Identifying the Most Cost-Effective Way to Large-Scale Vaccination in Rural Bangladesh

Presented by

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On behalf of
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Background & Motivation

Vaccination has emerged as a champion and the most cost-effective public health strategy to bring the COVID-19 pandemic to an end.

Watson et al. (2022) reported that the COVID-19 vaccination has prevented 20 million excess deaths globally

Despite massive investments and efforts, herd immunity has not yet been achieved in the majority of countries, particularly in the low- and middle-income ones.

The situation in Bangladesh is no exception

Problem Statement

While the first and the second doses of COVID-19 vaccination in Bangladesh were **reasonably high** (as of July 2022, they were **78%** and **72**%, respectively), they have **stagnated** since April 2022, indicating the need for **large-scale vaccination.** However, instead of investing ulation, the **barriers to vaccina**blindly in public health initiatives across the pop**tion** and the **effectiveness of different policies** need to be first assessed.

Literature Gap

Global supply chain failures and vaccine hesitancy are two widely mentioned causes of inequalities in vaccine coverage (Reza et al., 2022).

The three broad approaches to promote vaccine take-up that has emerged from the literature:

(1) Financial incentives

(2) Information diffusion & Nudging

(3) **Non-financial incentives** (e.g., vaccine passes; granting freedom to travel restrictions, accessibility to vaccination centres).

- Global initiatives and policy focuses on **demand-side issues** like hesitancy with little attention on **supply** and **internal distribution challenges** such as **access**. Vaccine hesitancy is also generally pronounced in developed counties in developing countries (Solıs Arce et al., 2021), such as Bangladesh.

Objective

- Identify barriers to vaccination among those unvaccinated
- Understand how best to promote COVID-19 vaccine take-up among these unvaccinated individuals in a most effective way

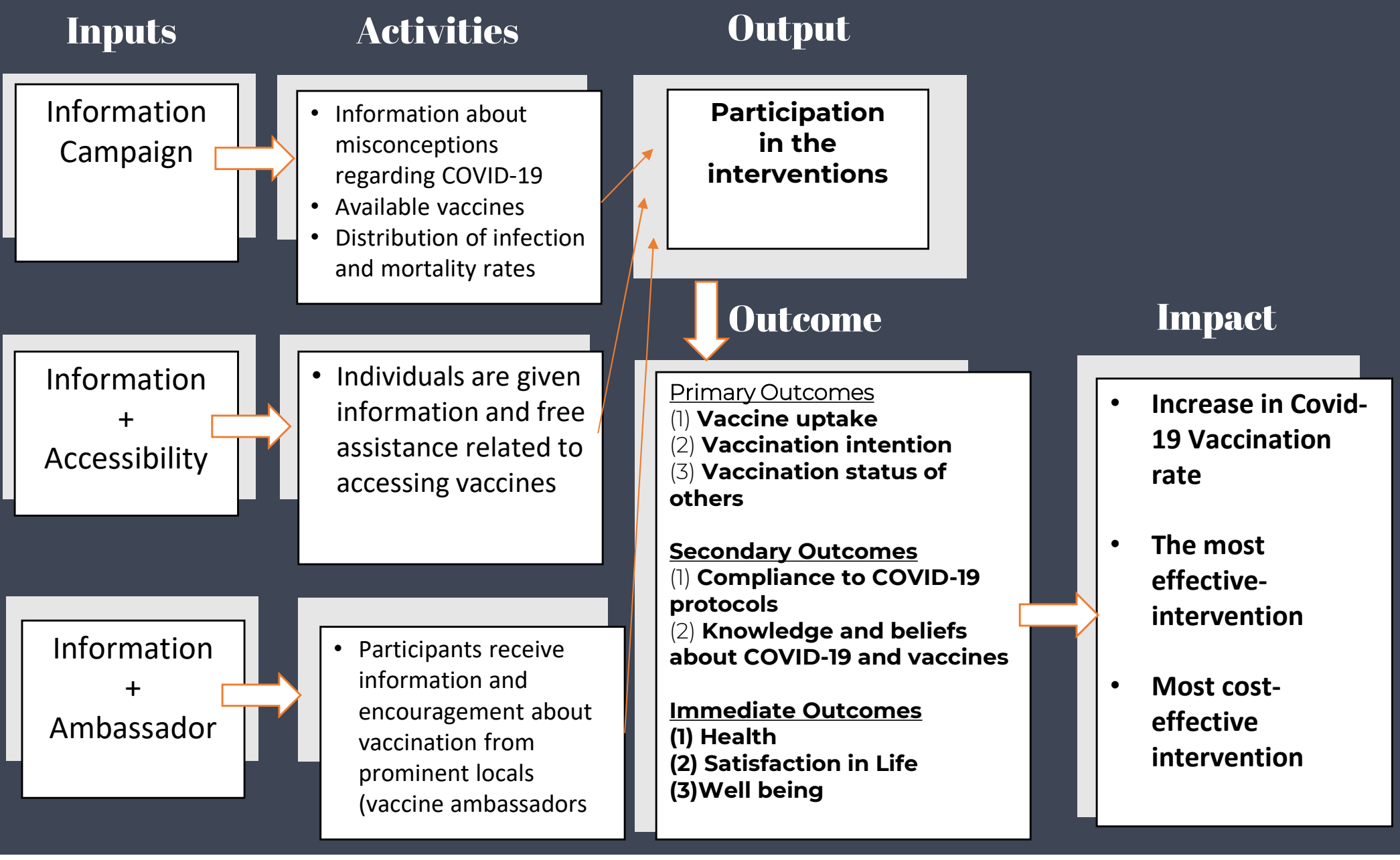
The proposed interventions in this study are all **low-cost**. If any of them are successful, some or all of them can be scaled up and used by policymakers in devising effective strategies to increase vaccination rates.

