Mobilizing Voices for Science to Promote Trust in Vaccination:

The *Health Ambassadors* Multi-site Randomized Controlled Trial

Intervention Concept and Research Design

Health Ambassadors Research Consortium:

Arsene Brice Bado*, CERAP Abidjan

Yapo Felix Boa, U. Félix Houphouët Boigny and CERAP Abidjan

Horace Gninafon, U. Laval and U.C. Berkeley/EGAP

Paul Kawale, Kamuzu U.

Fortunate Machingura, CeSHHAR Zimbabwe

Cyrus Samii, New York U.

Samba Corr Sarr, Senegal Ministry of Health

Mame Mor Anta Syll, U. Gaston-Berger

Mavuto Thomas, Malawi Ministry of Health

Maarten Voors, Wageningen U.

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* *Study authors listed in alphabetical order. All authors are contributors to the formulation, design, and implementation of the research.* *This research was organized as part of the Social Science Research Council's Mercury Project with generous funding from the Rockefeller Foundation.*

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Executive Summary

This document provides details on the research design for the Health Ambassadors multi-site trial in Côte d'Ivoire, Malawi, Senegal, and Zimbabwe. The Health Ambassadors trial tests a strategy of mobilizing "voices for science" to initiate conversations with those who are hesitant about vaccination. The goal of these encounters is to overcome such hesitancy and promote trust in scientific health information. The broader goal of the intervention strategy is to define an approach that goes beyond unilateral messaging to improve public responses to health emergencies.

The rationale for the intervention is based on challenges from the "infodemic" that complicated countries' responses to the COVID-19 health emergency. The lessons learned were that unilateral messaging through standard media sources may be inadequate, and that more proactive strategies to engage in discussions and allow for individuals' concerns to be heard would be needed.

While COVID-19 motivated the study, public health priorities have shifted away from an overwhelming emphasis on COVID-19. This, the trial will promote adherence to a variety of public health recommendations, including vaccination against diseases other than COVID-19 (e.g., cholera, typhoid, HPV, and Hepatitis B).

The sections below begin by expanding on the rationale and objectives of this cluster-randomized controlled trial. We then go on to explain the details of the research design. We begin by explaining the selection of research sites (clusters) within Côte d'Ivoire, Malawi, Senegal, and Zimbabwe. We focus on places of relatively low COVID-19 vaccination and high population density (and, thus, primarily urban areas), since for vaccine-preventable illnesses, these present areas of concentrated risk. The clusters are defined as the catchment areas surrounding urban health centers. In Cote d'Ivoire, the clusters include neighborhoods in Abidjan and Bouake; in Malawi, they include neighborhoods in Lilongwe and Blantyre; in Senegal, they include neighborhoods in Dakar, Kaolack, Pikine/Keur Massa, Saint-Louis and Thies; and in Zimbabwe, they include neighborhoods in Harare and Bulawayo. We describe the randomization plan, which involves random assignment of treatment and control clusters, blocking by cities within each country.

Next, we describe our household recruitment strategy. We select households using a spatial random sampling process. Specifically, we select households surrounding randomly selected geographical points in the catchment areas of health facilities where vaccines are administered.

We then describe the country-specific strategies of recruiting and mobilizing health ambassadors, as well as their protocol for how the health ambassadors will engage households and the training that will be given to develop the ambassadors' skills. We recruit "health ambassadors" with relevant expertise to be deployed to initiate conversations with the vaccine hesitant. In Malawi and Zimbabwe, the ambassadors will be recruited from among the community nurses and health workers currently engaged in the public health system. In Cote d'Ivoire and Senegal, ambassadors will be recruited among graduates from biomedical sciences. The ambassadors will be trained on a protocol based on the AIMS (Announce, Inquire, Mirror, Secure) methodology. Ambassadors will use active listening to discuss subjects' reasons for hesitancy, seek to build trust, and identify ways to overcome such hesitancy without challenging subjects' views in a confrontational manner.

Next, we discuss the outcome measurement strategy. We will use surveys to capture both public health behaviors and attitudes. Finally, our analysis plan includes statistical analyses to estimate the average effects of the intervention as well as factors that moderate the effectiveness of the intervention. We will analyze costs data to determine cost-effectiveness and potential for scale up. We will also analyze process data, including interviews with the health ambassadors themselves, to derive lessons for effective implementation.

Rationale

The trial was motivated by the challenges in achieving high rates of adult vaccination during the COVID pandemic, although its scope will extend beyond COVID-19 per se to consider other types of adult and adolescent vaccination (e.g., cholera, typhoid, HPV, and Hepatitis B). The COVID crisis revealed how "infodemics" can exacerbate health emergencies (Chowdhury et al., 2021; Do Nascimento, 2022; Sell et al., 2021). Mis- and dis-information, spread through various media or word of mouth, can drown out information from health authorities and conflate health recommendations with politics (Muhammed & Mathew, 2022). The consequence is to hamper health authorities' efforts to promote scientifically-recommended courses of action to contain emergencies. Most interventions addressing vaccine hesitancy, including during the COVID crisis, have been based on unilateral transmission of information (whether through social media or traditional media) and have shown very limited results (Athey et al., 2022; Dai et al., 2021 Kerr et al., 2021; Rabb et al., 2022; Reddinger et al., 2021).

This context motivates the design of the Health Ambassadors trial:

- "Voice for Science": Rather than relying on non-expert intermediaries for vaccine-related and other health information, evidence shows that individuals want a trustworthy point of reference who can speak with expertise on the science.
- Safe space for discussing concerns: Evidence shows that simple unilateral messaging may not work, and that vaccine trust, other attitudinal measures and behavioral change requires opportunities to privately discuss concerns so that they see clearly that their concerns are heard and addressed.
- Replicable and scalable: To ensure that the research directly informs policy options, rather than being a merely academic exercise, we want to test interventions that are integrated into health systems.

