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SMS Interventions Do Not Increase COVID-19 Vaccination Completion in Kenya[1]

Florence Aketch, Kevin E. Carney, Michael R. Kremer, Elisa M Maffioli, James Otieno, Leah R. Rosenzweig, and Wendy N. Wong[2]

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Abstract

Objective: To evaluate the impact of SMS interventions on COVID-19 vaccination completion in Kisumu County, Kenya and address barriers to completion among people who receive a first but not a second dose of a two-dose COVID-19 vaccine sequence.

Methods: We conducted four experiments between July 2022 and January 2023 testing the effect of SMS messages that provided people with information about the vaccines and reasons to get fully vaccinated, including incentives. Partnering with the Kisumu County Ministry of Health, we randomly assigned 69,824 people to receive one SMS or to a control where they received no message. After the fourth, final experiment, we randomly selected 114 participants for a qualitative phone survey.

Findings: We find no significant treatment effects of any of the SMS messages on vaccination completion rates. Vaccination completion rates increase over the study period but do not increase significantly more in any treatment condition than in the control group. Phone surveys reveal that 85% of people recalled receiving the message, but that concern about COVID-19 could be a

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substantial barrier, with approximately one-third of the sample saying they are “not at all worried” about COVID-19.

Conclusion: Two-to-three years into the pandemic, a simple SMS intervention in Kisumu, Kenya does not increase COVID-19 vaccination completion rates among those who received only the first dose of a two-dose sequence.

I. Introduction

Vaccination is a vital tool for decreasing the severity and transmission of COVID-19, yet in low-income countries, only one-quarter of adults has completed a primary series of the COVID-19 vaccine (WHO, 2023). Increasing COVID-19 vaccination completion rates is a crucial policy challenge. One population where policymakers may make inroads is those who have received the first dose of a two-dose sequence but have not yet returned for their second dose. Attrition rates between doses are often high, with serious consequences, as receiving only one dose provides significantly less protection than receiving two (Lopez Bernal et al. 2021). In Kenya, an estimated 23% of people who received a first dose did not return to complete their full primary series of the COVID-19 vaccine (Mathieu et al. 2023).

SMS interventions have been used to support policy goals across a variety of domains, such as encouragement to save (Karlan et al. 2016), reminders to appear in court (Cooke et al. 2018), and health behavior change (Hall et al. 2015). Such interventions are attractive because of their low costs: at just several cents per message, even interventions with small impacts could be highly cost-effective. Especially in low- and middle-income (LMICs) countries, researchers and policymakers often turn to SMS messages as a way of disseminating information at scale to people who may have limited access to the internet or live in areas that are difficult to reach (Fabregas, Kremer, and Schilbach 2019).

Policymakers have used SMS interventions during the COVID-19 pandemic in an attempt to encourage vaccination and other prevention measures. Research from the United States finds that text messages encouraging people to get vaccinated for COVID-19 increased appointments and vaccination rates (Dai et al. 2021) early in the pandemic. However, later research, conducted more than one year after vaccines first became available in the U.S., finds no

effect of SMS messages on COVID-19 vaccination rates (Rabb et al. 2022). In low- and middle-income countries, SMS messages have been effective at encouraging childhood vaccination (Eze, Lawani, and Acharya 2021; Gibson et al. 2017; Manakongtreecheep 2017; Mekonnen et al. 2021) and COVID-19 prevention measures such as social distancing and handwashing (Bahety et al. 2021; Breza et al. 2021). Yet scant evidence exists on whether SMS campaigns can be an effective tool to encourage COVID-19 vaccinations in low- and middle-income countries.