Interventions

3 Treatment arms and 1 control arm is proposed

Information Campaign Only	Information + Accessibility	Information + Ambassador	Control
• Information about misconceptions regarding COVID-19 • Available vaccines • Distribution of infection and mortality rates	• Individuals are given information and free assistance related to accessing vaccines.	• Participants receive information and encouragement about vaccination from prominent locals (vaccine ambassadors)	• Participants receive no treatment

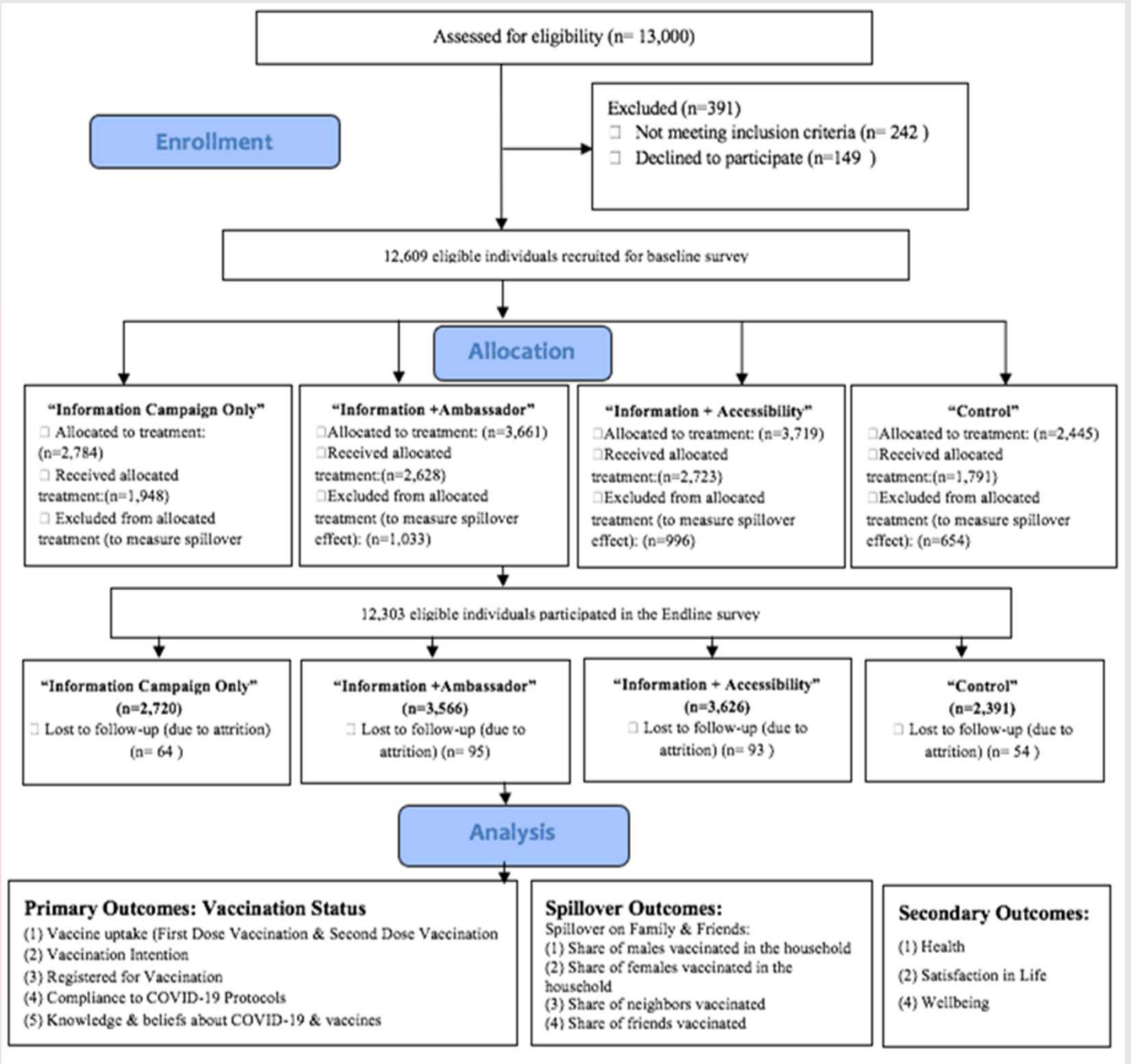
Theory of Change



Consort Flow Diagram

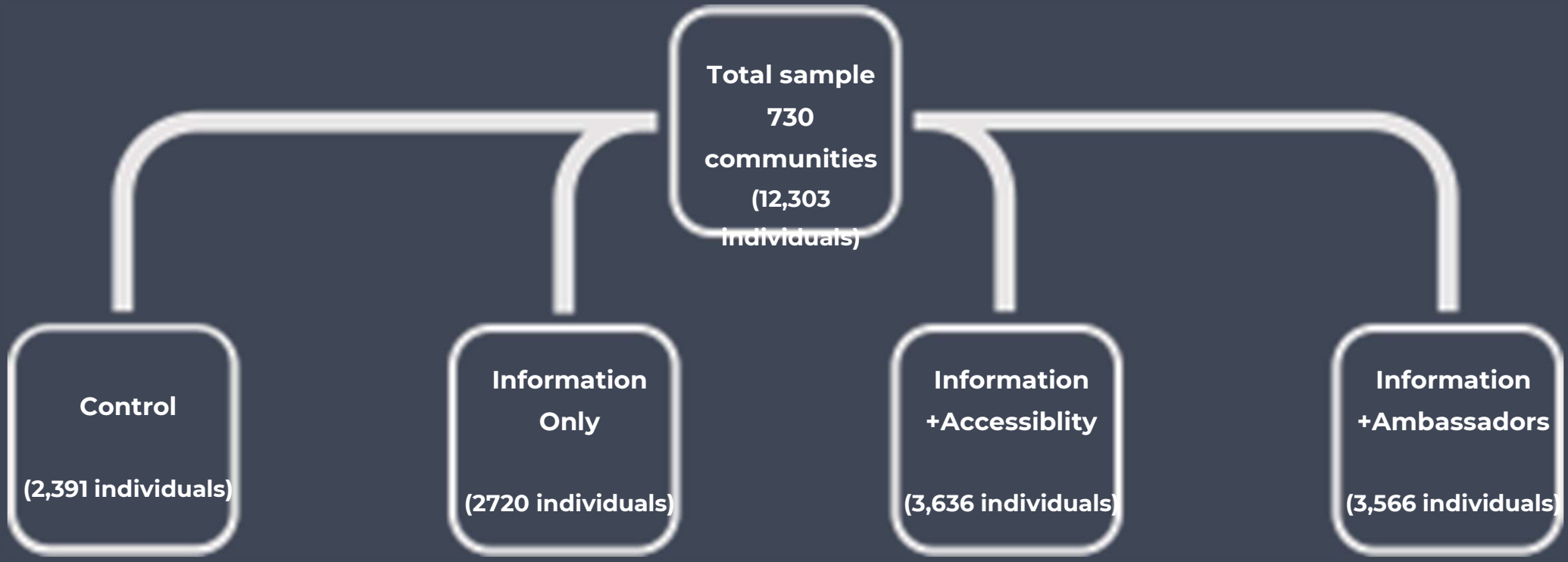
Two-step randomization:
(1) Village-level
(2) Individual-level

Our final sample comprises 12,303 individuals from 730 communities (rural and urban) spread across four districts in Bangladesh (with about 13 individuals per community on average). These villages are randomized into three treatments and one control arm