With background in mind, the trial will study an intervention that recruits "health ambassadors" with relevant expertise to be deployed to initiate conversations with the vaccine hesitant. In Malawi and Zimbabwe, the ambassadors will be recruited from among the community nurses and health workers currently engaged in the public health system. In Cote d'Ivoire and Senegal, ambassadors will be recruited among graduates from biomedical sciences. To create a safe space for discussing concerns ambassadors will be trained on a protocol based on the AIMS (Announce, Inquire, Mirror, Secure) method (Parrish-Sprowl et al. 2023). Ambassadors will use active listening to discuss subjects' reasons for hesitancy, seek ways to build trust, and identify ways to overcome hesitancy without countering subjects' concerns in a confrontational manner. Finally, to ensure replicability and scalability, the studies in each country are being designed in collaboration with partners from the relevant health ministries and municipal health departments.

Objectives

The objectives of the trial are as follows:

- To learn the impact of a "health ambassadors" intervention strategy that engages subjects through conversation and trust building for promoting vaccine uptake and trust in scientific health information among the vaccine hesitant in high-risk (that is, urban, densely populated) contexts in sub-Saharan Africa,
- To understand the mechanisms through which the strategy succeeds for fails in bringing about vaccine trust and behavioral change among the vaccine hesitant, and
- To learn the potential and cost-effectiveness for the "health ambassadors" strategy to be used at scale by health authorities in sub-Saharan Africa.

These objects inform the research design.

Cluster selection

The structure of the trial is a cluster-randomized controlled trial. Clusters are centered on health facilities where vaccines are administered and include households in their catchment areas. Clusters are defined in ways such that they do not overlap so that (1) there is no ambiguity as to whether a household is in one or another study cluster and (2) the potential for inter-cluster spillover effect is minimal. This will be ensured by having singular clusters defined within a given administrative area (e.g., a health district or ward), and the cluster boundaries will not extend past the boundary of the administrative area.

We select a common number of clusters within each of the four study countries. The goal is to have enough clusters so that the study is powered to detect a 0.15 control group standard deviation effect (Glass's Delta) on the Vaccine Trust Indicator (VTI), equivalent to a 7ppt. effect on the vaccination rate outcome, with 80% power and 95% confidence in an analysis that pools that data from the four countries. For the power analysis for the VTI (our primary outcome variable), we assume the control group VTI outcomes are normally distributed (we use this assumption due to the unavailability of actual distributional information on the VTI for the countries under investigation at the time of power calculation) and that all outcomes are normalized relative to the control group standard deviation. For vaccination rates, we used the most recently available (as of summer 2023) health-district-level COVID-19 vaccination rates (when available) as the input data. We simulated a 0.15 control group SD effect, which was equivalent to a 7 ppt. effect on vaccination, and then evaluated what sample size would be needed to achieve 80% power with 95% confidence. The power analysis showed that having **16 treated clusters** and **16 control clusters per country** and **24 households per cluster** would suffice. This implies (16+16)*24 = **768 households sampled per country**, with an **overall sample size of 3,072 households and 128 clusters** across all four countries.

The study aims to increase vaccine trust, with COVID-19 vaccination being the primary basis for assessing current hesitancy. In each country, our primary focus lies on the two largest, most densely populated cities. This strategic decision is driven by the critical need for vaccination in these regions, owing to their heightened potential for disease transmission and the prevailing low COVID-19

vaccination rates. In each priority locality, clusters are defined as neighbourhoods served by health centers or clinics that meet the following criteria:

- The health center must offer COVID-19 vaccination services and services for other target vaccines (varies by country).
- For each targeted city, the health facilities used for defining the clusters must be separated by a distance of at least 4 to 5 km. This precautionary measure is taken to prevent potential spillover effects.

We proceed by describing the criteria employed for selecting priority districts within each country.

Côte d'Ivoire, Malawi, Senegal and Zimbabwe

In Côte d'Ivoire, Malawi, and Zimbabwe, we implement a specific approach in the two largest and most densely populated cities to create clusters representing localities served by each health center. We utilize a list of health centers and Ministry of Health data on COVID-19 vaccination rates. In each country, we meticulously select 32 health centers for this purpose.

During the selection, we prioritize the proximity of these health centers to each other. For each city targeted by the study, we choose health centers that are at least 1 to 2 kilometres apart, aiming to minimize potential spillover issues to the greatest extent possible. If several health centers fulfill these criteria, we prioritize, whenever feasible, the ones with the lowest vaccination rates.

Similar to Côte d'Ivoire, Malawi, and Zimbabwe, in Senegal we adopt the same strategy to define clusters that will be part of the study. However, In Senegal, given the restricted availability of health centers in the cities selected for the study, we have chosen to use health posts instead of health centers to create the clusters for this research. These health posts provide equivalent healthcare services, including vaccination for the population, and offer the added benefit of being more plentiful in the designated towns. This approach enables us to meet the necessary cluster count while adhering to the criteria outlined in the preceding section.

In the appendix, Tables A2, A3 A4 and A5 display the chosen health facilities for Côte d'Ivoire, Malawi, Senegal, and Zimbabwe, respectively. These selected centers serve as the foundation for identifying the clusters.

Cluster Randomization

The randomized controlled trial operate as a multisite locality-level cluster-randomized experiment across Côte d'Ivoire, Malawi, Senegal, and Zimbabwe. The treatment is whether a locality received "health ambassadors" in combination with any already-existing public outreach (treated = 1) versus no additional intervention above and beyond any already-existing public outreach (control = 0). We randomly assign half of the clusters to treatment and the other half to control. The randomization is stratified on the basis of city, and where possible, health district within city. The result will be a balanced block-cluster random assignment of 16 clusters to treatment and 16 clusters to control per country, for a total of 64 treated clusters and 64 control clusters. The statistical analysis will control for the block stratification.

Household Recruitment

Household Recruitment

We define households using the definition from the international Demographic and Health Surveys (eat from the same pot, live under the same roof, and share the same household head). In selected clusters, after obtaining approval from health district authorities to proceed with field activities, field enumeration staff (*separate from the health ambassadors*) will operate under the research team's supervision to employ the following process to identify the households to be surveyed in the cluster. As explained above, our target is 24 households per cluster. However, since the study is conducted in densely populated urban areas where households may migrate, field enumerators were instructed to survey 30 households per cluster to account for potential attrition. Due to logistical challenges, such as difficulties in finding eligible households during the survey period and data quality control measures that prompted some enumerators to survey more than 30 eligible households, cluster sizes ended up varying between 24 (in Zimbabwe) and 37 (in Côte d'Ivoire). Table A1 presents the total number of households and adults surveyed at baseline by country.

