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Can Leaders Promote Better Health Behavior? Learning from a Sanitation and Hygiene Communication Experiment in Rural Bangladesh

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Abstract

This study looks at the roles that local women leaders can play in addressing the important environmental health issue of sanitation and hand hygiene by improving access to quality sanitation and hygiene practices through information and education campaigns and promotions. Pathogens of fecal origins (coliforms and other bacteria in addition to helminthes) still pose an important public health hazard for poor households in Bangladesh and elsewhere, which impose a significant disease and mortality burden. We devise an experiment where we exogenously vary the leadership capacity of the women leaders and their involvement in the sanitation and hygiene campaigns. We find that, in the treatment areas, households report higher interaction with local women leaders and community women group members compared to the control areas. However, we neither find a reduction in the number of households engaged in the practice of open defecation (which was anyway already very low before the interventions) nor an increase in the number of latrine construction. We further look at objective hand hygiene outcomes as measured by bacteriological counts on the hands of very young children and their primary female caregivers. We find that interactions with the local women leaders have positive impacts on hand hygiene outcomes as suggested by a reduction in the microbial counts of total coliforms, fecal coliforms and E. coli in the hand samples of the young children though not for those from the mothers. We conclude that leadership capacity can be effective in improving sanitation and hygiene outcomes that are mainly behavioral in nature and do not involve substantial financial investment.

JEL Classifications: D12, I12, I15, O12

Keywords

Sanitation and hygiene promotion, Female leadership, Microbial outcomes, Randomized evaluation

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1. Introduction

This study aims to understand whether local political leaders can play effective roles in sanitation and hygiene campaigns and encourage beneficial health behaviors among households in rural Bangladesh through active inter-personal communications. The roles of good governance and effective political institutions in economic growth and development are well recognized in the economic literature (Acemoglu & Robinson, 2013). Despite the complementary roles that different agencies may play in ensuring quality governance, both the design of policies and their implementation will depend on the people who shape them, which only goes to confirm that good governance requires good leaders (Besley, 2007). Even an individual leader can shape the course of a country's prosperity and can influence economic and social policies by his/her control over public goods and services (Jones & Olken, (2005) .

The personal preferences and abilities of leaders can dictate political outcomes since legislative decisions are partly driven by personal motives (see Levitt, 1996). For instance, the gender of leaders can determine the types of public goods mobilized (Chattopadhyay & Duflo, 2004). According to Beaman ***et al***. (2009), exposure to women in leadership positions can reduce negative perceptions regarding the effectiveness of women leaders. However, in developing countries like Bangladesh, women constitute only a small share of governments and legislative bodies.[1] The under-representation of women in leadership positions may arise from gender-based bias against women in leadership positions or the incomplete information that voters have on the suitability or capacity of women in leadership positions. As such, the expected capacity of women leaders can be lower than that for men because of the limited experience of voters with women in leadership positions resulting in "statistical discrimination" (Bertrand & Duflo, forthcoming).

This study explores whether capacity building among female local government members and community women's groups can improve overall leadership in the community and whether such leadership can be effective in promoting and motivating households to invest in improved sanitation and better hygiene practices. Despite vast improvements in access to sanitation over the last few decades, about 2.5 billion people still lack access to improved sanitation (WHO/UNICEF, 2014). Both community awareness and cash incentives have been extensively used to promote such access with mixed results (Clasen ***et al***., 2015). However, the roles of local women political leaders in promoting beneficial investment in health have not been explored extensively in the existing literature.

We use a randomized field experiment that encourages and involves female local political leaders in a sanitation and hygiene campaign in rural Bangladesh. In the process, the intervention also addresses the management capacity of local political leaders and community women groups. We pay special attention to the overall causal pathways between the macro treatment assignments (at the union level) and individual household level outcomes (e.g., sanitation and hygiene communication, sanitation situations, hand hygiene outcomes). We collect detailed data on different outcomes that allow us to estimate different treatment effects of interest (e.g. various immediate, intermediate and final outcomes). We further estimate the impacts of the sanitation and hygiene communications on hand hygiene outcomes in an OLS as well as an IV framework using an endogenous binary treatment assignment

[1] It is all the more paradoxical because, over the last twenty-five years, all elected governments in Bangladesh have been headed by women.

framework with the initial random assignment as an instrumental variable. We pay special attention to objective hand hygiene measurements using microbial counts of pathogens of fecal origin in children aged two and three years as well as primary female caregivers (mostly the mothers). While microbial outcomes are used commonly in the biology and health science literature, it is not commonly used in impact evaluation literature. In the absence of actual health outcomes such as diarrhea prevalence, the presence of bacteria can be an objective surrogate estimate of health outcomes.

We found that capacity building exercises through training and workshops have raised awareness about sanitation and hygiene issues among the local women leaders in comparison with their male peers who are in the same administrative body but have not taken part in the training exercises. This suggests the efficacy of the intervention among the targeted group. The women leaders in the intervention areas are also more involved in their communities delivering knowledge and conducting awareness campaigns and persuading households in their constituencies to adopt better sanitation and hygiene practices. This is further corroborated by independent household surveys.

The household surveys also reveal that interactions between the local political leaders and the households are higher in areas where local leaders have received capacity building training. But we do not find any differences in the building of improved latrines between the households in the treatment and control areas. However, we found latrines in the treatment areas to be generally cleaner and better maintained. We also did not find any significant reduction in open defecation among children in the treatment areas in comparison with those in the control areas. However, households in the treatment areas were less likely to report open defecation by children in the household courtyard suggesting an improvement in the household environment through the behavioral channel. The households in the intervention areas also reported better hygiene behaviors such as use of soap and water to wash hands.

Self-reported hand hygiene status can be unreliable (Pickering *et al*., 2011). Hence, for a subset of households, we collected information on biological pathogens that are indicative of contamination by fecal origins via hand swabs. We found that the hygiene outcomes as measured by microbial counts were significantly better for five of the six types of bacteria for the children in the treatment areas though not for primary female caregivers (e.g., the mothers).

The rest of the paper is organized as follows. In Section 2, we describe the nature of the intervention, empirical models, analysis plan and strategies to identify the impacts of leadership. In Section 3, we describe the basic baseline household characteristics and empirically validate the experiment. In Section 4, we focus on the household outcomes while, in Section 5, we show the impacts on household sanitation and hygiene outcomes. In Section 6, we provide details on the hand hygiene outcomes as measured by microbial counts on common strains. Lastly, in Section 7, we discuss the overall policy implications of our findings.

2. Description of the Intervention

2.1 Background

Diarrhea and other waterborne diseases continue to impose a major burden of disease globally among pre-school children. Every year, about 1.3 million children die from diarrheal diseases (Moore, Lima, & Guerrant, 2011; Prüss-Ustün *et a*l., 2014). Diarrheal diseases can also have long term adverse health impacts on children such as enteric diseases, which can undermine nutritional absorption leading to outcomes such as malnutrition (e.g. stunting and wasting) and even cognitive shortfalls (Guerrant *et al*., 2008). Water, sanitation and hygiene (WaSH for short) have received much attention from policy makers and health professionals as access to clean drinking water, safe toilets and improved hygiene behavior can protect people from exposure to these dangerous pathogens.

Bangladesh has a long tradition of engaging in community-based social development where grass-roots-level organizations, community leaders and other members of the general public have actively participated in the delivery of health, education, safety nets and financial services. However, empirical evidence on the effectiveness of women

political leaders can well be confounded by other factors. Hence, to test whether female political leaders are effective in motivating households within their constituencies to invest in better sanitation and hygiene behavior, we rely on a randomized experiment which aims at empowering local women political leaders through training, knowledge-building and networking with community women groups (CWGs). The information campaign, training and other knowledge-building exercises, along with community empowerment, focused on encouraging the households to improve sanitation and hygiene-related outcomes by investing in improved sanitation and adopting better hygiene practices (e.g. cleaner surroundings and hand-washing).

