index	1411	1.93	0.3523609	0	2
Teacher Knowledge Index	460	1.99	4.5276	0	2
Presence of Soap	456	0.39	0.313	0	1
Student Self Report Handwashing	1413	1.06	.904	0	2
Classroom observation soap	456	0.39	1942.861	0	1
Enumerators handwashing observation	1416	0.27	0.44	0	1

Summary Statistics showing the difference between control and treatment

Study arm:	Midline			Endline		
	Control	Hand wash	Δ	Control	Handwash	Δ
Handwashing knowledge						
Student handwashing knowledge score	1.938	1.934	-004	1.936	1.934	-002
#Students	793	771		653	606	
Teacher handwashing knowledge score	1.997	1.994	-0.003	1.958	1.954	0.004
#Teachers	460	300		460	300	
Observed presence of soap	.28	.55	0.27408	.24	.046	-0.2
#Classrooms	526	498		534	525	
Observed presence of soapy bottles	.55	.83	0.27	.4	.88	0.48
#Classrooms	535	489		507	507	
Enumerators surprise observation handwashing	.30	.60		.30	.43	
#Schools	94	96		94	94	

Table 5:

As shown in the above summary statistics, the teachers and students learning the curriculum have a ceiling effect. That is, essentially 100% of both teachers and students gave the “right” answers on key times to wash hands. This result indicates that we cannot study any steps within the theory of change which involve the hygiene knowledge of both students and teachers.

7 Process Evaluation

The process evaluation section will break down the 6 of the 10 steps within the theory of change.

When required, each step will be spilt into variables which are temporal (require Midline and Endline Analysis) and non temporal which are variable s such as Membership in whatsapp, Number of Photos Sent, and BRTE checkseet for soap presence.

7.1 Step 1: Teachers sign up for WhatsApp Group correlated with Teachers teach Material

Curriculum Uptake: When photos submitted to WhatsApp group is predicted based on membership in WhatsApp group

	(1) Photos submitted to the WhatsApp group
Membership in WhatsApp group	0.385 (0.296)
Constant	1.001 (0.747)
Observations	100
R^2	0.017

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Univariate regression of Photos submitted with Whatsapp with Membership in WhatsApp

A 1 member increase within the WhatsApp group predicts 0.385 increase in the number of photos submitted to the WhatsApp group ($\beta = 0.385$, $SE = 0.296$).

This result is consistent with our first stage within the theory of change where an increase in uptake of teachers leads to more hygiene curriculum related material being conveyed to students through WhatsApp . At the same time, the lack of statistical significance makes this support quite weak.

7.2 Step 2 Students learn the material correlated with Student's Presence of Soap

Student Survey Presence of soap measured through curriculum uptake variables: Photos submitted to WhatsApp group and membership in WhatsApp group

	(1)	(2)
	Student survey: Soap presence Midline	Student survey: Soap presence Endline
Membership in WhatsApp group	-0.146* (0.0597)	-0.0138 (0.0635)
Photos submitted to the WhatsApp group	-0.00717 (0.0226)	0.0194 (0.0166)
Constant	1.051*** (0.145)	0.852*** (0.157)
Observations	98	79
R^2	0.050	0.015

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Curriculum uptake on soap presence at both Midline and Endline levels

In Table 7, we use WhatsApp membership and photos to predict student reports of soap in the classroom. The two coefficients are small and not statistically significant. Thus, the measure of membership in WhatsApp group may not capture engagement in curriculum.

7.3 Step 3: Students observation of soap correlated with the enumerator’s observation of soap in classrooms

Classroom observation of soap is measured through curriculum uptake variables: Photos submitted to WhatsApp group and membership in WhatsApp group. In addition to univariate correlations on soap presence from student survey at both midline and endline levels.

In Table 8, in contrast to the previous table, we see now that there is a positive relationship between curriculum uptake (that is, membership in the WhatsApp group) and the presence of soap reported by the enumerators ($\beta = 0.00768$, $SE = 0.0532$).

The student survey measure of soap presence is statistically significant, at the endline level, in correlating with enumerators measure of soap in classroom ($\beta = 0.193$, $SE = 0.0849$).

From midline to endline the magnitude of the correlation more than doubled, while also becoming statistically significant.