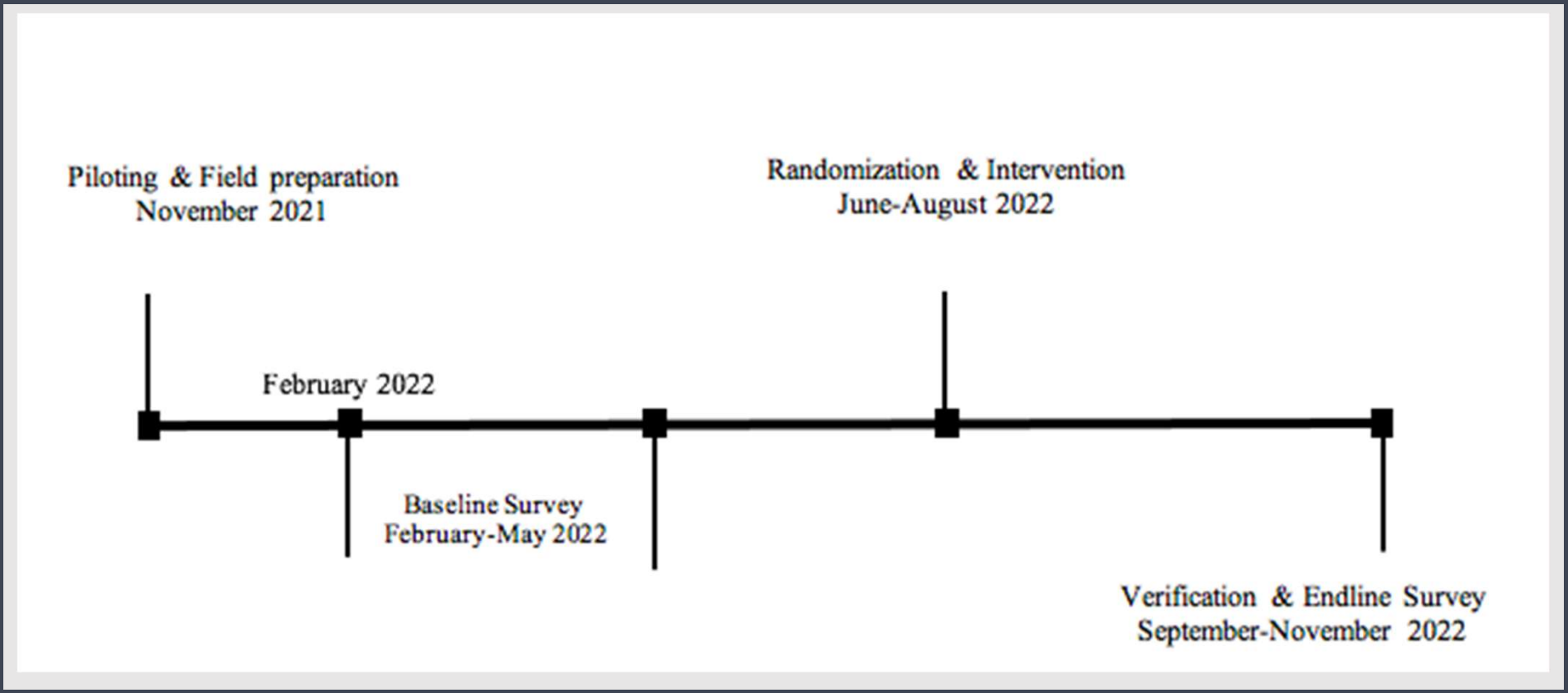
Research Design

Two-step randomization:
(1) Village-level
(2) Individual-level



Our final sample comprises 12,303 individuals from 730 communities (rural and urban) spread across four districts in Bangladesh (with about 13 individuals per community on average). These villages are randomized into three treatments and one pure control arm

Project Timeline



The baseline survey, which was finished in mid-June 2022, and the endline survey was conducted between September-November 2022, serve as the primary data sources in this study.

Outcome Variables

Primary

Vaccine uptake (1st dose)

- Defined as at least one dose within 30 days of enrollment

Vaccine completion (2nd dose)

- Defined as two doses within 60 days of enrollment

(Based on vaccine cards)

Secondary

Vaccination status of others in household and immediate neighborhood - to identify any potential spillover effects of the intervention

Other outcomes

Self reported

(1) **Health**

(2) **Satisfaction in Life**

(3) **Wellbeing**

Baseline statistics & Sample Balance

	N	Mean (pooled)	Difference between Groups (p-value)					
			Control = Information only	Control = Info+Ambassador	Control = Info+Accessibility	Info only = Info+Ambassador	Info only = Info+Accessibility	Info+Ambassador = Info+Accessibility
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Individual characteristics								
Male	9,090	0.30	0.813	0.188	0.111	0.273	0.165	0.736
Married	9,090	0.86	0.212	0.268	0.121	0.817	0.799	0.596
Muslim	9,090	0.89	0.777	0.348	0.791	0.502	0.554	0.175
Rural	9,090	0.97	0.732	0.529	0.714	0.836	0.524	0.329
Joint family	9,090	0.43	0.977	0.793	0.479	0.758	0.436	0.615
Own house	9,090	0.97	0.564	0.795	0.903	0.308	0.597	0.631