2.2 Description of the interventions

The main goal of the project was to train the female UP members elected to the three seats reserved for women. However, the common perception of these women leaders, with exceptions, is that they are ineffective (Khan & Ara, 2006; Nazneen & Tasneem, 2010). Hence, the interventions also aimed at increasing the capacity of these women leaders to address the sanitation and hygiene issues in the community. To facilitate the process of interaction between the households and the political leaders in each of the treatment unions, three community women groups (CWGs) were also formed. However, the interventions were "soft" in the sense that the households did not receive any subsidy or financial assistance to set up or upgrade toilets.[2]

Since the women leaders are often marginalized and perceived as incompetent to carry out their political responsibilities in a traditionally male-dominated society, one can expect *ex ante* that an intervention aiming to build capacity among women leaders will enable them to carry out the sanitation and hygiene campaign as well as can lead to behavioral change among the households. Moreover, since sanitation and hygiene issues often fall within the domain of the women of the households, women leaders would be better suited to communicate with mothers and other women caregivers which would bring about beneficial behavioral changes in the context of sanitation and hygiene.

Table 1: Project time line

Period	Activity
March - December, 2011	Project development
March - April, 2012	Household census
July - August, 2012	Baseline household survey
September - December, 2012	First round of promotional campaign, Training of the FLGMs, Formation of CWGs
February - March, 2013	Round 1 survey of local government leaders
April - September 2013	Second round of the promotional campaign, further training of the women leaders
January - February, 2014	Round 2 survey on female LGMs' management capacity
April - May, 2014	Microbial data collection, small household survey
November, 2014	Project completion
March-April, 2015	Endline Survey

Notes: Developed by the author in consultation with the implementing partner

The actual implementation of the project in the targeted unions started in the second half of 2012 (see Table 1). The first phase of implementation was preceded by a household census and a household survey, respectively. We first carried out an orientation program for all the members (including men) of the targeted Union *Parishads*, which was followed by an extensive week-long training for the women leaders of the UPs. The training included educating women leaders about the importance of good water, sanitation and hygiene behavior as well as the different options for promoting better sanitation and hygiene practices in the localities. They were also made aware of local needs

[2] Sanitation promotion interventions usually encompass financial assistance in the form of a subsidy to encourage demand for upgraded latrines by the households. The interventions considered in our study confined themselves to pure communications and campaigns by the local female political leaders. For incentive-based sanitation promotion interventions, see Clasen, et al. (2015) and Guiteras, Levinsohn, & Mobarak (2015).

as well as areas where attention was needed.[3] Technical knowledge regarding communication and promotion of improved sanitation practices and hygiene behavior were also imparted during the training so that the women leaders would become more confident and effective when they carried out the actual promotional activities. The control unions, on the other hand, were not part of any type of intervention and were expected to carry on as usual. There were, however, other sanitation interventions going on concurrently with our interventions. For purposes of our study, we have assumed other interventions to be independent of the programs coming under the purview of our study and that there were no strategic interactions. We have tested some of the implications of this assumption and can largely reject the presence of any such interactions, strategic or otherwise.

We carried out the first survey among both female and male local government members (including the chairmen of the UPs who were all male. In the survey, we deliberately collected two types of information. The first sets of information were collected on time-invariant individual and household characteristics of the UP members (allowing us to infer the validity of the randomization, see Table 2). We also collected information on sanitation- and hygiene-related information in order to understand possible changes in such behavior that one can associate with the capacity and communication skills of the women political leaders.

2.3 Econometric methods

We use a number of different econometric models and empirical techniques to analyze the outcome variables and find a causal relationship between the interventions and outcome variables, namely, sanitation practices and access, the practice of open defecation and hand-washing behavior as well as hand hygiene outcomes as measured by microbial counts of aforementioned bacteria. Since we had set up an experiment initially, we will present the *intent-to-treat* (ITT) estimates of the impact of hand wash promotion on hand washing behavior using the model below.

$$y_i = \alpha + \beta d_i + \Gamma X_i + \varepsilon_i$$

where, y_i is an outcome variable. The d_i is the assignment variable, which takes the value 1 if the household *i* is in the treatment unions and 0 otherwise. We also include other variables (denoted by the vector X). Even though we use a random assignment to identify the impact of promotional activities on hand washing behavior, we include other covariates that allow for more efficient estimation of the impact (Glennerster & Takavarasha, 2013). In most cases, y_i is a binary outcome variable (whether the individual washed her hand with water and soap or not, for example), for which we have used a simple linear probability model in order to estimate the marginal probability of hand washing from the treatment assignment.

We further extended our analysis to understand the impact of the sanitation and hygiene campaign on hand hygiene outcomes as measured by microbial counts for a subset of our sample. We used the same notation (y_i as the outcome variable and d_i as the intervention assignment) to describe an endogenous binary treatment assignment model.[4] We can also assume the local leaders to allocate their time optimally as it may carry a high opportunity cost since none of the women leaders work full time on their political job and may be responsible for taking care of their families as well. Hence, we can expect the local women leaders along with the project volunteers to select households to communicate with during the intervention that they think are more likely to improve their sanitation practices and hygiene behavior although this information is not observable to the researcher. We therefore define a new binary variable (t_i) indicating whether the *i-th* household has received the sanitation and hygiene

[3] The implementing partner assessed the needs with extensive qualitative explorations. Additionally, we carried out an extensive survey in order to understand the current situation of the localities targeted for intervention.

[4] This is similar to the case of "sorting based on gains" where eligibility of a program is varied randomly. However, the actual participation in the program (for e.g., a sanitation and hygiene campaign) may depend on a joint decision of many different agents (for e.g., targeted households and women leaders). See Heckman, Urzua, & Vytlacil (2006) for further discussion on this.

communications from the local political leaders (t_i=1, if yes, t_i=0 otherwise). We can therefore write the decision outcome for a household to receive treatment as

$$t_i = \begin{cases} 1 & if\ '' \gamma d_i + \eta_i > 0 \\ 0 \end{cases}$$

while the outcome (for e.g., the microbial counts for the hand samples) is given by

$$y_i = \beta t_i + \Gamma X_i + \varepsilon_i$$

The error terms (η_i and ε_i) are mean zero with a covariance matrix:

$$\begin{bmatrix} \sigma^2 & \sigma p \\ \sigma p & 1 \end{bmatrix}$$

The orthogonality between the treatment assignment (d_i) and the error terms (*i.e.*, $d_i \perp \eta_i, \varepsilon_i$) allows us to identify the impact of the sanitation and hygiene communication on different outcomes of interest.

In other words, we consider the actual receipt of the campaign (as defined by self-reported interactions between households and women leaders) as an endogenous treatment outcome and use the random assignment as an instrument for this outcome, which by construction is exogenous and independent of both potential outcomes and delivery of the message. We can therefore use this framework to identify the exact impact of the campaign beyond the random assignment of the training at the union level (see Wooldridge, 2002).