We conducted a field experiment in Kenya from July 2022 through January 2023 testing SMS interventions targeted at increasing a critical health action: COVID-19 primary series vaccination completion. As a benchmark, our first experiment was launched at the end of Kenya's sixth COVID-19 wave, which occurred in late June and early-to-mid July 2022. As of July 2022, Kenya had reported a cumulative number of 337,242 COVID-19 cases (6,361 per million people) and 5,670 deaths (106 per million people), though estimates of COVID-19 cases and deaths are likely underreported (Cabore, 2022). After the sixth wave, daily COVID-19 cases in Kenya remained low, at under 200 weekly confirmed cases nationally. The adult COVID-19 vaccination completion rate, as measured as having completed the recommended doses of the initial vaccine protocol (eg. two doses of Astra-Zeneca or Pfizer or one dose of Johnson and Johnson), at the time was approximately 26% (Our World in Data, 2022). The study took place in one of Kenya's largest counties, Kisumu, in partnership with the County Ministry of Health (MOH). We targeted people who had received a first but not a second dose of the COVID-19 vaccine, a population of particular interest to our government partner, who aimed to increase vaccination completion. The Ministry of Health provided us with administrative data to measure vaccination behavior. We used these data to test the impact of a series of SMS interventions

involving incentives and framing, designed based on theories from behavioral economics. We also tested a series of messages that addressed more standard reasons why someone might not get vaccinated, such as limited information about vaccination sites and concerns about side effects. We conducted a follow-up phone survey among a subsample of participants to better understand our experimental treatment effects.

II. Methods

The Sample

Our study targeted individuals who had received their first COVID-19 dose in one of three sub-counties in Kisumu, Kenya — Kisumu West, Kisumu Central, and Nyakach — but had not returned to receive their second dose.[3] These three locations were chosen to be a representative subset of Kisumu County: Kisumu Central is primarily urban, while Kisumu West is peri-urban and rural, and Nyakach is primarily rural. Each sub-county has a population of between 150,000 and 175,000 people. A meaningful fraction of the total population in each sub-county had received only one dose of the COVID-19 vaccine at the beginning of the interventions in July 2022: 11.9% in Kisumu Central, 9.7% in Kisumu West, and 5.5% in Nyakach. The Kisumu County Ministry of Health kept a list of these people from the moment they received a first dose, along with their phone numbers (mChanjo database). We use the entire list as our sample, as the Kisumu County Ministry of Health removed individuals from the list when they received their second dose. We measured COVID-19 vaccination completion by tracking daily which individuals in our sample were removed from this list. This measure allowed us to measure the treatment effects of the interventions and track trends over time for the duration of the study.

[3] Most people in Kenya received the two-dose AstraZeneca (42%) or Pfizer (33%) vaccine (African Union 2023).

We generated our sample by downloading this list of people in our three sub-counties from the mChanjo database on a given date. We use the full universe of these individuals in our experiments. For the first and second experiments, we downloaded the list and randomized on July 17, 2022, several days before the first experiment began on July 22. The second experiment took place using the same list downloaded on July 17, and the messages were sent on August 2.[4] As a result, the second experiment includes people with a longer time between their first vaccine dose and the SMS intervention. Individuals from the July 17 list were randomized to either experiment 1 or experiment 2 and were then randomized to a treatment condition (or control) within that experiment. For the third experiment, we downloaded a new list of people and randomized on August 22, 2022, and we sent messages on August 23. For experiment 4, we downloaded the list and randomized on January 16, 2023, and launched the SMS interventions on January 18. All participants were included in a single experiment and excluded from later experiments.

Treatments

Drawing from existing research in behavioral economics on SMS interventions to induce behavior change, we designed a series of messaging interventions that we tested using four randomized experiments. Our goal was to test simple reminders (Karlan et al. 2016), appeals to social norms (Frey and Meier 2004), scarcity (Cialdini 2008), and time-limited incentives focused on mitigating procrastination due to present bias (Laibson 1997). Within each experimental sample, individuals were randomized with equal probability into each of the different messages and a control group, which did not receive any message. Each individual assigned to an SMS treatment arm received the message assigned to them at the same time and received any relevant follow-up messages immediately upon replying "1" to ask for more

[4] We removed people on the list who received a second dose between the first and second experiments.

information.[5] We partnered with two non-profit organizations in Kenya, the Busara Center for Behavioral Economics and Maisha Meds, to send these messages.