	(1)	(2)	(3)
	Classroom observation soap	Classroom observation soap Midline	Classroom observation soap Endline
Membership in WhatsApp group	0.00768 (0.0532)		
Photos submitted to the WhatsApp group	0.0262 (0.0186)		
Student survey: Soap presence Midline		0.0852 (0.0810)	
Student Survey: Soap Presence Endline			0.193* (0.0849)
Constant	0.314* (0.138)	0.357*** (0.0594)	0.274*** (0.0598)
Observations	90	78	60
R^2	0.029	0.015	0.082

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Curriculum uptake on Enumerator’s Classroom observation of soap. Univariate regression of student survey’s and enumerators soap presence

7.4 Step 4: Students and Enumerators reporting of soap correlations with BRTE’s reporting of Soap

BRTE’s observation on Presence of soap measured through curriculum uptake variables. In addition to univariate correlations on soap presence from student survey and enumerator (classroom observations) at both midline and endline levels.

In column (1), both WhatsApp membership and photos had tiny and statistically insignificant negative correlation with the BRTEs presence of soap ($\beta = -0.0680 / -0.00428, SE = 0.0480/0.0193$).

At endline, Student survey of soap presence had a small and statistically significant negative correlation ($\beta = -0.69, SE = 0.0729$)

While classroom observation had a small and statistically insignificant negative effect in predicting BRTE reports ($\beta = -0.164 / -0.0684, SE = 0.0953/0.129$).

	(1) BRTE check sheet	(2) BRTE check sheet	(3) BRTE check sheet	(4) BRTE check sheet	(5) BRTE check sheet
Membership in WhatsApp group	-0.0680 (0.0480)				
Photos submitted to the WhatsApp group	-0.00428 (0.0193)				
Student survey: Soap presence (Midline)		0.151 (0.114)			
Student survey: Soap presence (Endline)			-0.169* (0.0729)		
Classroom observation soap (Midline)				-0.164 (0.0953)	
Classroom observation soap (Endline)					-0.0684 (0.129)
Constant	1.061*** (0.106)	0.785*** (0.0994)	1.036*** (0.0214)	0.957*** (0.0267)	0.921*** (0.0578)
Observations	62	62	49	47	39
R ²	0.024	0.042	0.035	0.033	0.005

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Curriculum uptake on BRTE’s checksheet on presence of soap. Univariate regressions of student survey and enumerator’s classroom observation of soap with BRTE presence of soap.

Overall negative correlations show how BRTE’s reporting is in contradiction with the other measurement variables for soap presence.

In short, we have no evidence that BRTE reports are valid.

7.5 Step 5: How Soap in Classrooms correlated with Student’s following Hand-washing routines

Student’s self reports of handwashing correlated with soap presence and curriculum uptake. Used all 3 soap presence measures as controls to isolate the correlation of curriculum uptake on handwashing.

Although the relationship is not statistically significant, BRTEs observation of soap are negatively correlated with self-reported handwashing by student ($\beta = -0.192$, $SE = 0.168$)

The presence of soap reported by the students strongly correlates with the self-reporting of handwashing at the 1% significance level ($\beta = 0.727$, $SE = 0.189$).

Both student self-reports of soap presence and enumerator reports of soap predict student self-reported

	(1) Student survey: Self-reports handwashing	(2) Student survey: Self-reports handwashing
Membership in WhatsApp group	0.0275 (0.0757)	-0.0955 (0.0693)
No Photos submitted to the WhatsApp group	-0.0582* (0.0259)	-0.0162 (0.0255)
Student survey: Soap presence	0.727*** (0.189)	
Classroom observation soap	0.163 (0.168)	
BRTE Checksheet	-0.192 (0.162)	
Constant	1.103*** (0.285)	1.639*** (0.170)
Observations	55	100
R ²	0.305	0.026

Table 10: Examine correlations of student self-report of handwashing. Col(1) "Horse run" of all variables controlled compared with Col(2) of just curriculum uptake

handwashing. When all control variables are placed in Col (1), student self-reports have the stronger effect . Column (2) shows negative correlation between curriculum uptake and involvement and observed handwashing.