Received government assistance	9,090	0.12	0.538	0.207	0.059	0.526	0.187	0.430
Age	9,090	27.58	0.423	0.366	0.052	0.946	0.241	0.235
Have secondary education	9,090	0.31	0.123	0.183	0.203	0.715	0.635	0.911
Employed	9,090	0.22	0.979	0.697	0.960	0.707	0.934	0.597
High monthly income household	9,090	0.93	0.415	0.757	0.517	0.591	0.840	0.725
Follow COVID-19 protocols (index)	9,090	1.18	0.364	0.170	0.829	0.705	0.238	0.086
Joint-Test Prob > F			0.799	0.559	0.259	0.898	0.736	0.548
Panel B: Village characteristics								
Proportion of muslims	685	0.75	0.314	0.181	0.412	0.816	0.779	0.563
Nearest distance to COVID-19 vaccine centers (in km)	685	2.69	0.181	0.385	0.465	0.546	0.407	0.836
Nearest distance to community clinic (in km)	685	2.33	0.916	0.985	0.941	0.919	0.849	0.911
Nearest distance to railway station (in km)	685	63.47	0.780	0.503	0.356	0.704	0.508	0.730
Nearest distance to secondary school (in km)	685	3.95	0.857	0.746	0.742	0.908	0.907	0.998
Nearest distance to college (in km)	685	6.11	0.694	0.539	0.700	0.872	0.938	0.772
Nearest distance to post office (in km)	685	2.13	0.330	0.808	0.864	0.232	0.402	0.670
Nearest distance to bank (in km)	685	4.37	0.656	0.605	0.659	0.957	0.317	0.259
Nearest distance to police station (in km)	685	10.36	0.993	0.979	0.593	0.987	0.594	0.560
Nearest distance to hospital/doctor (in km)	685	2.79	0.979	0.746	0.730	0.776	0.758	0.963
Proportion of poor families	685	0.27	0.051	0.526	0.159	0.126	0.471	0.374
Proportion of landless households	685	0.22	0.281	0.537	0.536	0.545	0.556	0.992
Village head lives in the village	685	0.93	0.821	0.859	0.733	0.673	0.559	0.853
Number of families in the village	685	730.94	0.987	0.957	0.588	0.971	0.581	0.553
Joint-Test Prob > F			0.607	0.974	0.950	0.950	0.958	0.993