3. Baseline Characteristics and Validity of the Experiment

3.1 Baseline survey

We determined the sample size in order to ensure that the minimum detectable impact was at least 10 percentage points (see Duflo, Glennerster, & Kremer, 2007). Since the intervention is at the union, not the individual, level, it was also important to consider within union (intra-cluster) correlations.[5] For the baseline survey, we drew a random sample of 35 households from the census. In cases where a household was not found in the field, it was replaced with another household randomly chosen from the census data. The research team collected data for 2,287 households (1,167 in Comilla and 1,120 in Dinajpur).[6] This allowed us to have about 36 households per union on avearge. Extra households were included in the baseline survey in case there was attrition in between the baseline and follow-up surveys.[7]

3.2 Outcome variables

We can categorize the outcome variables into three distinct categories. Since the project actively engaged different change agents (female UP members, community women groups and project volunteers), we looked at their interactions with households within their catchment areas. We asked both the female members as well as the households whether any interactions took place between these local leaders (the change agents) and the households and also whether these interactions entailed any communications having to do with sanitation and

[5] We used different intra-cluster correlations (ICCs) as robustness checks. We took advantage of different prior studies, namely, Demographic and Health Surveys and Household Income and Expenditure Surveys to determine how sensitive the sample sizes were to different ICCs. We found 0.2 to be a reasonable upper bound from these prior studies. However, we measured the ICC for our sample ex post facto at a level of about 0.07, which is well within the ranges we tested. This should also allow us to estimate and identify impacts that are smaller than what we used to justify the study design.

[6] For the baseline survey, the research team appointed more experienced enumerators and trained them more extensively. In cases where an enumerator did not perform up to the mark, he was replaced immediately to ensure quality data collection.

[7] We checked for attrition by predicting whether a household was missing based on baseline household characteristics. We did not find any systematic association with such attrition.

hygiene issues and how to address them. So the first categories of outcomes that we were interested in involved the capacity and communication skill of the change agents (with the households).

Secondly, we focused on self-reported sanitation and hygiene behaviors of the households along with spot checks and visual inspections of the latrine infrastructure of the households by trained enumerators. We looked at both the physical infrastructure of the latrines (the hardware) as well as the cleanliness of the latrines. We also collected information on sanitation behavior (using latrines, open-defecation, etc.) as well as information on the availability of water and soap for hand washing.

Lastly, we collected information on self-reported hand washing while also applying a more objective measure of hand hygiene status for a subset of households. The self-reporting included whether household members usually washed their hands at critical moments (such as before eating or feeding and after using the latrine). We complemented these self-reported hand hygiene practices with an enumeration of microbial counts on the hands of very young children (between one and two years old) and their primary female caregivers (who were almost always their mothers). We focused on microbes that were commonly associated with fecal origination.

Table 2: Household characteristics by treatment status of the unions

	Unions		
	Treatment	**Control**	**p-value**
Number of rooms	3.08	3.02	= 0.351
Walls			
Brick/cement	19.6%	12.6%	< 0.000
Tin/wood	40.6%	49.4%	< 0.000
Mud	27.7%	24.0%	= 0.044
Bamboo	12.2%	13.9%	= 0.205
Roof(s)			
Brick/cement	3.8%	1.6%	= 0.001
Tin/wood	92.5%	95.4%	= 0.003
Mud	0.2%	0.4%	= 0.254
Bamboo	3.5%	2.5%	= 0.184
% HHs with separate kitchen	86.8%	87.4%	= 0.680
% HHs connected to the power grid	48.0%	44.1%	= 0.061
% with solar power	3.3%	6.2%	= 0.001
HH distance in km to the nearest road	80.4%	85.0%	= 0.259
Total cultivated land in decimal	68.4	59.0	= 0.119

Source: Baseline household survey, author's calculations

3.3 Baseline household characteristics and balance check

Though there are some differences in characteristics among the sample households, it is difficult to discern whether they are systematic or not. But there is no difference in the number of rooms per household between households from the control and treatment areas (see Table 2) although houses in the treatment unions are better structured (with 20 percent of households having brick/cement walls) than those in the control unions (at 13 percent). These differences extend to roof structure as well. However, there is no statistical difference with regard to the availability of separate kitchens for households while the difference with regard to the percentage of households connected to the power grid is only significant at the 10 percent level. There is also no difference between households in the control and treatment unions with regard to the households' total cultivated land or distance to the nearest road.

Table 3: Characteristics of the household heads by treatment status of the unions

	Unions		
	Treatment	Control	p-value
= 1 if Male	95.4%	95.6%	= 0.773
Age in years	45.0	44.7	= 0.642
Primary occupation			
Day-labor	22.5%	25.5%	= 0.099
Farmer	26.8%	24.3%	= 0.161
Non-agri worker	14.6%	15.6%	= 0.504
Business	12.6%	12.9%	= 0.832
Service	10.1%	7.3%	= 0.015
Not working	7.5%	7.1%	= 0.701
Other	5.9%	7.4%	= 0.127
= 1 if currently married	93.0%	94.0%	= 0.316
Education			
No schooling	40.5%	44.4%	= 0.058
Below primary	9.1%	8.5%	= 0.614
Primary or more	29.2%	29.2%	= 0.979
SSC or more	12.1%	10.3%	= 0.190
HSC or more	9.2%	7.5%	= 0.155
= 1 if MFI member	7.1%	7.2%	= 0.921
= 1 if migrant	16.2%	14.7%	= 0.311

Source: Baseline household survey, authors' calculations

Table 3 reports the different socio-economic characteristics of the heads of households from the control and treatment unions. The results again suggest that there is no systematic difference between the two groups. Most households are headed by men (about 95 percent in the control and treatment unions) and the average age of household heads is roughly 45 years. The primary occupations of household heads are as day laborers or farmers and there is no difference, with regard to occupation, between heads of the households from the control and treatment unions. Almost 93-94 percent of household heads are married while the level of education is quite low with only 18-21 percent of household heads having more than 10 years of schooling. We found microfinance membership among household heads to be quite low (about 7 percent) with roughly 15 percent of household heads working as migrant labor (with no statistical difference again between the two groups). We also estimated a model to predict the treatment assignment based on household characteristics though we do not report it here. The overall fit of the model suggests rejection at a reasonable level of confidence based on the F-test. We therefore conclude that randomization has worked fairly well and that there is no systemic difference between households from the control and treatment unions.[8]

[8] Since unions are the units of intervention, we further checked the balance by comparing union level factors between the same treatment and control unions from the population census data collected in 2010 (i.e., about three years before the interventions). We did not find any systematic differences between the unions in the control and treatment groups. We also collected information on the female political leaders. Their characteristics also did not show systematic variation between the control and treatment unions.

4. Impacts on WaSH Communication, Sanitation and Hygiene Outcomes

4.1 Impacts on sanitation and hygiene related communications

We commence the analysis by first looking into whether the "change agents" (the female local political leaders of the union *parishads*, the members from the community women groups and the project volunteers) involved in the project had any communications with the households. The interventions would only work if and only if the women leaders and community women groups (along with the volunteers) interacted with the households. Hence, this is a necessary element in the casual link between the interventions and the end outcomes. We systemically analyze this using both the endline household survey data and a detailed survey of the local women leaders.

Households from the treatment unions interviewed for the end-line survey reported significantly higher visits from all three types of "change agents" or local leaders mobilized under the project. It should be noted that because of the random assignment, we did not select the relevant individuals in the control unions as change agents to carry out the sanitation and hygiene campaigns.