The goal of the first experiment was to test different SMS addressing potential reasons that might prevent people from getting vaccinated (e.g. lack of information, forgetting that a second dose is required, and lack of motivation). The goal of the second experiment was to examine incentives, testing the effect of providing different deadlines to get vaccinated and obtain a 100 Kenyan shilling (approximately US$0.80) airtime benefit for doing so. The second experiment used varying deadlines to test this tradeoff between commitment to take an action and flexibility to do so when convenient (Laibson, 2015), with the goal of maximizing vaccination completion rates. The third and fourth experiments focused on a subset of messages from the second experiment, to increase the precision of the null effects we find. Immediately following the fourth experiment we conducted a follow-up phone survey with 114 randomly selected respondents to better understand reactions to the messages. Across all experiments, we measured the impact of these messages on vaccination completion rates using Kenya's administrative COVID-19 vaccination records. We also collected data on the frequency of replies to our messages, which allowed people to request more information about vaccination sites.

In the first experiment, participants were randomized into one of the following groups:

1. **Control:** No message
2. **Reminder:** Reminder from Kisumu MOH to finish your COVID-19 vaccination.
3. **Reminder + info:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Reply 1 (no cost) for more info.

[5] Approximately 5% of people who received a message replied to receive more information when the option was available.

4. **Reserved for you:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Your 2nd jab has been reserved for you.[6] Reply 1 (no cost) for more info.
5. **COVID side effects:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Mild side effects are normal & mean you are building protection. Reply 1 (no cost) for more info.
6. **Duty:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. It's our duty to protect each other. Vaccination is part of that. Reply 1 (no cost) for more info.
7. **COVID still a threat:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. COVID-19 is still out there. Get your 2nd jab today! Reply 1 (no cost) for more info.
8. **Time-limited reimbursement - deadline of one week:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Get your 2nd jab in the next week and receive 100/= airtime! Reply 1 (no cost) for more info.

In the second experiment, participants were randomized into one of the following groups:

1. **Control:** No message
2. **Reminder:** Reminder from Kisumu MOH to finish your COVID-19 vaccination.
3. **Reminder + info:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Reply 1 (no cost) for more info.
4. **Time-limited reimbursement - deadline of current day:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Get your 2nd jab today and receive 100/= airtime! Reply 1 (no cost) for more info.

[6] This message is motivated by Milkman et al. (2021)

5. **Time-limited reimbursement - deadline of one week:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Get your 2nd jab in the next week and receive 100/= airtime! Reply 1 (no cost) for more info.
6. **No limit reimbursement (with reimbursement valid for one month):** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Get your 2nd jab and receive 100/= airtime! Reply 1 (no cost) for more info.
7. **Scarcity:** Reminder from Kisumu MOH to finish your COVID-19 vaccination. Hurry! The next 100 to get a 2nd jab receive 100/= airtime. Reply 1 (no cost) for more info.

The third and fourth experiments included messages 1 to 5 from the second experiment.

Upon replying 1, participants received an SMS stating: "Your 2nd vaccine dose reduces your risk of getting COVID-19 & severe illness. Available for free at most health facilities." We then provided a link to a full list of facilities. This allowed us to measure engagement with the messages through replies of "1" and by tracking link clicks. Where airtime is offered, upon replying 1 (treatment arm 4 and 5), participants also received an SMS stating: "100/= airtime will be sent to your phone if you reply here with the facility name and date where you got your 2nd jab. Offer not transferable."[7]

III. Results

Treatment Effects

Despite an aggregate increase in vaccination rates across all experiments and all intervention groups over time, we find no evidence of statistically significant differences in vaccination completion rates between those who received any single SMS intervention and those who did not. In the third experiment, we find that the airtime offer with a one-day deadline leads

[7] Because replying 1 was not listed as a requirement for the airtime offer in the initial message, we sent airtime to anyone in the incentive conditions who was vaccinated during the study period.

to a significantly higher vaccination rate after one week, relative to the control. However, this difference is small in absolute terms: we estimate that the offer increased vaccination rates by 0.4 percentage points (but large in relative terms: a 170% increase over the control completion rate of 0.23%). This difference is not statistically significant when we adjust for multiple hypothesis testing (Anderson 2008).