Note: Variable *Follow COVID-19 protocols (index)* has the maximum value of 8. Column 1 reports total number of observations. Column 2 reports average value of each variable for the whole sample (pooled). Columns 3 to 8 report *p*-values of the coefficient from regressing each baseline variable on treatment group indicators. Robust standard errors are clustered at village level. Joint Orthogonality Test Prob > F refers to the p-value of F-test of a regression of treatment indicators being compared on all baseline variables (separately for individual and village characteristics) reported in this table. This test provides an overall evaluation of the balance between groups across all baseline variables. *, **, and *** denote statistical significance at 10 %, 5 %, and 1 % levels, respectively.

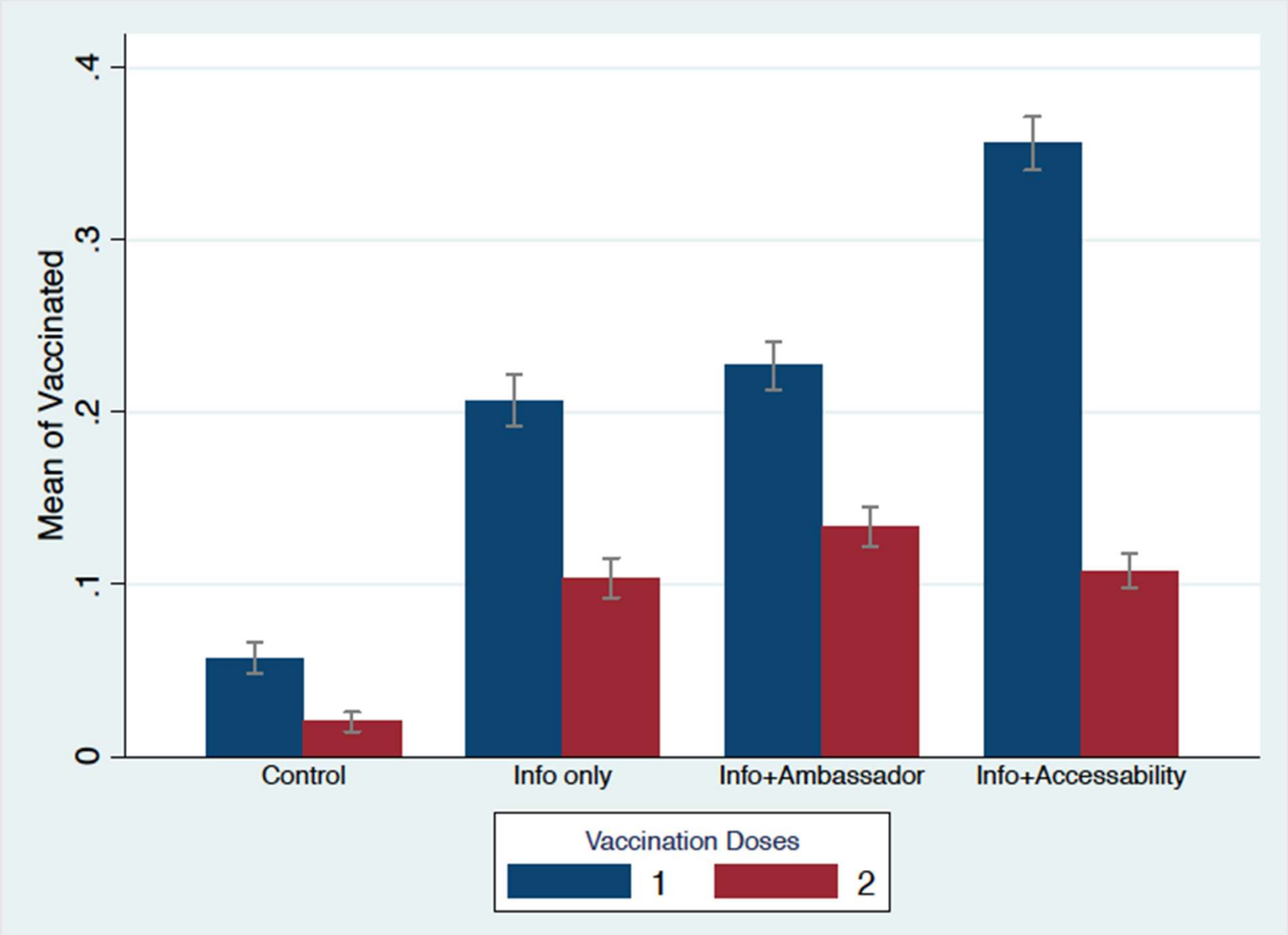
Treatment Effects on Vaccination Status

	Vaccine Uptake		Registered	Intention	Compliance to COVID-19 Protocols(index)	Knowledge & Beliefs on COVID-19(index)
	First dose	Second dose				
	(1)	(2)	(3)	(4)	(5)	(6)
Information Only	0.160***	0.085***	0.021*	0.012	-0.288***	0.298***
	(0.017)	(0.011)	(0.012)	(0.017)	(0.072)	(0.063)
Information+Ambassador	0.178***	0.120***	0.037***	0.016	-0.319***	0.255***
	(0.017)	(0.013)	(0.012)	(0.014)	(0.070)	(0.058)
Information+Accessibility	0.375***	0.106***	0.081***	-0.009	-0.353***	0.304***
	(0.015)	(0.010)	(0.014)	(0.017)	(0.070)	(0.057)
Constant	0.127***	-0.008	0.080*	1.178***	0.120	0.206*
	(0.048)	(0.032)	(0.041)	(0.045)	(0.143)	(0.120)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Upazila_ID FE	Yes	Yes	Yes	Yes	Yes	Yes
P-value (T1=T2)	0.374	0.023	0.234	0.799	0.547	0.390
P-value (T2=T3)	0.000	0.293	0.003	0.111	0.496	0.259
P-value (T1=T3)	0.000	0.112	0.000	0.252	0.223	0.896
P-value (T1=T2=T3)	0.000	0.0674	0.000	0.270	0.474	0.486
Observations	8,827	8,827	4,565	4,194	8,827	8,827
R-squared	0.111	0.056	0.024	0.141	0.099	0.073

Note: Dependent variables (in column 1-4) are vaccination decision dummies: in column (1) and (2) it equals to 1 if the respondent took the first and second dose of COVID-19 vaccination, respectively, and 0 otherwise; in column (3) it equals to 1 if the respondent is a direct beneficiary of the treatment and has registered for vaccination but has not been vaccinated yet, and 0 otherwise; in column (4) it equals to 1 if the respondent is a direct beneficiary of the treatment and has neither registered for nor been vaccinated but has intention to get vaccinated, and 0 otherwise; Compliance to COVID-19 Protocols (in column 5) and Knowledge & Beliefs on COVID-19 and Vaccines (in column 6) are standardized indexes, such that the control group has mean 0 and standard deviation 1; Controls include individual covariates such as age, indicators for being male, being married, living in rural areas, living in joint family, government assistance beneficiary, completed secondary-level education, living in a high monthly income household and being employed. The Upazilla_ID fixed effects are used as indicated. Robust standard errors in parentheses, clustered at village level. *, **, and *** denote statistical significance at 10%, 5%, and 1 % levels, respectively.