Table 4: Impacts on communications between local leaders and households

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Communications between the community leaders and the sampled households					
	Did the household receive any communications from…			**The number of communications household received from…**		
	Female LG leader(s)?	**Community women group(s)?**	**Community volunteer(s)?**	**Female LG leader(s)?**	**Community women group(s)?**	**Community volunteer(s)?**
Control mean	0.017	0.024	0.025	0.03	0.064	0.104
Treatment	0.434***	0.610***	0.597***	0.823***	1.930***	2.876***
	0.000	0.000	0.000	0.000	0.000	0.000
Observations	2,198	2,198	2,198	2,198	2,198	2,198
R-squared	0.28	0.429	0.411	0.201	0.271	0.288
	Panel B: Sanitation and hygiene communications reported by the sampled households					
	Households receiving FLGM messages related to…		**Households receiving FLGM from community women groups' messages related to…**		**Households receiving FLGM from community volunteers' messages related to…**	
	Sanitation	**Hygiene**	**Sanitation**	**Hygiene**	**Sanitation**	**Hygiene**
Control mean	0.010	0.009	0.023	0.018	0.024	0.015
Treatment	0.287***	0.195***	0.524***	0.432***	0.565***	0.474***
	0.000	0.000	0.000	0.000	0.000	0.000
Observations	2,198	2,198	2,198	2,198	2,198	2,198
R-squared	0.169	0.113	0.341	0.267	0.377	0.301

Notes: Author's calculations using household survey data. Change agents included local women political leaders, the cluster women groups, and project volunteers. In all specifications, the standard errors are corrected at the cluster levels. p-values are reported in the parentheses. The following baseline control variables were included in all specifications: HH having a separate kitchen, connected to power grid, access to solar power, distance in km to the nearest road, total cultivated land in decimal, gender, age, education, MFI membership, migrant, incidence of diarrheal disease over last two weeks, latrine types, source of drinking water, water treatment, waste disposal and access to a drainage system. * denotes significance at 10 percent, ** at 5 percent, and *** at 1 percent.

However, interviews with households in the treatment and control areas on the number of actual visits help us to understand the right counterfactual for the interventions. About 45.4 percent of the surveyed households from the treatment unions reported a visit from a female local government member within the last one year in comparison with only 1.7 percent of households in the control unions. This difference is statistically significant with a p-value < 0.01. The impacts on communications between community women groups and project volunteers are even larger in magnitude between the control and treatment unions (see Panel A in Table 4).

We then look at the number of household visits by all three *change agents* over the last year from the date of the survey as reported by the respondents. The differences with regard to reports of such visits between the treatment and control union households are larger for the community women groups and project volunteers. On average, households from the treatment unions reported one visit from the female local government members (such visits almost nonexistent for households in the control unions with less than two percent reporting any such communications). In the case of community women group members, the households from the treatment unions reported two visits within the last one year while project volunteers had made three visits over the last one year according to them (see Panel A in Table 4).

Table 5: Communications with different agencies as reported by the households

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Govt. field health officer	**BRAC**	**EPRC**	**WaterAid**	**World Vision**	**Heed Bangladesh**	**UP male member**	**UP chairman**
Control mean	0.044	0.173	0.024	0.003	0.050	0.003	0.005	0.000
Treatment effects	-0.003	0.076***	0.436***	0.019***	-0.010	-0.002	0.006	0.004**
	(0.760)	(0.000)	(0.000)	(0.000)	(0.239)	(0.360)	(0.118)	(0.046)
Observations	2,198	2,198	2,198	2,198	2,198	2,198	2,198	2,198
R-squared	0.023	0.032	0.265	0.030	0.032	0.008	0.014	0.008

Notes: All estimates are from endline household survey data. Households report whether they have received any communications from the specific individuals or organizations. All the variables are binary in nature. Means for the control groups are presented along with the OLS-ITT estimates for the outcome variables. In all specifications standard errors are corrected at the cluster levels. p-values are reported in the parentheses. The following baseline control variables were included in all specifications: HH having a separate kitchen, connected to power grid, access to solar power, distance in km to the nearest road, total cultivated land in decimal, gender, age, education, MFI membership, migrant, incidence of diarrheal disease over last two weeks, latrine types, source of drinking water, water treatment, waste disposal and access to a drainage system. * denotes significance at 10 percent, ** at 5 percent, and *** at 1 percent.

We also look at sanitation and hygiene-related communications between the change agents and households (see Panel B in Table 4). In general, such communications were almost non-existent in the control unions (less than two percent of the households reported receiving sanitation and hygiene-related information from any of the change agents). On the other hand, households in the treatment unions reported a much higher incidence of such communications (i.e., receiving sanitation and hygiene-related information from at least one of the three change agents).

We also look at communications between the households and the different agencies addressing sanitation and hygiene issues in rural Bangladesh (see Table 5). The households report much higher rates of communication with the implementing partner when compared with other agencies. In comparison, only 2.4 percent of households in the control areas could mention the name of the implementing partners with a treatment effect of about 43.6 percent (p-value < 0.01). We do not find any such treatment effects for other NGOs, government health officers, or male members from the local government bodies except for BRAC (see Table 5). It is possible that with the overall promotion campaign, households in the treatment unions were more sensitive to sanitation and hygiene interventions in general and report a higher incidence of NGO activities.

Table 6: Reported practices of open defecation by different household members

	(1)	(2)	(3)
	Children below 10	**Adult female**	**Adult male**
Control means	**0.134**	**0.129**	**0.134**
Treatment effects	**0.000**	**0.026**	**0.026**
	(0.985)	**(0.279)**	**(0.272)**
Observations	**2,198**	**2,198**	**2,198**
R-squared	**0.096**	**0.200**	**0.196**

Notes: All estimates are from endline household survey data. Means for the control groups are presented along with the OLS-ITT estimates for the outcome variables. All the variables are binary in nature. In all specifications standard errors are corrected at the cluster levels. p-values are reported in the parentheses. The following baseline control variables were included in all specifications: HH having a separate kitchen, connected to power grid, access to solar power, distance in km to the nearest road, total cultivated land in decimal, gender, age, education, MFI membership, migrant, incidence of diarrheal disease over last two weeks, latrine types, source of drinking water, water treatment, waste disposal and access to a drainage system.

4.2 Impacts on the capacity of the women leaders

While we already have some evidence on the higher interactions and communications between the households and local women leaders, it is worth looking at the impacts on the actual capacity building of local leaders or change agents. This will allow us to understand both the scope and the limitations of the promotion program.

To have a better understanding of capacity building, we borrow a number of measurement techniques from the recent "organization economics" literature that conceptualize the management capacity and leadership ability of individuals (see Rasul & Rogger, 2016 for such measurement in the context of civil servants).[9] We look at a number of outcomes, namely, knowledge building, perception of the sanitation and hygiene problem and possible solutions, and evidence of actual participation in the institutional set up to solve the problem.

The knowledge scores for the female (and male) political leaders regarding sanitation and hygiene problems were constructed based on five questions that were asked of all the local political leaders separately. The five questions were as follows: (a) Mention a valid water-borne disease (WBD); (b) Mention valid prevention(s) of WBD; (c) Mention any problems with not using a sanitary latrine (SL); (d) Mention any problems with eating with unwashed hands; and (e) Mention valid problem(s) with children's open defecation in the yard. Each right answer was scored one so that each respondent could score a maximum of five points. This score was then analyzed to understand whether the interventions had had any impact on the sanitation- and hygiene-related knowledge of the respondents.

We find women leaders in the treatment unions able to answer about 3.7 questions right while their counterparts from the control unions got only 3.1 questions right (p-value < 0.01). This basically means that the training activities have enabled the local women leaders from the treatment unions to answer one more question right on average.

[9] This literature in turn depends on a burgeoning literature that focuses on the measurement of management capacity in the context of private sector firms. Bloom & Van Reenen (2007) have done some path-breaking work in this area which has since then been adopted in the context of small and informal firms in developing countries (see McKenzie & Woodruff, 2015). In 2016, Rasul & Rogger extended the scope of the focus to assess the producvity of civil servants in the Nigerian bureacracy. The present work is probably the first of its kind to apply the same measurement techniques to estimate the efficacy of political leaders in promoting and motivating the adoption of sanitation and hygiene practices.