	(1) Student survey: Self-reports handwashing Midline	(2) Student survey: Self-reports handwashing Endline	(3) Student survey: Self-reports handwashing Midline	(4) Student survey: Self-reports handwashing Endline	(5) Student survey: Self-reports handwashing Midline	(6) Student survey: Self-reports handwashing Endline
Classroom observation soap (Midline)	0.222 (0.214)				-0.00374 (0.197)	
Classroom observation soap (Endline)		0.212 (0.147)				0.133 (0.161)
Student survey: Soap presence (Midline)			1.002*** (0.168)		1.062*** (0.199)	
Student survey: Soap presence (Endline)				0.482* (0.221)		0.541* (0.259)
Constant	1.336*** (0.123)	1.404*** (0.0728)	0.698*** (0.148)	1.092*** (0.201)	0.694*** (0.159)	0.981*** (0.220)
Observations	76	59	98	79	76	59
R ²	0.012	0.020	0.370	0.078	0.429	0.149

Standard errors in parentheses ^{*} $p < 0.05$, ^{**} $p < 0.01$,
^{***} $p < 0.001$

Table 11: Univariate correlations of both classroom and student survey of soap presence on handwashing reported by students at Midline/Endline

Column (3) shows the univariate coefficient of Student's presence of soap at midline. The magnitude of the

correlation increases to 1.002 at the 1% significance level ($\beta = 1.002, SE = 0.177$).

The correlation further increases to 1.062 when controlling for just classroom observation.

Midline results for student’s presence of soap show the largest correlations while jointly remaining at the 1% significance level ($\beta = 1.002, SE = 0.177$). When controlling for just classroom observations the coefficient further increases to 1.062 while consistently remaining at the 1% significance level. However, when looking at our endline results the statistical significance drops to 10% as shown in Column (4) and (6).

This strong correlation between student reports of soap and handwashing may be due to common measurement error.

Classroom observations alone does not show any statistical significance in predicting student’s self reports of handwashing.

7.6 Step 6: Soap in Classroom and Curriculum Uptake correlated with Enumerator’s reporting of Handwashing

	(1) Enumerators surprise observation handwashing	(2) Enumerators Surprise Observation handwashing	(3) Enumerators surprise observation handwashing
Membership in WhatsApp group	0.0646 (0.0463)	0.0318 (0.0480)	
Photos submitted to the WhatsApp group	0.00597 (0.0146)	0.00381 (0.0150)	
Student survey: Soap presence	0.135 (0.121)		0.245 (0.136)
Classroom observation soap	0.0895 (0.104)		0.0106 (0.117)
BRTE Checksheet			-0.238 (0.123)
Constant	0.121 (0.156)	0.335** (0.123)	0.462** (0.152)
Observations	90	100	55
R^2	0.046	0.005	0.142

Standard errors in parentheses* $p < 0.05$, ** $p < 0.01$,
*** $p < 0.001$

Table 12: Univariate correlations of both classroom and student survey soap presence on enumerators handwashing at midline/endline level

Column (1) shows that curriculum uptake and observation of presence of soap are both positively correlated with the primary outcome of predicting Enumerator’s handwashing observations. BRTE is consistently

negatively correlated with the enumerators handwashing observations ($\beta = -0.238, SE = 0.123$).

	(1)	(2)
	Enumerators surprise observation handwashing Midline	Enumerators surprise observation handwashing Endline
Student survey: Soap presence(Midline)	0.163 (0.127)	
Classroom observation soap(Midline)	0.134 (0.196)	
Student survey: Soap presence (Endline)		-0.0427 (0.131)
Classroom observation soap (Endline)		-0.0460 (0.177)
Constant	0.444*** (0.123)	0.443*** (0.114)
Observations	76	70
R^2	0.029	0.003

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Measuring correlations of Soap presence by both students and enumerators on surprise Handwashing observations at midline/endline level.

Secondary outcome of presence of soap measured by both Student and Enumerator go from positively correlated with handwashing at midline to negatively correlated at endline. Thus, highlighting an inconsistency in the correlation between the presence of soap and observed handwashing.

Looking at the univariate correlation, student's survey of soap presence is statistically significant correlation with handwashing at midline ($\beta = 0.268, SE = 0.116$).

However, this significance drops at endline.

From column (5), we see that at midline the student and enumerators have a positive correlation at the 10% significance level ($\beta = 0.153, SE = 0.0671$).

This indicates that students reporting handwashing while enumerators valid this by observing them. This correlation becomes negative at endline, yet without any statistical significance to validate it.

Classroom observations does not show any significance in predicting handwashing at either the midline or endline levels.