To increase statistical power, we pool treatments that appeared across multiple experiments and compare them to the pooled control in the corresponding experiments. Figure 1 shows coefficient plots for these pooled comparisons. Again, we see no evidence of statistically significant effects for any of the SMS interventions. Furthermore, when we compare people who received any SMS intervention (pooling all 10 treatment arms) to those who received no message, we still find no statistically significant effects in vaccination completion rates measured one week after the messages were sent.[8] This indicates that the increase in vaccination completion rates occurred also for people who did not receive any of our messages and that our SMS messages did not increase completion rates beyond the general trend in the control group. These null effects are precisely estimated: for most of the intervention arms, we can rule out effects of larger than 1 percentage point at the 95% confidence level, and for the four treatment arms (1-4) that appeared only in the first experiment we can rule out effects of larger than 4 percentage points at the 95% confidence level.

Trends

To better understand the context for these null treatment effects, we explore how vaccination completion rates changed over the course of the experiments. Figure 2 plots vaccination completion rates over time for each of the four experiments. In all experiments,

[8] We also test the effect of SMS interventions on vaccination completion rates one day and three weeks after the SMS was sent, and find robust null treatment effect estimates.

vaccination completion rates increase with time. Vaccination completion rates increased the most in the first experiment (Panel A). This might be due to the fact that some governmental campaigns were ongoing at that time in Kisumu County. We observe a large increase over the first two-week period, with nearly a quarter of people in the sample returning to receive their second dose of the COVID-19 vaccine. This likely captures people who received their first dose shortly before the experiment began, and returned for their second dose as scheduled.[9] After this initial period, the likelihood of returning for the second dose decreases, as indicated by a flattening of the trend in Panel A.

The second, third, and fourth experiments occurred later, in August 2022 and January 2023, and did not align with any governmental campaign in the county. As such, the set of people on our list at the beginning of these experiments were presumably more likely to be overdue on their second dose. Consistent with this, vaccination completion rates do not increase as rapidly after the SMS interventions in the second, third, and fourth experiments as in the first one.

Discussion

There are several possible reasons for these null effects. It could be that people did not read the messages, read them but did not trust them, or that the SMS interventions were not frequent enough or did not contain appropriate content to lead to a measurable change in behavior. Data on message engagement and click tracking from the “more info" links in the messages suggest that a key barrier may be engagement with the SMS messages. Very few people across all four experiments (less than 5%) who received an SMS engaged with it by replying for more information (at no cost), and a negligible fraction of people (less than 10,

[9] This is speculative as the administrative list we had access to simply indicated whether someone had received a first but not a second dose, and not whether they were overdue for their second dose. The list does not include the date of the first dose or any other indicator of how long someone was overdue.

0.1%) clicked on the link we sent in some treatment arms. In this context, where people receive many SMS messages, often spam, SMS nudges may not be sufficient to change vaccination behavior (Bahety et al. 2021). In this study, a single SMS was not enough to change people's behavior on average, unless coupled with financial incentives such as airtime.

To shed light on some of these mechanisms and possible reasons for the null effects, we conducted a follow-up phone survey in January 2023, following the fourth experiment, with 114 randomly selected participants, blocking the randomization by treatment arm. Results in Table 1 suggest that memory was not a significant barrier to treatment effectiveness. 85% of survey participants recalled receiving the SMS. Conditional on recalling the SMS, 86% of survey participants successfully recounted the content of the message, and 79% correctly recalled that the message was from the Kisumu MOH. General trust in the messages was high: only 5% of survey respondents among those who recalled the message thought it was a scam. However, there is some evidence that the financial incentive (i.e. airtime) may have backfired and reduced trust in the message, as about half of those who received the financial incentive thought that the offer was a scam (whereas only 10% of those who did not receive an incentive thought the message they received was a scam).