"Information+ Accessibility" arm exhibits the highest treatment effect on

Vaccine Uptake (First and Second Dose)



Spillover Treatment Effects

	Spillover effect: on Family and Friends				Spillover effect: on indirect beneficiaries	
	Share of Males Vaccinated	Share of Females Vaccinated	Share of Neighbours Vaccinated	Share of Friends Vaccinated	Vaccine Uptake(First dose)	Vaccine Uptake(Second dose)
	(1)	(2)	(3)	(4)	(5)	(6)
Information Only	0.032***	0.069***	0.052	0.096***	0.119***	0.070***
	(0.012)	(0.015)	(0.036)	(0.034)	(0.016)	(0.013)
Information+Ambassador	0.041***	0.080***	0.042	0.083***	0.177***	0.115***
	(0.013)	(0.015)	(0.035)	(0.032)	(0.018)	(0.014)
Information+Accessibility	0.056***	0.167***	0.027	0.114***	0.112***	0.056***
	(0.012)	(0.014)	(0.035)	(0.032)	(0.016)	(0.011)
Constant	0.840***	0.541***	0.618***	0.437***	-0.044	-0.040
	(0.044)	(0.046)	(0.072)	(0.064)	(0.058)	(0.047)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Upazila_ID FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,827	8,827	8,827	8,827	3,433	3,433
R-squared	0.184	0.162	0.159	0.075	0.047	0.037

Note: Dependent variables (in column 1-4) depicts spillover treatment effects on Family and Friends. Column (1) and (2) represents the share of males and females, respectively, in the respondent's household who got vaccinated; in column (3), it equals to 1 if any of the respondent's neighbours took up vaccination, and 0 otherwise; in column (4), it equals to 1 if any of the three closest friends of the respondent got vaccination, and 0 otherwise; in column (5) and (6) spillover effect among those who are not direct beneficiary of the treatment is depicted. Indirect beneficiaries are those who live in the same village as the respondent but is not part of the respondent's family and friends' network. It equals to 1 if an indirect beneficiary took the first (column 5) and second dose (column 6) of COVID-19 vaccination, respectively, and 0 otherwise; Controls include individual covariates such as age, indicators for being male, being married, living in rural areas, living in joint family, government assistance beneficiary, completed secondary-level education, living in a high monthly income household and being employed. The Upazilla_ID fixed effects are used as indicated. Robust standard errors in parentheses, clustered at village level. *, **, and *** denote statistical significance at 10%, 5%, and 1 % levels, respectively.