1. Using Google Maps, we map the outline of each cluster and geolocate the focal health facility where free vaccination is available for all of the target vaccines in the country.
2. We stratify the area into 5 or 6 bands of increasing distance from the health facility.
3. We randomly sample a geolocated point within each band.
4. Using Google Maps, we identify the home nearest to each of those sampled points.
5. We choose the home nearest to the sampled point.
6. On the same side of the street as that first home, demarcate a total of 6 additional homes that are evenly between the first selected home and either end of the street.
7. Randomly order these 6 additional homes and select the first three.
8. If a home includes more than one household, we number them and then draw one number at random from a hat.
9. If a household either does not consent to participation in an initial intake, is ineligible (see below), or does not consent to participate in the full study, then move to the next household in the list of 6. If one exhausts this list, then perform the same enumeration strategy on the other side of the street.

Upon being selected, an enumerator approach the household head or adult representing the household for their consent for a brief intake survey to determine the household's eligibility. Households will be eligible if it contains at least one adult member who was eligible for COVID vaccination but has never been vaccinated against COVID-19.

If eligible, the household head or adult representing the household will be asked for their consent to participate in the full study, which would involve being approached at a future date for in person "discussions of health-related issues, including adult vaccination." This consent process will be done for households in both treated and control clusters. For those in treated clusters, such "discussion" would include the visit from the health ambassador and then the endline survey. In control clusters, such "discussion" would include only the endline survey.

Recruitment and Mobilization of Health Ambassadors

Profile

The intervention aims to mobilize Health Ambassadors who meet the following criteria:

- Willing to work on a volunteer basis, exhibiting intrinsic motivation to contribute to social welfare and a willingness to engage households in an empathetic manner;
- Up to date on vaccination for COVID and other target diseases;
- Possess enough education and capacity to be a "voice for science", that is, to effectively and accurately communicate the scientific processes and regulations that ensure vaccine safety, the scientifically understood protective benefits of vaccines, and the scientifically understood risks of vaccinations; and
- Possess connections to the communities in which target households reside so as to operate on the basis of trust.

In Cote d'Ivoire and Senegal, the Health Ambassadors are selected from recently graduated students from graduate programs in medicine, nursing, biomedical, health sciences, or public health. In Malawi and Zimbabwe, the Health Ambassadors are selected from existing community health volunteers and community health nurses. To the extent possible, we will prioritize Community Health Workers who have completed post-graduate education in health. This selection is motivated by evidence from the country contexts of this research showing that populations trust those with relevant expertise (e.g., doctors, nurses, or health workers) more than other types of leaders when discussing health issues. In Malawi, for example, while about half of those not planning to vaccinate against COVID-19 are likely to trust COVID-19 vaccine information when health professionals give it, only 10% and 7% claim to trust COVID-19 vaccine information when it comes from religious or community leaders, respectively.

Given cultural norms in the context of the countries in which we work and to promote the compliance of local populations to work in synergy with the Health Ambassador, we aim to recruit Health Ambassadors that come from the regions in which they would be operating in the context of the study.

Recruitment Process

In Cote d'Ivoire and Senegal we employ a recruitment process in partnership with medical or health sciences faculties and schools to identify potential health ambassadors. This process allow recently graduated students from these institutions, who are seeking opportunities and are available during the intervention period, to express their interest in becoming health ambassadors for this intervention. Preference are given to graduates in medical, nursing, biomedical, or related fields. To accomplish this, the project research team in each country (Côte d'Ivoire and Senegal) establish contact with multiple medical or medical science faculties to acquire the contact details of recent graduates in the relevant medical disciplines.

In Malawi and Zimbabwe, we work with the health authorities in the relevant cities to identify community health volunteers and nurses who meet the qualifications listed above.

For all candidate Health Ambassadors, we convey information on duties, locations, and time commitments. We collect information pertaining to the qualification criteria:

- Assessment of willingness to work on a volunteer basis, intrinsic motivation, and empathy;
- Status with regard to vaccination for COVID and other target diseases;
- Education level and relevant technical experience; and
- Location of origin, current location, and languages spoken.

Incentives

The Health Ambassadors receive a small stipend to cover basic costs such as transportation, communication, and meal allowances during the days of their work. After the intervention work is completed, the research team will offer to them the opportunity to participate in a training activity on the research, which will include a mix of in-person and Zoom sessions with the broader international research team. We will also organize the opportunity for them to meet with leadership from the Ministry of Health to commend their contributions. The Health Ambassadors will also receive certificates of participation endorsed by the organizing institutions.

This incentive strategy assumes that those with strong intrinsic motivation will be best positioned to strike trusting relationships with the participant households. The opportunities for training will further enhance this selection based on intrinsic motivation.

Numbers and Timeline

16 Health Ambassadors are mobilized per country, with each Health Ambassador covering one treated cluster. They will have 6 weeks to work with the 24 households in their cluster. However, in Senegal, due to personal constraints, one health ambassador was unable to start the work just before the intervention and was replaced by another. This maintained the total number of health ambassadors in Senegal at 15. They are be required to have one initial engagement and then at least one follow-up engagement with each of the 24 households (although additional engagements are encouraged). Individual engagements should consist of a conversation with the head of household and other adult, on a one-on-one basis and in private. Each conversation is expected to last 30 minutes. However, in some cases, the conversation may extend beyond the designated 30-minute timeframe if all parties have an interest to do so.

Health Ambassador Assignment to Households

In Malawi and Zimbabwe, Health Ambassadors are health workers who already have designated communities. They will continue to work in those communities, although they will be employing novel techniques for engaging households relative to current approaches.

In Cote d'Ivoire and Senegal, Health Ambassadors are assigned to the treatment clusters, conditional on meeting the language and "connection to community" requirements.