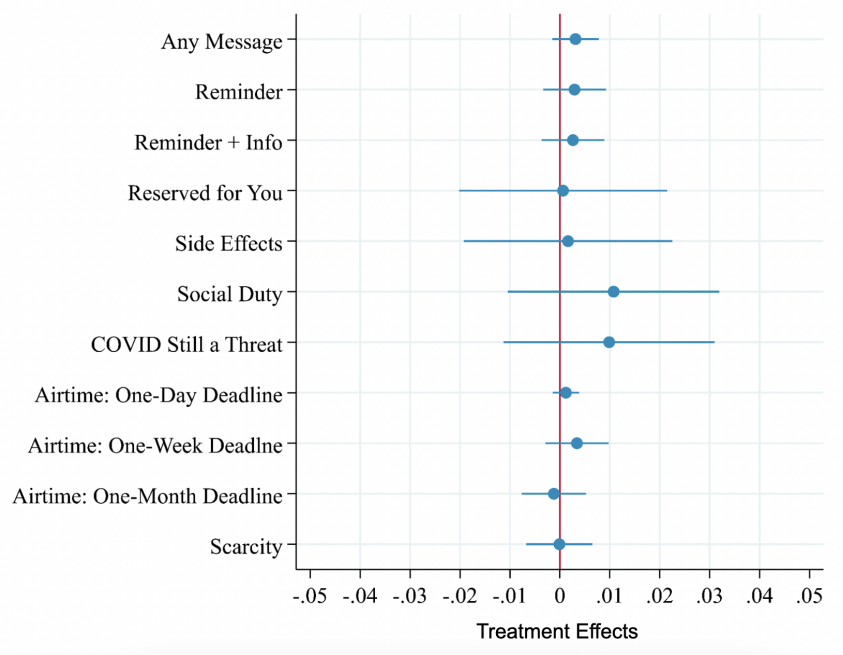
Furthermore, participants reported receiving 12 SMSs daily, of which an average 2.7 were spam, and an additional 12 phone calls daily. Our single message intervention could have been easily dismissed in this information environment. Also, only 18% of the survey participants were concerned about COVID-19 at the time – in early 2023, three years after the onset of the pandemic and Kenya's relatively low death rate. Only six percent of people reported having had COVID-19 in the past: while this is likely an underestimate, it could also reflect selection of the

individuals who had received at least a first dose, if those who previously recovered from COVID-19 are less likely to go for vaccination.

Altogether, the combination of these factors may have contributed to why only a single SMS was ineffective at changing individuals' behavior. Our follow-up survey shows that the messages were not ignored, forgotten, or disbelieved. However, the respondents received a high volume of SMS and calls, they were not particularly concerned about COVID-19, and only 6% of people saying they have had COVID-19. As such, one additional message, even if memorable, may not have been enough to change individuals' behavior.