"Information+ Ambassador" arm exhibits the highest spillover effects on others in the same village

"Information+ Accessibility" arm exhibits the highest spillover effects on Friends & Family members

Treatment Effects on Health and Wellbeing

	Health				Satisfaction in Life			Wellbeing	
	Perceived Stress (Index)	Patient Health (Index)	Mental Health (Index)	Physical Health (Index)	Life satisfaction (Index)	Happiness (Index)	Ladder (Index)	Certainty (Index)	Hopelessness (Index)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Information Only	-0.119*	-0.161***	0.228***	0.190***	0.124*	0.141*	0.059	0.094	0.052
	(0.070)	(0.053)	(0.053)	(0.052)	(0.068)	(0.084)	(0.069)	(0.079)	(0.080)
Information+Ambassador	-0.119*	-0.143***	0.215***	0.208***	0.157***	0.155**	0.099	0.133*	0.098
	(0.064)	(0.050)	(0.049)	(0.048)	(0.059)	(0.070)	(0.063)	(0.070)	(0.071)
Information+Accessibility	-0.129**	-0.155***	0.196***	0.190***	0.169***	0.157**	0.159***	0.180**	0.145**
	(0.065)	(0.052)	(0.047)	(0.046)	(0.058)	(0.074)	(0.061)	(0.074)	(0.073)
Constant	0.393***	0.175	-0.244*	-0.190	-0.372**	0.055	-0.834***	-0.160	-0.136
	(0.152)	(0.111)	(0.142)	(0.140)	(0.183)	(0.156)	(0.145)	(0.159)	(0.143)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Upazila_ID FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,827	8,827	8,827	8,827	8,827	8,827	8,827	8,827	8,827
R-squared	0.058	0.088	0.045	0.053	0.046	0.122	0.036	0.076	0.037

Note: Column 1-4, depicts treatment effects on Health outcomes of an individual which includes indexes such as Perceived Stress, Patient Health, Mental Health and Physical Health. An individual's satisfaction in life is shows in column 5-7. It includes Life satisfaction index, Happiness in Life index and Ladder of life possibility index. Column 8 and 9, depicts treatment effects on Wellbeing of an individual which includes Certainty about future index and Hopelessness about future index. All the outcome variables are standardized indexes, such that the control group has mean 0 and standard deviation 1. Controls include individual covariates such as age, indicators for being male, being married, living in rural areas, living in joint family, government assistance beneficiary, completed secondary-level education, living in a high monthly income household and being employed. The Upazilla_ID fixed effects are used as indicated. Robust standard errors in parentheses, clustered at village level. *, **, and *** denote statistical significance at 10%, 5%, and 1 % levels, respectively.

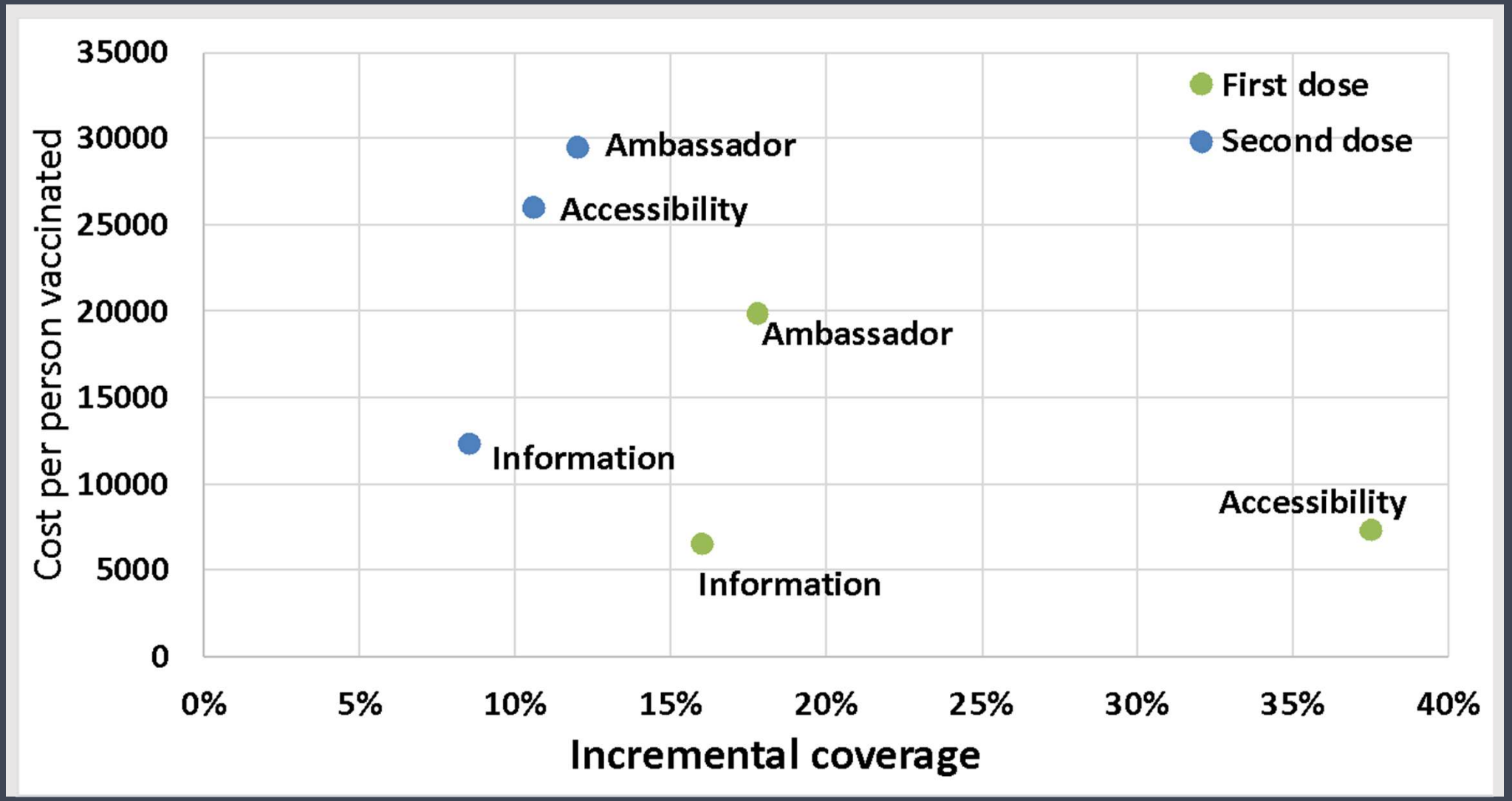
Heterogenous Treatment Effect on Vaccination Status