Health Ambassadors Protocol for Discussions with Households

Health Ambassadors aretrained using a handbook that defines the protocol for engaging household members. The handbook contain the following elements:

- Relevant *scientific information* on vaccine safety, the scientifically understood protective benefits of vaccines, and the scientifically understood risks of vaccinations, along with a brief "factsheet" to use as a tool when engaging households. This scientific information are draw from factsheets and other outreach materials produced by the health ministries from each of the study country.
- Guidance material on the strategy for engaging in conversations with households. The engagement strategy is based on the AIMS (Announce, Inquire, Mirror, Secure) methodology as explained in Parrish-Sprowl et al. (2023). The AIMS approach was designed specifically to address mistrust in the scientific and medical establish that drives vaccine hesitancy. The assumption is that overcoming such mistrust requires meaningful interactions, and cannot be addressed by unilateral messaging alone. Moreover, the interactions need to be carried out in a way that is effective for building trust. Thus, health workers, who represent the scientific and medical establish, will employ active listening so as to engage households in a manner that is empathetic and seeking to learn household members' points of view, while also trying to persuade them of the value of vaccination and of using "critical thinking" to scrutinize information about vaccination received from non-science-based sources. The health workers will be trained to avoid any confrontation or disparagement of household members' points of view, as this can undermine the goal of building trust.

We also hope to offer households an embodiment of a trustworthy "voice for science" in the minds of households, while conveying skills for scrutinizing health information.

Health Ambassadors Training

We organize a rigorous two-day training program for the Health Ambassadors selected for this research project in each targeted country. Despite their expertise in the field, this two-day training in person will equip them with the necessary knowledge and skills to effectively fulfill their responsibilities within the intervention. Health Ambassadors will be trained on the AIMS methodology as a respectful way to engage with household members and on the scientific evidence and "frequently asked questions" (FAQs) from their respective countries to inform their presentations to households on benefits of being vaccinated. Upon completion of the two-day in-person training, Health Ambassadors will be provided with summary guides outlining the training content.

The two-day in-person training sessions encompass the following content:

1. Presentation of the Research Project: Participants will receive a comprehensive overview of the research project, including its goals, and expected outcomes.
2. Role of Health Ambassadors: The training will emphasize the crucial role that Health Ambassadors play in the successful implementation of the research activities. Participants

will gain insights into their responsibilities, tasks, and the impact they can have in addressing vaccine hesitancy within communities.

3. Protocol and Content of the Intervention: Health Ambassadors will be trained on the specific protocol and content of the intervention. This includes an in-depth understanding of the tailored strategies for addressing different profiles of vaccine-hesitant individuals. They will learn effective communication techniques and methods to counter misinformation or concerns.
4. Attitude in Community Engagement: The training will focus on the appropriate attitude that Health Ambassadors should adopt when interacting with the communities they serve. This includes fostering trust, respect, and cultural sensitivity. Participants will learn to build meaningful relationships and collaborate with community members effectively.
5. Mini-Questionnaire Training: Health Ambassadors will be trained on how to properly complete the mini-questionnaire summarizing private discussions held with household members during the intervention. They will learn the importance of accurate data collection and confidentiality, ensuring that the information gathered is comprehensive and valuable for the research project.
6. Role playing practice.
7. Role playing exercises and written examinations to ensure preparedness.

Trainees are scored based on the role-playing exercises and written examination.

Monitoring of the Health Ambassadors

Weekly check-in meetings: The research team will conduct weekly check in sessions lasting 1 to 2 hours with the Health Ambassadors. These sessions will allow the team to assess the progress of the Health Ambassadors' work and address any challenges they may be encountering. During these meetings, the Ambassadors will have the opportunity to seek guidance and discuss any difficulties they are facing.

WhatsApp groups: Once the intervention commences, a dedicated WhatsApp group will be established for each country to serve as an official communication platform between the Health Ambassadors and the research team.

Outcome Measurement

Outcomes will be measured through endline surveys that will be timed so as to occur in the month following the week period of engagement in each community. We propose to measure the impact of the intervention in terms of both vaccine trust, other attitudinal outcome measures and behavioral outcome, with a standardized measurement strategy for households in treated and control clusters. We also plan to obtain process-relevant indicators from the Health Ambassadors as well as contextual information from staff at the focal health facilities.

Household Survey

The full household survey appears as an accompanying document. (The household questionnaire can be accessed here.) In the sections below, we describe the key sections and key questions.

Household Survey Data Structure

The data will be structured as (1) a household roster for all households' members including adults and children residing in the household and (ii) an individual questionnaire administered to the head of household or (if the head is unavailable) an adult who is accepted by the household members as speaking on behalf of the household.

Manipulation Check Measure

First, in the individual questionnaire, we will ask questions to assess the extent to which the Health Ambassadors' visits represented any meaningful increase in receipt of information about vaccination:

- Have you received any information about vaccination in the past three months?
- From whom did you receive it? (Do not read responses; add checklist: Health Ambassador, doctor, nurse, health worker, religious leader, chief or traditional leader, other relative or household member, internet/social media, books, other: specify).

  [Note for Enumerator: For the control group, if the information was obtained from a friend, acquaintance, or relative who is not a family member, please provide the following details regarding the source of the information:

  A. Name of the person:
  B. Place of residence:
  C. Content of the message received regarding vaccines:
- What types of vaccinations were featured in these vaccination awareness campaigns? COVID-19, HPV, Measles, etc. [Enumerators: This is a Multiple-Choice question; kindly let the household member respond.]
- For each of the vaccine information campaigns you attended, could you please share the outreach strategy used by the organizations responsible for the campaign to make you aware of this specific type of vaccine? Billboards, Posters, Radio announcements, Door to door, Public announcements at public events, etc.
- What is the core message of each of these vaccine awareness campaigns?

Primary outcome measure

Vaccine Trust Indicator

Our primary outcome is the perceived change in vaccine confidence/receptivity following health ambassador discussions with households on vaccination trust (VTI).

The main focus is on COVID-19 or other targeted vaccine confidence, evaluated through the Vaccine Trust Index (VTI). The VTI measures confidence in the importance, safety, and efficacy of vaccines, with each item rated on a 10-point scale ranging from 1 ('strongly disagree') to 10 ('strongly agree'). We will use the 6-item VTI to assess the effectiveness of our Health Ambassador (HA) intervention, designed to enhance dialogue among adults who are vaccine-hesitant and improve trust and confidence in vaccines. The VTI, a validated tool (Ellingson et al., 2023) used in various contexts (

Ellingson et al., 2023), genuinely aids us in observing changes in trust and the shift from hesitancy to confidence. Below are the different questions to capture the Vaccine Trust Indicator.