	(1) Enumerators surprise observation handwashing Midline	(2) Enumerators surprise observation handwashing Endline	(3) Enumerators surprise observation handwashing Midline	(4) Enumerators surprise observation handwashing Endline	(5) Enumerators surprise observation handwashing Midline	(6) Enumerators surprise observation handwashing Endline
Student survey: Soap presence (Midline)	0.268* (0.116)					
Student survey: Soap presence (Endline)		0.227 (0.169)				
Classroom observation soap (Midline)			0.159 (0.185)			
Classroom observation soap (Endline)				-0.169 (0.205)		
Student survey: Self-reports handwashing(Midline)					0.153* (0.0671)	
Student survey: Self-reports handwashing(Endline)						-0.0869 (0.0732)
Constant	0.414*** (0.0937)	0.318* (0.151)	0.518*** (0.0928)	0.591*** (0.105)	0.381*** (0.111)	0.542*** (0.112)
Observations	93	78	74	59	95	94
R ²	0.057	0.018	0.011	0.011	0.053	0.015

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: Measuring curriculum uptake and measurement of soap on enumerators handwashing observations at both midline/endline level.

7.7 Measurement

Some of those correlations discussed above inform us how well multiple raters of the same construct agree. With regards to the presence of soap, there was a strong correlation between students and enumerators at both the midline and endline levels. The BRTEs checksheet for this measure did not provide any significant correlations within this analysis. The measure of handwashing observations had a significant positive correlation between both students and enumerators at only the midline level.

7.8 Convergent validity

Sometimes different observers rated almost-identical constructs. Our measures have high convergent validity if they agree most of the time. However, we noticed that BRTE showed no positive correlation with either student and enumerators

To further understand the relationship between BRTE's and enumerators observations we performed a Cross-tab school-mean enumerator saw soap for 3 sets of schools: BRTE no data, BRTE report no soap, BRTE report soap within the Treatment Arm.

	Midline enumerator school average soap presence	Endline enumerator school average soap presence	Difference
BRTE reported soap	.3649574	.3372754	-0.02768
BRTE reported no soap	.5666667	.4166667	-0.15
No BRTE report	.4328208	.4493937	0.016573

Table 15: Cross-tab School-mean Enumerator’s Presence of Soap

From the first column, We see that the school average of soap presence is 64% higher (0.36 to 0.56) in the subset of schools where the BRTE’s supposedly reported no presence of soap. This applies at the endline level as well. The subset of school observations with no BRTE reporting had on average a higher enumerator measure compared to where BRTE reported soap.

8 Conclusion

8.1 Discussion of Results

To reiterate, some of these measures within our theory of change had variables to measure the knowledge uptake of both students and teachers. Unfortunately, both these measures of knowledge had a ceiling effect. The potential reasoning behind this is two-fold; firstly, the enumerators were not trained to collect wrong answers during the intervention. In addition, within the student survey questions, if we are interpreting, for instance, a wrong answer to wash hands before eating lunch, it may be misinterpreted as most people eat with their hands as South Asian customary practices. Thus, to gauge the students’ hygienic knowledge, there may be scope to redesign the survey questions. These surveys must stay specific to their cultural and socio-economic environment. Secondly, it looks as if the enumerators provided them with the proper answers. It seems relatively implausible that both the students and teachers had 99.9% correct results from the survey questionnaire. Thus, leading to the plausible hypothesis of the severe mixed case in both under-measured errors and over-measured correct answers.

The Process evaluation results highlight the following:

1)WhatsApp variables did not predict anything of significance, making us suspicious in its measure of capturing the engagement of the curriculum.

2)BRTE checksheet does not correlate with anything, and that makes us assume that they just looked at one classroom or did not do anything or just sat in the principal's office and filled the form.

3)At least on the enumerator side, we do see some correlation of what students are reporting in terms of both soap presence and handwashing

Overall, reflecting on the notion that the hygiene curriculum intervention could have had better data collection strategies. It is important to note that this paper alone cannot prove that we under-measured. However, individual steps within the theory of change can help us understand where the intervention may have broken down. For instance, the fact that BRTE reports of soap do not correlate with anyone else suggests a problem relying on the BRTEs to train the teachers. Understandably, the BRTEs can be very preoccupied, and they did not simply report the presence of soap for the sake of it. Nevertheless, it seems very unlikely that the BRTE reports would be uncorrelated if they were not for some form of biases.