	Vaccine Uptake (First Dose)						Vaccine Uptake (Second Dose)					
	Gender		Level of Education		Household Income		Gender		Level of Education		Household Income	
	Male	Female	High	Low	High	Low	Male	Female	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
T1: Information Only	0.183***	0.148***	0.154***	0.164***	0.159***	0.131***	0.093***	0.081***	0.105***	0.076***	0.087***	0.039
	(0.025)	(0.019)	(0.024)	(0.018)	(0.017)	(0.047)	(0.017)	(0.014)	(0.019)	(0.012)	(0.012)	(0.033)
T2:Information+Ambassador	0.188***	0.172***	0.158***	0.185***	0.172***	0.211***	0.130***	0.116***	0.113***	0.122***	0.119***	0.088**
	(0.025)	(0.018)	(0.024)	(0.018)	(0.017)	(0.055)	(0.019)	(0.014)	(0.017)	(0.014)	(0.013)	(0.042)
T3:Information+Accessibility	0.373***	0.373***	0.363***	0.379***	0.369***	0.437***	0.101***	0.106***	0.129***	0.094***	0.103***	0.139***
	(0.024)	(0.016)	(0.023)	(0.017)	(0.015)	(0.062)	(0.016)	(0.011)	(0.016)	(0.011)	(0.010)	(0.041)
Constant	0.118	0.099*	0.057	0.159***	0.125**	0.230*	-0.010	-0.014	-0.002	-0.011	-0.007	-0.060
	(0.091)	(0.057)	(0.091)	(0.053)	(0.051)	(0.130)	(0.054)	(0.040)	(0.059)	(0.038)	(0.034)	(0.068)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Upazila_ID FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
P-value (T1=T2)	0.870	0.287	0.873	0.363	0.564	0.177	0.121	0.042	0.711	0.007	0.039	0.310
P-value (T2=T3)	0.000	0.000	0.000	0.000	0.000	0.002	0.193	0.499	0.428	0.067	0.234	0.341
P-value (T1=T2=T3)	0.000	0.000	0.000	0.000	0.000	0.000	0.266	0.103	0.515	0.026	0.119	0.126
Observations	2,606	6,221	2,759	6,068	8,247	580	2,606	6,221	2,759	6,068	8,247	580
R-squared	0.117	0.113	0.118	0.114	0.108	0.222	0.067	0.056	0.067	0.057	0.054	0.156

Note: Dependent variables (in column 1-5) and (in column 7-12) are vaccination decision dummies that is equals to 1 if the respondent took the first and second dose of COVID-19 vaccination, respectively, and 0 otherwise. Four subgroups are analyzed for treatment effects where Gender equals to 1 if Male, and 0 if Female; Level of Education equals to 1(High) if respondent possesses high school education or more, and 0 (Low) otherwise; Household Income equals to 1 (High) if respondent's household income level is above poverty line, and 0 (low) otherwise. Controls include individual covariates such as age, indicators for being male, being married, living in rural areas, living in joint family, government assistance beneficiary, completed secondary-level education, living in a high monthly income household and being employed. The Upazilla_ID fixed effects are used as indicated. Robust standard errors in parentheses, clustered at village level. *, **, and *** denote statistical significance at 10%, 5%, and 1 % levels, respectively.

Incremental cost per person vaccinated

Improving accessibility - highly cost-effective for the first dose



Thank You