Please give your level of agreement with each statement using the scales provided (where 1 = strongly disagree/strongly against vaccination and 10 = strongly agree/strongly in favor of vaccination).

Please give your level of agreement with each statement using the scales provided (where 1 = strongly disagree/strongly against vaccination and 10 = strongly agree/strongly in favor of vaccination).

1.1. Thinking about vaccination in general, would you say you are…

1=strongly against vaccination, 10=strongly in favour of vaccination

1.2. I generally trust vaccine manufacturers or pharmaceutical companies

1=strongly disagree, 10=strongly agree

1.3. I generally trust the {country specific health department}

1=strongly disagree, 10=strongly agree

1.4. I understand how vaccination helps my body fight infectious disease

1=strongly disagree, 10=strongly agree

1.5. I feel it is important that I get vaccinated

1=strongly disagree, 10=strongly agree

1.6. Vaccination forms part of a healthy lifestyle

1=strongly disagree, 10=strongly agree

The items are summed to create a composite vaccine trust score. We will standardize in terms of control group standard deviations.

Secondary outcome measures

These secondary outcomes will be measured through a household questionnaire at baseline (before the intervention) and endline (after the intervention). The following questions will be asked to adult members of the household.

1. Vaccine uptake

1.1 For each vaccine and each target household members, the individual questionnaire will indicate whether the respondent (i) did not verbally affirm receiving the vaccination or provide documentation, (ii) verbally affirmed vaccination but did not provide documentation, or (iii) provided documentation of vaccination.

For respondents who have not been vaccinated due to time constraints or limited access to health centers, the survey will capture their intention to receive the vaccine if they were at a health center using the following question: Are you planning to be vaccinated for the [country specific disease] vaccine?

2. Knowledge about the disease: I will read you some statements and I would like you to tell me how much you agree or disagree with each statement. Please say whether you strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree.

    2.1. [The targeted disease name] exists.
    2.2. I am aware of how [The targeted disease name] is transmitted.

3. To the best of my knowledge, [Targeted disease name from the list] require vaccines for their cure?

4. Vaccine/disease knowledge:

    4.1. "Eating plenty of garlic can help cure a coronavirus infection." (Completely false, Likely to be false, Not sure, Likely to be true, Completely true)

    4.2. "Vaccines have been developed that are effective against getting very sick from COVID." (Completely false, Likely to be false, Not sure, Likely to be true, Completely true)

    4.3. "Even if you get vaccinated it still does not help others around you." (Completely false, Likely to be false, Not sure, Likely to be true, Completely true)

    4.4. "If a person feels ill after receiving a vaccine, including the Covid vaccine, it means that the vaccine gave them the disease." (Not at all likely, a little bit likely, somewhat likely, fairly likely, completely likely + "do not know" and "refused to answer")

    4.5. [Design similar for other target vaccinations/diseases]

5. Beliefs about the (targeted) vaccine: I will read you some statements and I would like you to tell me how much you agree or disagree with each statement. Please say whether you strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree.

    5.1. [Targeted vaccine name] are safe.
    5.2. [Targeted vaccine name] are efficient.
    5.3. [Targeted vaccine name] help prevent disease or protect against severe cases.
    5.4. [Targeted vaccine name] are necessary to protect my health.
    5.5. [Targeted vaccine name] are necessary to protect other people's health.
    5.6. I am willing to encourage other people to take the [Targeted vaccine name]
    5.7. The benefits of receiving the [Targeted vaccine name] surpass any potential side effects.

6. Access:

    6.1. If you wanted to figure out when and where to get a vaccination, how easy or hard would that be? (very hard, a little bit hard, a little bit easy, very easy)

    6.2. Suppose you wanted to get a dose of the Covid vaccine. How feasible would this be for you, in terms of the time and money required? Not at all feasible, a little bit feasible, somewhat feasible, fairly feasible, totally feasible.

7. Vaccine confidence

7.1. To what extent do you believe that the [XXX] vaccination currently available at health centers in this country is safe and effective? (Not available; Not at all; a little bit; somewhat; mostly; completely)

7.1.1. [XXX] = ask for all target vaccinations in the country

7.2. Which of the following statements best describes your status regarding the [XXX] vaccine? (I am fully vaccinated; I am not vaccinated, but if someone brought it to me I would take it; I am not vaccinated, and I do not want to be vaccinated)

7.2.1. [XXX] = ask for all target vaccinations in the country

7.3. Suppose that COVID cases started to rise again. If the health ministry recommended that you get vaccinated or boosted for COVID, would you get it? (Definitely not, Probably not, maybe/maybe not, probably yes, definitely yes).

7.4.

8. Trust in healthcare system:

8.1. In the past 3 months how often have you visited a nurse, doctor, or community health worker for any health? (Yes/No)

8.2. In the past 3 months how often have you visited a nurse, doctor, or community health worker for vaccination related issues? (Yes/No)

8.3. In the past 3 months how often have you visited a nurse, doctor, or community health worker for vaccination related issues? (Never, only sometimes. often, always)

8.4. In general, how often have you visited a nurse, doctor, or community health worker for any health-related issues? (Never, only sometimes. often, always)

8.5. In general, how often have you visited a traditional medicine practitioner or a traditional healer for any health-related issues? (Never, only sometimes. often, always)

8.6. Which of the following statements is closest to your view? Choose Statement 1 or Statement 2.

Statement 1: Whenever I experience a health problem, I tend to seek medical advice from professionals in modern medicine.

Statement 2: Whenever I face a health issue, my preference is to consult traditional medicine practitioners for guidance and treatment.

Agree with neither [Do not read]

8.7. How confident are you in the government's healthcare system to help prevent you and your loved ones from getting very sick from diseases? (Not at all; a very little bit; somewhat; mostly confidence; totally confident)

8.8. If you wanted to verify the safety of a medication or vaccination, what is the best source to do so? (Do not read responses: Health Ambassador, doctor, nurse, health

worker, religious leader, chief or traditional leader, other relative or household member, internet/social media, books, other: specify).