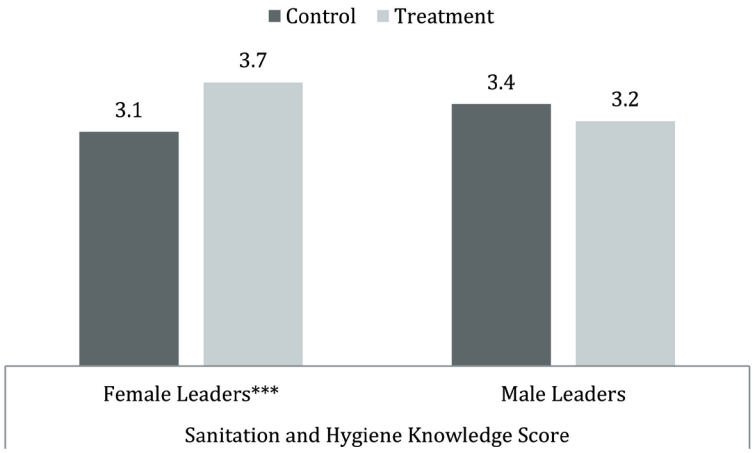

Figure 1: Impacts of the intervention on sanitation and hygiene knowledge of the local political leaders

Notes: Author's calculations from the local political leader surveys. The knowledge score is calculated using five different sanitation- and hygiene-related questions. See Appendix I for further explanations. The range for the possible score is between 0 and 5. Female leaders included those women members in the reserved seats in the union *parishads*. The male leaders included both the chairman of the union *parishad* and two other members.

Interestingly, the same set of questions to the male counterparts of the women leaders from the same union *parishads* (the chairman and two other male leaders) did not yield any difference in the number of correct answers between the two types of unions (3.4 in the control unions as opposed to 3.2 in the treatment unions, a difference which is statistically insignificant). This difference is to be expected because the male leaders had not received any training (as part of the intervention). This suggests that there is no cross learning (knowledge spill-over) between members of the same political organization.

We also find that the women leaders are also more likely to recognize sanitation and hygiene as a problem within their communities. For example, while roughly 30 percent of the leaders in the control areas recognized sanitation

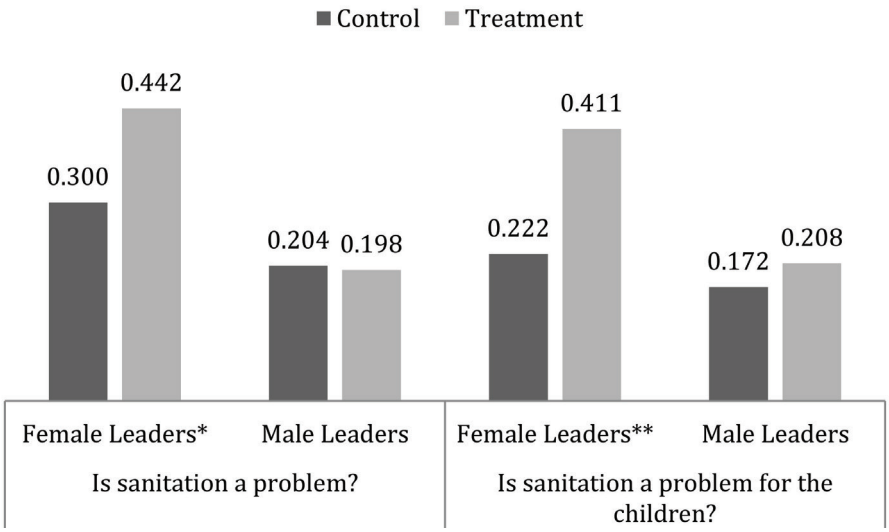

Figure 2: Impacts on the assessments of sanitation and hygiene as a problem

Notes: Author's calculations from the local political leader surveys. Female leaders included those women members in the reserved seats at the union *parishads*. The male leaders included both the chairman of the union *parishad* and two other members.

and hygiene as generally a problem, 44 percent of the female local leaders from the treatment areas recognized sanitation (and hygiene) as a problem in the communities (a 14 percentage point difference which is significant with a p-value < 0.1, see Figure 2). We further asked whether the leaders thought sanitation and hygiene to pose problems for children. We again find that more women leaders in the treatment unions (41 percent) see sanitation as a problem for children as opposed to women leaders from the control unions (at 22 percent, which is a 19 percentage point difference significant with a p-value < 0.05). In the case of male leaders, we do not find any difference for either of the two questions.

Interestingly, while we find the training (which was part of the sanitation and hygiene promotion program) to have some discernible impacts (on the knowledge and perception of both male and female UP leaders on the sanitation and hygiene issues), it does not have any positive impacts on participation by women leaders in the treatment unions in the actual political process in comparison with their counterparts from the control unions (see Figure 3). We do not find any evidence that the interventions have led to higher levels of engagement in different leadership activities (e.g., attending meetings of the UP or standing committees of the wards). This suggests that while interventions can lead to better knowledge about sanitation and hygiene as well as recognition of the existence of certain issues (for e.g., sanitation and hygiene as public health concerns), it is difficult to encourage women leaders to take the leadership in political activities and processes.

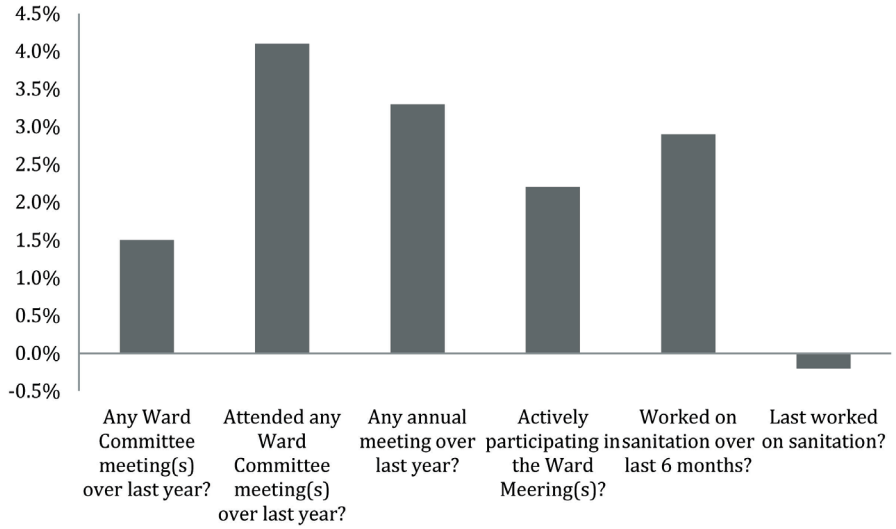

Figure 3: Difference in activities of the female political leaders in control and treatment unions

Notes: Author's calculations from the local political leader surveys. Female leaders included those women members in the reserved seats in the union *parishads*. This figure shows the differences in political participations by the local women leaders between the treatment and control unions. None of these results is statistically significant at the 10 percent level of confidence.

5. Impacts on Sanitation and Hygiene Outcomes from the Endline Survey

5.1 Impacts on the practice of open defecation

We first look at self-reported outcomes of open defecation practices by household members. Tables 7 and 8 present the results from the end-line survey. We also compare these results with those in Table 3 in order to arrive at a more complete analysis of the potential impacts of open defecation. It should be noted that for both the treatment and control groups, there was a reduction in open defecation between the baseline and end-line surveys (with a gap of about two years, see Table 1). We show the relative trends in Figure 4.