Thus, there will be plans on running our regression in the future to see if BRTE only chose to report where there was a higher presence of soap. Potential reasoning could be because they do not like to report failure.

8.2 Interpretation

These results show both the challenges and opportunities of integrating good hygiene into Tamil Nadu schools. It is not sufficient to teach, "Wash your hands." Schools need routines to provide soap and routines for washing hands at key times. Because this intervention used the school system's own trainers, the school system could easily scale it. At the same time, the school system would presumably replace our intervention's monitoring whether teachers implemented the curriculum using WhatsApp photos with adding a few items onto the BRTE's standard check sheet. For example, BRTEs could monitor the presence of star charts. Control schools also increased observed handwashing and presence of soap from baseline to midline, though less than treatments. Teachers and HMs regularly meet with peers from other schools. In follow-up interviews, HMs and teachers in treatment schools noted that they discussed the handwashing intervention peers in control schools. (Control schools received a dental hygiene intervention, which HMs also discussed.) BRTEs trained teachers at both treatment and control schools. They claimed not to have discussed handwashing at control schools; but some may have mentioned soap (given that they were training on its importance). Finally, our baseline visits (when we visibly asked about the presence of soap) may have prompted HMs and/or teachers to acquire and use soap.

8.3 Limitations and future research

The hygiene observation was not blinded, which may have led to unconscious bias. We are missing 15% of baseline observations of handwashing, largely because of challenges finding schools (so the observer arrived after lunch began) or Head Masters delaying the enumerator to enter the school (due to lack of familiarity with our project). Schools in Tamil Nadu closed abruptly due to COVID-19 on March 13, 2020. We did not complete the Endline survey and school observations for 40 schools (20%). Thus, restrictions related to COVID-19 limit our ability to follow up this intervention. Future studies with a longer follow-up would be helpful.

We intend to run a impact evaluation, as well as reevaluate the missing data from the classroom observations. This will not change the results of our correlations significantly but will have a better understanding of the difference in measurements of presence of soap as a secondary outcome of the experiment.

References

- [1] Levine, David I., Samuel Raj Srinivas, and Geetha G., “Hygiene Heroes: A cluster randomized trial of a dental curriculum in Tamil Nadu Primary Schools.” Working paper. 2021.
- [2] Biran, Adam, Wolf-Peter Schmidt, Kiruba Sankar Varadharajan, Divya Rajaraman, Raja Kumar, Katie Greenland, Balaji Gopalan, Robert Aunger, and Val Curtis. ”Effect of a behaviour-change intervention on handwashing with soap in India (SuperAmma): a cluster-randomised trial.” *The Lancet Global Health* 2, no. 3 (2014): e145-e154.
- [3] Cialdini, Robert B. *Influence: The psychology of persuasion* . Vol. 55. New York: Collins, 2007.
- [4] Dreibelbis, Robert, Peter J. Winch, Elli Leontsini, Kristyna RS Hulland, Pavani K. Ram, Leanne Unicomb, and Stephen P. Luby. ”The integrated behavioural model for water, sanitation, and hygiene: a systematic review of behavioural models and a framework for designing and evaluating behaviour change interventions in infrastructure-restricted settings.” *BMC public health* 13, no. 1 (2013): 1015.
- [5] Fjeldsoe, Brianna, Maike Neuhaus, Elisabeth Winkler, and Elizabeth Eakin. ”Systematic review of maintenance of behavior change following physical activity and dietary interventions.” *Health Psychology* 30, no. 1 (2011): 99.
- [6] Handwashing Liaison Group. ”Hand washing: a modest measure—with big effects.” *BMJ: British Medical Journal* 318, no. 7185 (1999): 686.
- [7] Heath, Chip, and Dan Heath. *Made to stick: Why some ideas survive and others die*. Random House, 2007.
- [8] Lally, Phillippa, Cornelia HM Van Jaarsveld, Henry WW Potts, and Jane Wardle. ”How are habits formed: Modelling habit formation in the real world.” *European journal of social psychology* 40, no. 6 (2010): 998-1009.
- [9] Kar, Kamal. ”Practical guide to triggering community-led total sanitation (CLTS).” (2005).
- [10] Levine, David I., Samuel Raj Srinivas, and Geetha G., “Hygiene Heroes: A cluster randomized trial of a dental curriculum in Tamil Nadu Primary Schools.” Working paper. 2021.