8.9. I would like to offer you an opportunity to sign up to receive Ministry of Health bulletins via text [ASSUMING SUCH A SERVICE EXISTS]. Would you like me to sign you up for this service? (Yes/No)

Household level process indicators

Treated households will be asked about the nature of their interaction with the Health Ambassadors in the Endline survey:

- What is the name of the Health Ambassador you interacted with?
- Was the Health Ambassador someone that you already knew? Yes/No
- How frequently have you engaged in conversations with the Health Ambassador in the past two months? [Instructions for enumerator: This pertains to the duration from the beginning of the intervention until the date of the end-of-intervention survey.] (Indicate number of interactions)
- I will read you some statements and I would like you to tell me how much you agree or disagree with each statement. Please say whether you strongly agree, agree, neither agree nor disagree, disagree or strongly disagree.
    D. I learn something new in every discussion I have with the Health Ambassador
    E. The conversation with the Health Ambassador were interesting.
    F. I always share the lessons I learn from the discussion with my friends and other family members who do not attend.
- On a scale of 0-10, where 0 is POOR and 10 is EXCELLENT, please rate each of the topics that you discussed with the Health Ambassadors about the vaccine. If you did not cover a topic, let me know and we can skip the topic.
    A. Benefit of vaccine
    B. Availability of the vaccine
    C. Confidence in the vaccine
    D. Religious/Cultural reasons for not taken the vaccine.
    E. Others

- Did the Health Ambassador treat you with respect or were they disrespectful? Respect/Disrespectful
- Would you like it if the Health Ambassador came to speak to you more? Yes/No
- What did you talk about with the Health Ambassador? [open response]

Covariates

We measure the following covariate information in the household roster:

- Whether female for each adult,
- Age of each adult,
- Level of education for each adult,
- Ethnicity of a selected adult,
- Religion of a selected adult,

- Occupational status of a selected adult,
- Household size.

- Measures of opportunity cost from HoH survey:
    - Distance from focal health facility from GPS coordinates
    - How much time would it take to walk to the nearest health facility? (time in minutes)

- Measures of opportunity cost from roster:
    - How many days per week does this person work?
    - How many hours does this person work on a typical work day?

Health Ambassador Surveys

Health Ambassadors Check-In Surveys

At the end of each interaction with a household, the Health Ambassador will complete a brief questionnaire on (i) topics addressed during the discussions with the household, (ii) duration of each discussion topic, (iii) concerns regarding vaccines raised, (iv) the sentiment of the household members after the discussion, and (v) whether the discussion was participatory or tense. This will be submitted securely daily through an online platform.

Health Ambassadors Endline Survey

We will ask the Health Ambassadors to reflect on their experience in a debrief interview, during which they will be asked the following questions:

- What are the key things you learned about the reasons that some people do not get vaccinated?
- What are the key things you learned about how to talk to people so that they will listen to you?
- Did you enjoy this experience – why or why not?
- What would you change about how we asked you to do your job?
- What would you keep the same?

Health Facility Surveys

This survey is addressed to the administrators or any staff members at the health/post center who can represent the administrator's perspective for the targeted health centers in this study. This questionnaire is designed for all the health centers/clinics within the study's scope.

This questionnaire will provide a comprehensive overview of vaccination rates and shed light on the ongoing sensitization activities concerning vaccine hesitancy. Additionally, it will help us explore various contextual aspects related to the topic:

- How many inhabitants does this health center serve?

- Over the past three months, approximately how many patients have sought medical attention at this health/post center?
- In the last 3 months, are the following vaccines available in this health center/health post?
    - [List of vaccines with indication for Yes/No]
- In the last 3 months, are the following vaccines free in this health center/health post?
    - [List of vaccines with indication for Yes/No]
- Over the past three months, for the population that this health/post center is serving, have you been informed of any awareness campaigns, apart from those conducted by the government, health district, and our organization, aimed at reducing vaccine hesitancy for each of the following vaccines:
    - [List of vaccines with indication for Yes/No]
- For each of the vaccines that have been the subject of information campaigns within the localities served by this health center in the past 3 months, what were the awareness-raising strategies employed by the respective organizations?
    - [List of vaccines with indication for type of information campaign]
- Which organization(s) led this vaccination campaign?
    - [List of vaccines with space to indicate organization(s)]
- For each of the vaccines provided at this health center, what is the vaccination rate by June 2023?
    - [List of vaccines with space to indicate rate]
- In this health/post center, have you faced any instances of vaccine shortages in the last 3 months for each of the following vaccines?
    - [List of vaccines with indication for Yes/No]

Note: For each country (Côte d'Ivoire, Malawi, Senegal, and Zimbabwe), the list of vaccines will be limited to those specifically targeted by the study. This list of vaccines varies from one country to another.

Analysis Plan

Estimating Average Effects with Household Data

For the vaccine trust and other attitudinal measures in the individual survey, we will use a hierarchical index strategy.[1] All outcome measures will first be standardized in terms of control group standard deviations. That is, we will construct a standardized sum of scores index for each of the 4 groupings listed above. Then, we will construct a global index that is a standardized sum of the grouping indices. Indexes will be oriented so that more positive values indicate a movement in the beneficial direction. For a given index, we will estimate average treatment effects using the following regression specification:

$$y_i = \alpha + \beta\, Treated_i \; + Rand.Block\; FE_{b[i]} \; + X_i'\gamma \; + \epsilon_i \;\; , \qquad (1)$$

where *i* indexes the individual-survey respondent for household *i*, and $Rand.Block\; FE_{b[i]}$ and the covariate vector X_i are defined the same way as in equation (1). We calculate cluster-robust

[1] The approach follows that of Casey et al. (2012).

standard errors taking the error term ϵ_{vji} to be clustered at the level of the randomization cluster. Again, we hypothesize that $\beta > 0$, and we test using a two-sided test (allowing for the possibility that effects could go in the opposite direction as what is hypothesized) with 95% confidence. We will use a hierarchical statistical significance testing strategy:

- For the global index, we will use the standard asymptotic p value and a two-sided null hypothesis with 95% confidence.
- If the global p-value rejects the null, then for the grouping-specific indices, we will use a Benjamini-Hochberg FDR correction for the 4 p-values.
- For any grouping index that rejects the null, we will use the Benjamini-Hochberg FDR correction for the item level p-values.