As evident from Figure 4, there is a declining trend common to households in both the control and treatment groups. After the intervention, about 11.7 percent of households reported having no access to a latrine in the control unions while roughly 13 percent households reported having no access to a latrine in the treatment unions.

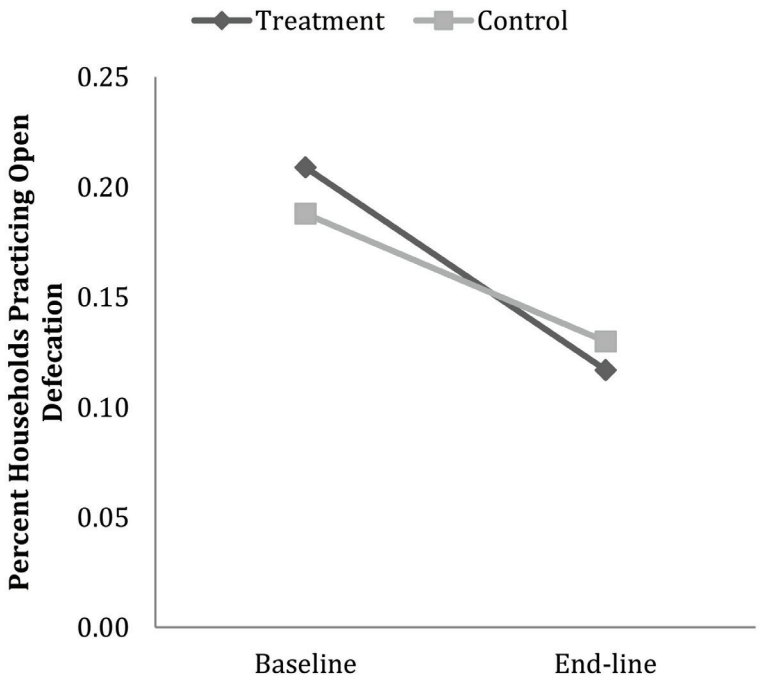

Figure 4: Trends in open defecation for control and treatment groups

Notes: Author's calculations from baseline and end-line household surveys. We carried out the baseline survey in July and August, 2012 and the end-line survey in March and April in 2015. The overall decline was statistically significant. But the difference between the treatment and control unions was not statistically significant. Also see Tables 4 and 5.

Thus we do not find any statistical differences in access to latrines between the treatment and control unions. Moreover, if we look at the actual practice of open defecation for different household members, we do not find any differences between household members of the two comparison groups (see Table 6). For example, 13.4 percent of children from households in the control unions report the practice of open defecation with no difference between the control and the treatment unions (p-value = 0.985). We also find open defecation rates of similar magnitude for adult males and females in the control unions with no statistically significant difference between the two groups (see columns (2) and (3) in Table 7).

5.2 Impacts on toilet infrastructure

We looked at access to improved sanitation facilities by examining the different structural components of an improved latrine. We present the results in Panel A of Table 7. The findings are based on observations by the enumerators (who engaged in inspections after receiving permission from respondents to do so). Access to latrines is very high overall in the study areas though it was 2.3 percentage points lower in the treatment areas, which is not statistically significant. All latrines in the control and treatment areas have ring slabs. The latrines in roughly 75.3 percent of households in the control unions and 72.3 percent of households in the treatment unions have pits, either single or double (the difference between the treatment and control households not being statistically significant). Lids are not a common feature of latrines in the area with only three percent of latrines having such a feature with no difference between households in the control and treatment unions.

We find evidence of some improvement in terms of water seals. We find latrines in the treatment unions to have more unbroken water seals, with 61.2 percent of latrines having unbroken water seals with a treatment effect of 9.2 percent (a difference which is significant at 10 percent only). About 36.6 percent of toilets had unbroken vents with a difference of roughly 5.6 percentage points for the treatment unions (p-value = 0.18). Interestingly, we find a negative treatment effect of about 3.5 percentage points for toilets with septic tanks, which is statistically significant at only the 10 percent level. However, alternate specifications show that this result is not very robust. Overall, we find a very weak impact on latrine infrastructure because of the interventions.

Table 7: Impacts on access to improved latrine

	Control means	Treatment effects	p-value
PANEL A: IMPACTS ON ACCESS TO IMPROVED LATRINE			
Access to a latrine	0.883	-0.023	0.358
Latrine component			
Ring slab	1.000	0.000	.
Pit	0.753	-0.030	0.488
Lid	0.033	0.006	0.751
Water-seal unbroken	0.612	0.092*	0.070
Vent unbroken	0.366	0.056	0.180
Septic tank	0.162	-0.035*	0.093
Compost	0.005	-0.002	0.600
PANEL B: IMPACTS ON CLEANLINESS OF THE LATRINES			
Absence of			
Flies/mosquitoes	0.545	0.148***	0.006
Possibility of fecal matter for human contact	0.822	0.035	0.393
Bad odor	0.586	0.133**	0.011
Possibility of leakages	0.808	0.060**	0.043
Visible fecal matter	0.729	0.050	0.187
Fecal matter not confined to pit	0.869	0.030	0.261
Water logging around the latrine	0.874	0.030	0.298
Fecal matter in the yard	0.973	-0.018	0.438
Overall cleanliness score (out of 8)	6.204	0.468**	0.044

Notes: All estimates are from endline household survey data. Means for control groups are presented along with the OLS-ITT estimates for the outcome variables. Both the latrine status and cleanliness were assessed by the enumerators through visual inspections. In all specifications standard errors are corrected at the cluster levels. p-values are reported in the parentheses. The following baseline control variables were included in all specifications: HH having a separate kitchen, connected to power grid, access to solar power, distance in km to the nearest road, total cultivated land in decimal, gender, age, education, MFI membership, migrant, incidence of diarrheal disease over last two weeks, latrine types, source of drinking water, water treatment, waste disposal and access to a drainage system.

5.3 Impacts on cleanliness of the latrines

Interestingly, we find some discernible improvements in terms of the cleanliness of the latrines. We look at different cleanliness aspects of the latrines that household members use (see Panel B in Table 7, which is based on the observations of enumerators).

We find fewer flies and mosquitoes in latrines of the treatment unions. In the control unions, roughly 54.5 percent of latrines show absence of these vectors with a treatment effect of 14.8 percentage points (p-value < 0.01). Most of the latrines, in general, were found to be free of visible fecal matter though we do not find any treatment effects for this set of variables. The enumerators also found the sampled latrines in the treatment unions to be freer from bad odors and the possibility of leakages and water around the sanitation structure. We therefore construct a cleanliness score (by adding all the binary outcomes together), which show latrines in the treatment unions to fare better (with a score of roughly 6.2 in the control unions with a treatment effect of roughly 0.47, p-value = 0.044). We can conclude thereby that communications had a positive impact on the cleanliness of household sanitation facilities.

Table 8: Self-reported hand washing practices of the respondents for different critical times

	Handwashing Practices Reported by the Respondents		
	Last visit to toilet	**Generally after defecation**	**Generally before eating/ feeding**
Control mean	0.547	0.771	0.532
Treatment	0.137***	0.118***	0.189***
	(0.000)	(0.000)	(0.000)
Observations	2,198	2,198	2,198
R-squared	0.044	0.062	0.064

Notes: All estimates are from endline household survey data. Means for the control groups are presented along with the OLS-ITT estimates for the outcome variables. Both the latrine status and cleanliness were assessed by the enumerators through visual inspections. In all specifications standard errors are corrected at the cluster levels. p-values are reported in the parentheses. The following baseline control variables were included in all specifications: HH having a separate kitchen, connected to power grid, access to solar power, distance in km to the nearest road, total cultivated land in decimal, gender, age, education, MFI membership, migrant, incidence of diarrheal disease over last two weeks, latrine types, source of drinking water, water treatment, waste disposal and access to a drainage system.