For estimating peer effects, we will use the same specification (2), with *I* indexing the peer respondent and *Treated*$_i$ indicating the treatment status of the person that recommended them.

For our behavioral outcome measured in the household roster, we will estimate the average treatment effect on the pooled vaccination rate using the following regression specification:

$$y_{vji} = \alpha + \beta\, Treated_i + Vaccine\ FE_v + Rand.Block\ FE_{b[i]} + X_{ji}'\gamma + \epsilon_{vji}\ , \qquad (2)$$

where *v* indexes the vaccine, *j* indexes the individual adult in the household roster, *i* indexes the household, and *b*[*i*] indexes the randomization block for household *i*. The variable $Treated_i$ is an indicator for whether the household is in a treated cluster or not. Then, $Vaccine\ FE_v$ are fixed effects (dummy variables) for the different vaccines and $Rand.Block\ FE_{b[i]}$ are fixed effects (dummy variables) for the randomization blocks. The covariate vector X_{ji} includes the following elements:

- Indicator for female of individual *j*,
- Age for individual *j*,
- Level of education for individual *j*,
- Pre-intervention vaccination rate in the household's cluster.

We calculate cluster-robust standard errors taking the error term ϵ_{vji} to be clustered at the level of the randomization cluster. We hypothesize that $\beta > 0$, and we test using a two-sided test (allowing for the possibility that effects could go in the opposite direction as what is hypothesized) with 95% confidence. If we reject the null, we will then test effect on each individual vaccine, using the Benjamini-Hochberg FDR correction for the vaccine-level p-values.

Effect Heterogeneity with Household Data

We propose an exploratory analysis of background conditions that may moderate the size of the treatment effects on behavior and attitudes. These include:

Respondent attributes:

- Gender,
- Age,
- Level of education,
- Ethnic group (coded for collectivist norms),
- Proximity to health center.

Health ambassador attributes:

- Gender,
- Age,
- Type of degree program,
- Co-ethnicity with respondent,
- Personality measure of empathy (empathy assessment scale).

This analysis will take advantage of the random assignment of health ambassadors to households. We will perform a "dummy" random assignment for the control group so that we know, for each control group household, which of the health ambassadors *would* have treated them, counterfactually.

These analyses will be conducted as separate one-way interaction regressions with the following specifications:

$$y_{vji} = \alpha + \beta_1 Treated_i + \beta_2 W_{ji} + \beta_3 Treated_i * W_{ji} + Vaccine\ FE_v + Rand.Block\ FE_{b[i]} + X_{ji}'\gamma + \epsilon_{vji}\ , \quad (4)$$

$$y_i = \alpha + \beta_1 Treated_i + \beta_2 W_i + \beta_3 Treated_i * W_i + Rand.Block\ FE_{b[i]} + X_i'\gamma + \epsilon_i\ , \quad (5)$$

where W_{ji} or W_i refers to the background characteristic in question. We will use FDR control on the p-values for the respondent attribute (as one family of estimates) and then the health ambassador attributes (as a separate family) interaction effect estimates.

Mechanisms through which the intervention may increase vaccine uptake

To identify the mechanisms through which the intervention may increase the primary outcome of interest, we estimate the following two equations:

$$M_{ji} = \alpha^M + \beta^M Treated_i + Rand.Block\ FE_{b[i]} + X_{ji}'\gamma^M + \epsilon_{vji}{}^M \quad (6)$$

$$Y_{ji} = \alpha^Y + \beta^Y Treated_i + \kappa M_{vji} + Rand.Block\ FE_{b[i]} + X_{ji}'\gamma^Y + \epsilon_{vji}{}^Y \quad (7)$$

The "first stage" effect of the Health Ambassador treatment on the mediating variables is captured by β^M and then the extent to which a mediating variable is responsible for transmitting the effect of the HA treatment onto vaccine outcomes is given by $\beta^M\kappa$. We will use the Imai et al. "mediation" software in R to implement this analysis. We hypothesize that the intervention will improve vaccine trust through subjects' acceptance of the benefits of vaccination, subjects' access to vaccination and affordability. Additionally, the subjects are aware of the availability of vaccines and the benefits and risks associated with the vaccine and are motivated to seek vaccination. Moreover, the subjects accept the medical system as a trustworthy healthcare provider.

Descriptive Analyses of Process and Context

We will prepare simple descriptive summaries of the process data from households and Health Ambassadors and the context data from the health facility authorities. These summaries will be used to understand more precisely how the intervention functioned and also what contextual factors may help to explain both patterns in the control group and patterns in effects.

Cost Analysis

We will conduct a Cost Analysis using the detailed input cost accounting methodology proposed by Dhaliwal et al. (2013).

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Appendix

Table A1: Total number of households and adults surveyed at baseline by country

Country	Total number of households surveyed by country	Total number of adults surveyed by country
Côte d'Ivoire	1,022	3,206
Malawi	1,001	2,515
Sénégal	959	4,766
Zimbabwe	791	2,131
Total	3,773	12,618

Table A2: List of 32 Health Facilities in Côte d'Ivoire by city

City	Health Facilities	Treatment Status
Abidjan	CSU COM ALIODAN	Control
Abidjan	CS ANYAMA PALMERAIE	Control
Abidjan	CSU AKOUPE ANYAMA	Control
Abidjan	CSU COM VRIDI 3	Control
Abidjan	CSU SONGON KASSEMBLE	Control
Abidjan	CSR AUDOIN	Control
Abidjan	CMS ASAPSU 2	Control
Abidjan	CM DON -- CSU ATTINGUIE	Control
Abidjan	CS MACA	Control
Abidjan	HMA	Control
Abidjan	CSU COM BANCO SUD	Treatment
Abidjan	MATERNITE WILLIAMSVILLE	Treatment
Abidjan	FSU HINNEH	Treatment
Abidjan	POLYCLINIQUE ADJOUFFOU	Treatment
Abidjan	CSU COM GONZAGUEVILLE	Treatment
Abidjan	FSU COM KOWEIT	Treatment
Abidjan	CSU DJIBI	Treatment
Abidjan	CSU LOCODJRO	Treatment
Abidjan	CSR AHOUE	Treatment
Abidjan	INHP-CHUT	Treatment
Bouake	CSU BROBO	Control
Bouake	CSU DJEBONOUA	Control
Bouake	FSU KOKO	Control
Bouake	CSU AIR FRANCE III	Control
Bouake	CSR BELLEVILE	Control
Bouake	CSU SOKOURA	Control
Bouake	CSU DARES SALAM	Treatment
Bouake	CSU BROKRO	Treatment
Bouake	CSU NIMBO	Treatment
Bouake	FSU DIEZOUKOUAMEKRO	Treatment
Bouake	CSC KOTIAKOFFIKRO	Treatment