5.4 Impacts on self-reported hand hygiene

We now turn our attentions to self-reported hand hygiene outcomes. We first look at hand washing practices by the respondents during different critical times. Table 8 presents the results which report whether the respondent washed their hands with soap and water for each of the critical times.

The respondents in the treatment unions do better for all the practices observed, the differences presented in Table 9 being statistically significant. For example, 69 percent of the respondents in the treatment unions reported washing their hands with soap and water on the last occasion they washed their hands in contrast with 55 percent in the control unions. As for washing hands on the last occasion they used the latrine, 89 percent of the respondents in the treatment unions reported washing their hands with soap and water as opposed to 77 percent in the control unions. Similarly, 73 percent of respondents from the treatment unions reported washing their hands with soap after eating or feeding while only 53 percent reported such practices in the control unions. Together with the results presented in the previous sub-sections, we can therefore conclude that the sanitation and hygiene campaign had some measurable impacts on the sanitation and hygiene outcomes that require behavioral changes (for example, hand washing or keeping the latrine clean). However, we do not find any impacts of the campaign on the construction of new latrines or a reduction in open defection by household members.

6. Impact of WaSH Communications on the Hand Hygiene Outcome

6.1 Microbial counts as an objective hand hygiene measurement

To directly estimate the impacts on hand hygiene outcomes, we measure bacteriological counts for the common microbes that are associated with fecal pathogens, namely, total coliforms, fecal coliforms and E. coli counts. Additionally, we also enumerate total microbial counts, i.e., *Salmonella* and some *Shigella* spp. and *Staphylococcus*. For this purpose, we collected swabs from the dominant hands of the targeted subjects from the treatment and control areas and enumerated the microbial counts.

Hand hygiene behavior is justifiably considered difficult to measure. Thus, the presence of bacteria on hand (say, measured by the total number of colony-forming units or CFUs) can serve as a good proxy for hand washing (Pickering *et al*., 2010). Further, the hands of small children and their primary caregivers can serve as an important carrier for environmental pathogens of a fecal nature. Hence, a lower presence of bacteria on the hands of small children and their mothers (and other female caregivers) can be a critical factor in lowering diarrheal and other enteric diseases (Nizame *et al*., 2013).

6.2 Sample collection and measurement protocol

We collected samples from the subjects' hands using sterilized cotton swabs wet with the NaCl solution. Trained enumerators rubbed the sterilized swabs all over the dominant hands of the subjects (which, in Bangladesh, are almost always the right hand because of cultural aversion to the use of the left hand for eating and feeding) and preserved the swabs in individual containers with appropriate codes for each individual.[10] The enumerators were deliberately kept blind about the interventions so that they had no knowledge about the treatment assignments of the households that they visited. The containers were then transported to the microbiology laboratory at the University of Dhaka where they were stored and processed for culture in the appropriate media or agars for each bacteriological agent.

Our analyses primarily focus on the total coliforms, fecal coliforms and *E. coli*. It is common to use coliform bacteria as indicators of sanitation and the hygienic quality of food and water (Samakupa, Einarsson, & Eypórsdóttir, 2003). Additionally, we also look at the total bacteriological counts, i.e., *Salmonella* and some *Shigella* spp. and *Staphylococcus*. Since hands are a major vector interface in fecal-oral contamination, it is natural to use the presence of coliform bacteria as an indicator of the overall hygiene quality of households (Pickering ***et al***., 2011). Coliform bacteria can also be present in different types of environments and are always common in the feces of warm-blood vertebras. Hence, they are associated with the presence of fecal matter and pathogens though coliform bacteria can be present naturally in the environment, exposing household members to such pathogens.

Table 9: Intent-to-treat estimates for hand hygiene outcomes as measured by microbial counts

VARIABLES	(1) Total bacteriological count	(2) Total coliforms	(3) Fecal coliforms	(4) *E. coli*	(5) *Salmonella/ Shigella*	(6) *Streptococcus*
PANEL A: SAMPLES FROM HANDS OF THE PRIMARY FEMALE CAREGIVERS						
Mean for the control group	2.901	1.868	0.786	1.306	1.548	0.056
Treatment assignment	-0.487	-0.147	0.145	-0.115	-0.016	-0.021
	(0.400)	(0.305)	(0.192)	(0.243)	(0.273)	(0.049)
PANEL B: SAMPLES FROM HANDS OF THE CHILDREN						
Mean for the control group	2.737	1.903	0.866	1.607	1.855	0.129
Treatment assignment	-1.024***	-0.646**	-0.312*	-0.547**	-0.710***	-0.109
	(0.335)	(0.273)	(0.167)	(0.255)	(0.258)	(0.094)

*** p<0.01, ** p<0.05, * p<0.1. Total microbial enumerated after about 24 hours of culture in appropriate assays. The counts are expressed in log10 million colony forming units (CFUs).

[10] The focus only on the right hand was motivated by a number of reasons. Firstly, the main objective of the study was to understand the impact of the "leadership" intervention on the pathways of fecal-oral transmission. Since our sample size is not large enough to estimate the health outcomes, focusing on hand-hygiene was the next best thing for this purpose. Secondly, because of cultural reasons, children are discouraged from using their left hand for eating and feeding from a very early age. Thus, in addition to the funding constraint, the focus on the hygiene status of the right hands of study subjects was the result of a conscious decision.

6.3 Intent-to-Treat estimates of the program assignments

We do not find any discernible impacts of lower bacteriological counts for any of the microbes on the hands of the mothers that could causally be associated with the program. The baseline means for the control groups (see Panel A in Table 9) suggest that there is a substantial presence of bacteria, usually associated with fecal origins, on the hands of the primary female caregivers. For example, ignoring column 1 in Table 9, we find that the total coliforms were roughly 1.87 $\log_{10}$ million CFUs for the primary female caregivers' hands while it was 0.15 $\log_{10}$ million CFUs lower in the treatment areas compared to the control areas. However, this difference is not statistically significant (p-value = 0.631). We do not find any statistically significant differences in the hand samples from the control and treatment areas with regard to bacteriological counts for the other microbes even though, evidently, there are substantial levels of microbes in the hand samples as evident from the control means.

We find substantial improvements in the hand hygiene outcomes for children in the treatment areas compared to those in the control unions for all the microbes except for the *Staphylococcus* strain (see Panel B in Table 9). For example, we find that, for the total bacteriological counts, the mean count is 2.74 $\log_{10}$ million CFUs per hand in the samples collected from children in the control areas. However, the mean count is 1.02 $\log_{10}$ million CFUs lower for the hand samples collected from the children in the treatment unions compared to those in the control unions. With a p-value of 0.002, we can infer that the lower counts are causally associated with the interventions. We find similar patterns for all the other microbial counts (again except for *Staphylococcus*). For the total coliforms, the impact is about 0.65 lower $\log_{10}$ million CFUs per hand with a p-value of 0.019 and, for total fecal coliforms, the impact is 0.31 $\log_{10}$ million CFUs per hand (p-value = 0.064 signifying a difference that is significant at the 10 percent level of confidence). The average treatment effect on the presence of *E. coli* is about 0.55 $\log_{10}$ million CFUs per hand (p-value = 0.033). We further find a similar negative impact for *Salmonella* and some *Shigella* spp. of 0.71 $\log_{10}$ million CFUs per hand (p-value = 0.006). We do not find any significant impact for *Staphylococcus* (with a difference of 0.11 $\log_{10}$ million CFUs per hand with a p-value = 0.244). Therefore, we find statistically significant differences for five of the six measures for bacteriological counts for different microbes, the expected negative signs of which can be causally associated with sanitation and hygiene promotions.

6.4 OLS and LATE estimates of the sanitation and hygiene communications

Next, we go beyond focusing on the impacts of the treatment assignment to understand the impacts of actual sanitation and hygiene communications on the hand hygiene outcomes. Since we find robust impacts on children's hand hygiene outcomes, we present here the results for the children only.[11] We consider the sanitation and hygiene communications (resulting from participation in the leadership capacity building program through a random assignment) as an *endogenous binary treatment variable* and take this into consideration, as discussed before, to estimate the average treatment effect. We find that OLS results underestimate the impacts of the sanitation and hygiene communications. This is consistent with the impact of sorting by local women leaders, while carrying out the sanitation and hygiene promotion, on possible gains, something that is not observable by the researchers (see Heckman, Urzua, & Vytlacil, 2006).

We find that the OLS results for WaSH communications on microbial outcomes are not very strong and often imprecise (see Table 10). In the first row of Table 10, we reproduce the mean values for different hand hygiene outcomes as measured by microbial counts from Table 9. While the OLS estimates are always negative, we find them statistically significant for only two cases (total microbial count in columnn 1 and *E. coli* in column 4). We do not find any negative impact for the *Streptococcus*, which is consistent with the previous intent-to-treat results.

The first stage results basically support the validity of the random assignment as an instrument for sanitation and hygiene promotion. We have already found support for increase in activities by local women leaders to promote sanitation and hygiene practices. Here, for the smaller sample of households for which we have the hand samples,

[11] Since the reduced form estimates for the effects are imprecise for the hand hygiene outcomes for mothers, we restrict ourselves to children's hand hygiene outcomes. The instrumental variable framework that we intend to use can actually accentuate the bias in such frameworks and our results support this. We omit the results here to ensure brevity of the paper. See Angrist (2006).

we find a significant positive relationship with the treatment assignement at the union levels and higher promotional activities including communications between the women leaders (and other change agents) and the households.

Table 10: Effects of sanitation and hygiene communications on children's hand hygiene outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Total bacteriological count	Total coliforms	Fecal coliforms	*E. coli*	*Salmonella/ Shigella*	*Streptococcus*
Mean for the control group	2.737	1.903	0.866	1.607	1.855	0.129
OLS	-0.712*	-0.517	-0.266	-0.563*	-0.515	0.001
	(0.080)	(0.117)	(0.165)	(0.094)	(0.121)	(0.993)
First stage	0.447**	0.426**	0.398*	0.418**	0.442**	0.383*
	(0.031)	(0.041)	(0.071)	(0.047)	(0.036)	(0.084)
LATE	-2.520***	-1.832**	-0.854*	-1.697**	-1.852**	-0.133
	(0.004)	(0.017)	(0.060)	(0.035)	(0.016)	(0.554)
Observations	247	247	247	247	247	247

*** p<0.01, ** p<0.05, * p<0.1. Total microbial enumerated after about 24 hours of culture in appropriate assays. The counts are expressed in $\log_{10}$ million colony forming units (CFUs).

When we estimate the local average treatment effects for the microbial outcomes, we find more robust and significant estimates on improvements in hand hygiene outcomes.[12] For example, the LATE estimates for the total bacteriological count is a reduction in approximately 2.52 $\log_{10}$ million CFUs (p-value < 0.01) in hand samples in the case of the children who received the sanitation and hygiene promotion. This is consistent for all other microbes. It is also interesting to note that the magnitude of reduction (as suggested by the LATE estimtes) is very similar to the mean levels of microbial counts in the hand samples collected from the children. This suggests that local leaders can nudge households into improving hand hygiene outcomes. This also suggests, more intuitively, that there may be negative sorting by local leaders regarding which households they wanted to include in the promotion activities. The comparison between the OLS and LATE estimates suggests that the leaders may selectively focus on households with potentially higher hygiene impacts because of the interventions. This is consistent with the downward bias in the OLS estimates, which is corrected in the endogenous binary treatment model.

7. Conclusions

The study attempted to understand whether local leadership (community and/or political) can motivate individuals to adopt better health behaviors with regard to sanitation and hygiene. It looks at whether women leaders can be effective in a campaign to promote better sanitation and hygiene practices using an experimental protocol. Community-led sanitation (and hygiene) promotion programs are a very common approach to encouraging the

[12] We refrain from interpreting the IV results here as average treatment on the treated (ATET) because of non-trivial reported sanitation and hygiene-related communications received by the households in the control areas. We believe that there would be significant "always compliers" households who would receive the sanitation and hygiene related communications even in the absence of the interventions that we have described previously in Section 2.2, which is also our source of exogenous shock. Hence, we are more inclined to interpret these results as the local effects of the leadership experiments that we are examining in this study.

adoption of improved sanitation and better hygiene practices and has been used in a wide variety of contexts.[13] While leadership may have differential impacts on political outcomes and citizen satisfaction, the interventions evaluated in this study, to the best of our knowledge, are one of the first of its kind to understand whether the involvement of local female leadership would have any positive impacts on households' sanitation and hygiene behaviors.

The existing literature suggests that behavioral modification may be key to improving people's health as well as other domains such as education and technology adoption. We contribute to the literature by suggesting that community leaders can play an important role in modifying behavior with regard to sanitation and hygiene for households in rural Bangladesh, which may carry implications for other contexts as well. The local elected bodies are often responsible for the betterment as well as management of the sanitation infrastructure within their constituencies and Bangladesh is no exception. However, such roles are often limited to betterment of the physical infrastructure. As Clasen *et a*l. (2015) have shown, while building toilets can provide households with access to improved sanitation, actual use may depend on behavioral modifications which could mitigate interventions that solely provide access to toilets.

Nevertheless, though desirable, we typically see only limited engagement by women leaders in the promotion of better sanitation and hygiene behavior. One barrier may be the limited scope that women leaders have to contribute to community improvement in general (given the patriarchal culture and political economy of the country). This is further aggravated by the possibly unjust perception of voters regarding the capacity of women leaders which further limits the capacity and effectiveness of women leaders in such promotional campaigns (Beaman *et al*., 2009; Bertrand & Duflo, forthcoming). Hence, an external shock such as capacity building training along with linking women leaders with community members can potentially have implications for changing perceptions towards female leadership.

Access to quality sanitation infrastructure remains an important policy issue globally which has very important environmental implications. Biological pathogens of fecal nature often find their ways into food cycles and within habitats where small children live. Young children often ingest these pathogens and become exposed to enteric diseases. Such sickness has important implication for the growth of children and can also contribute to cognitive impairment. Improvements in hand hygiene can be encouraged through information and education campaigns and, as demonstrated in our study, local political leaders can be effective in improving the sanitation quality and hygiene outcomes. We therefore believe that our findings will contribute in a meaningful way to a very important environmental health policy issue and how to deal with it.

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[13] As a matter of fact, the whole community-based promotion of better sanitation and hygiene practices has its root in Bangladesh. It has come to be widely replicated in different countries since then. See Kar (2003) and Sanan & Moulik (2007).

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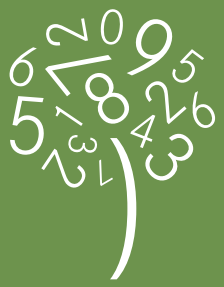

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