Bouake	FSU AHOUGNANSOU	Treatment

Table A2: List of 32 Health Facilities in Malawi by city

City	Health Facilities	Treatment
Blantyre	Madziabango	Control
Blantyre	Bangwe	Control
Blantyre	G Pensuro Health Centre	Control
Blantyre	MDEKA Health centre	Control
Blantyre	Chileka	Control
Blantyre	Chilomoni Health Centre	Control
Blantyre	Mlambe Mission Hospital	Control
Blantyre	Lirangwe Health Centre	Control
Blantyre	Mbayani Health Center	Treatment
Blantyre	Zingwangwa	Treatment
Blantyre	Limbe Health Center	Treatment
Blantyre	Ndirande	Treatment
Blantyre	South Lunzu	Treatment
Blantyre	Mpemba	Treatment
Blantyre	Soche Maternity	Treatment
Blantyre	Makhetha Health Centre	Treatment
Lilongwe	Likuni Mission Hospital	Control
Lilongwe	Chitedze Health Centre	Control
Lilongwe	Kabudula Rural Hospital	Control
Lilongwe	Chilinde Health Services	Control
Lilongwe	Blessings Hospital	Control
Lilongwe	ABC Comm. Hospital	Control
Lilongwe	Ukwe Health Centre	Control
Lilongwe	Chimwala Clinic	Control
Lilongwe	Chadza Health Centre	Treatment
Lilongwe	Malingunde Health Centre	Treatment
Lilongwe	Kang'oma Health Centre	Treatment
Lilongwe	Dzenza Health Centre	Treatment
Lilongwe	Daeyang Luke Hospital	Treatment
Lilongwe	Nathenje Health Center	Treatment
Lilongwe	Area 25 Health Centre	Treatment
Lilongwe	Area 18 Health Centre	Treatment

Table A3: List of 32 Health Facilities in Senegal by city

City	Health Facilities	Treatment Status
Dakar	Le poste de santé de Saint Martin	Control
Dakar	Postes de santé Diamalaye	Control
Dakar	Le poste de santé de Hann	Treatment
Dakar	Le centre de santé des HLM	Treatment

Dakar	Postes de santé Mermoz	Treatment
Kaolack	Poste de santé Kabatoki	Control
Kaolack	Poste de santé Koundam	Control
Kaolack	Centre de santé Kasnack	Control
Kaolack	Poste de santé abattoirs	Treatment
Kaolack	Poste de santé Tidiane	Treatment
Mbacke	Poste de Santé Keur Gol	Control
Mbacke	Poste de santé Madiyana 2 (Mame Seynabou Ndiaye)	Control
Mbacke	Poste de santé Tindody	Control
Mbacke	Poste de santé Bobarelle	Treatment
Mbacke	Poste de Santé Serigne Souhaibou Mbacké Madiyane 1	Treatment
Mbacke	Poste de santé Ndindy Abdou	Treatment
Pikine/Keur Massar	Poste de santé de petit Mbao	Control
Pikine/Keur Massar	Poste de santé Jaxaye	Control
Pikine/Keur Massar	Poste de santé Madame Thiam	Treatment
Pikine/Keur Massar	Poste de santé Pikine darou khoudos	Treatment
Saint-Louis	Poste de santé Pikine	Control
Saint-Louis	Poste de santé Guet Ndar	Control
Saint-Louis	Poste de santé Goxxu Mbacc	Control
Saint-Louis	Poste de santé de Ngallèle	Control
Saint-Louis	Poste de santé Bango	Treatment
Saint-Louis	Poste de santé Sor	Treatment
Saint-Louis	Poste de santé Sor Dagga	Treatment
Thies	Poste de santé Hersent	Control
Thies	Poste de santé Medina Fall2	Control
Thies	Poste de santé Diakhao	Treatment
Thies	Poste de santé Keur Seib Ndoye	Treatment
Thies	Poste de santé Mbour2	Treatment

Table A4: List of 32 Health Facilities in Zimbabwe by city

City	Health Center	Treatment Status
Bulawayo	Njube	Control
Bulawayo	Magwegwe	Control
Bulawayo	Pumula South	Control
Bulawayo	Mzilikazi	Control
Bulawayo	Entumbane	Control
Bulawayo	Luveve	Control
Bulawayo	Cowdray Park	Treatment
Bulawayo	Pelandaba	Treatment
Bulawayo	Mahatshula	Treatment
Bulawayo	Tshabalala	Treatment
Bulawayo	Maqhawe	Treatment

Bulawayo	Pumula	Treatment
Harare	Glen View Sate	Control
Harare	Mabvuku Polyclinic	Control
Harare	Kuwadzana Sate	Control
Harare	Braeside F.H.S	Control
Harare	Warren Park Polyclinic	Control
Harare	Kuwadzana Polyclinic	Control
Harare	Budiriro Polyclinic	Control
Harare	Mufakose F.H.S	Control
Harare	Rutsanana Polyclinic	Control
Harare	Glen Norah Sate	Control
Harare	Budiriro Satelite	Treatment
Harare	Sunningdale Sate	Treatment
Harare	Hatcliffe Polyclinic	Treatment
Harare	Rujeko Polyclinic	Treatment
Harare	Highfield Polyclinic	Treatment
Harare	Kambuzuma Polyclinic	Treatment
Harare	Mbare Polyclinic	Treatment
Harare	Mabvuku Sate	Treatment
Harare	Tafara F.H.S	Treatment
Harare	Hopley Tariro	Treatment