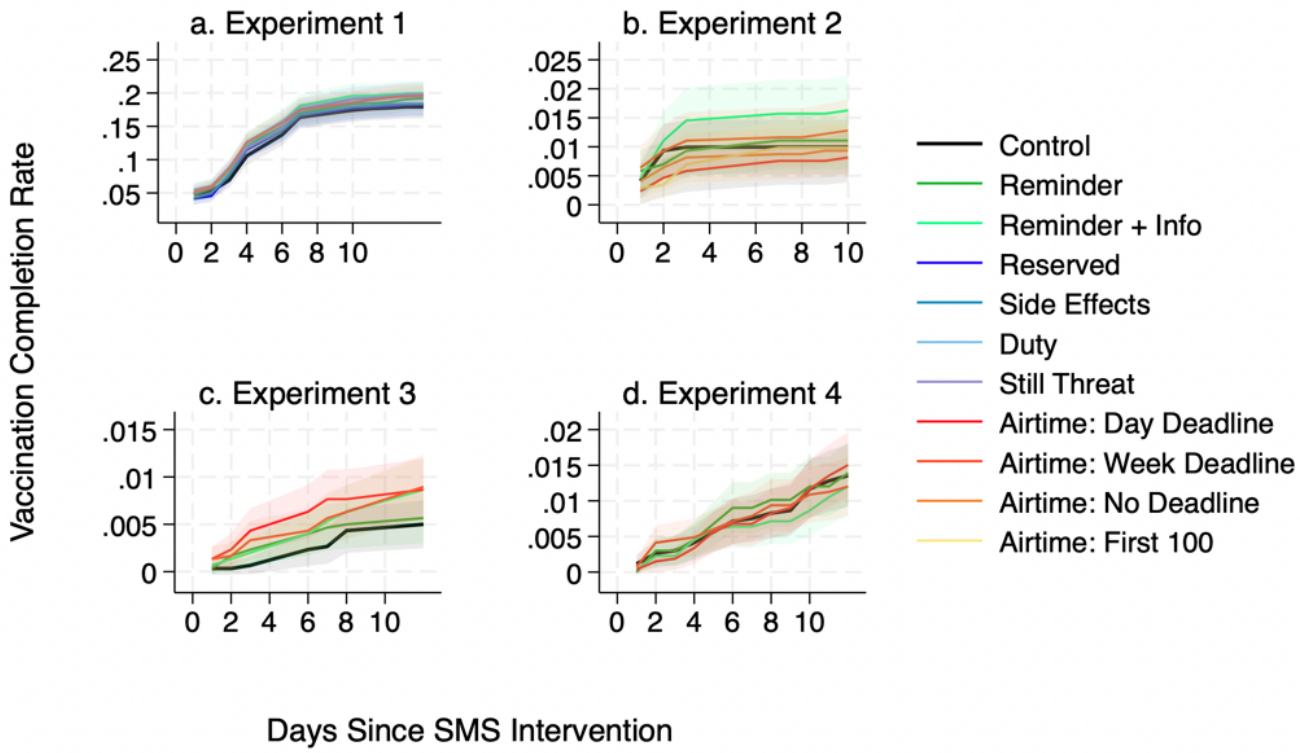
This paper reports results from a series of four experiments in July and August 2022 and January 2023 testing SMS interventions to encourage vaccination completion for those who had received a first, but not second dose of the COVID-19 primary series in Kisumu County, Kenya. None of the SMS interventions tested significantly increased vaccination completion rates, compared to a control group who did not receive any intervention, in either the individual experiments or pooled analysis. Our SMS interventions, coupled with airtime incentives, were aimed at addressing different behavioral and economic factors, including limited memory (Karlan et al. 2016), social norms (Frey and Meier 2004), scarcity (Cialdini 2008), and procrastination due to present bias (Laibson 1997). Policymakers seeking to design SMS campaigns for behavior change should consider the intensity of their intervention relative to their audiences' perceived importance of the target behavior and the SMS ecosystem.

Figure 1. Main Effects of SMS Interventions on Complete Vaccination Rates



Note: this figure plots the treatment effects of each of the messages we tested on vaccination completion rates, pooling the experiments in which a given message appeared. The total sample of the pooled experiments includes 69,824 people. The individual messages are distributed across the experiments as described in section II.

Figure 2. Complete Vaccination Rate by Experiment



Note: This figure plots the fraction of the sample who returned for their second vaccination dose across time, in days since the SMS intervention was sent, for each of the four experiments. These vaccination completion rates are plotted separately for each of the treatment conditions within an experiment. Shaded regions show 95% confidence intervals. Experiment 1 has 29,474 observations. Experiment 2 has 12,022 observations. Experiment 3 has 15,023 observations. Experiment 4 has 13,305 observations.

Table 1. Summary Statistics (Follow-Up Phone Survey)

Variable	Mean	SD	N
Recalls SMS	0.85	0.36	114
Recalls Content	0.86	0.35	97
Recalls Sender	0.79	0.41	92
Though SMS was a scam	0.05	0.23	91
Thought incentive was a scam	0.49	0.51	41
Daily SMS received	12.1	11.6	100
Daily spam SMS	2.74	3.09	100
Daily calls received	12.2	13.4	100
Shares phone	0.06	0.24	100
Has had COVID-19	0.06	0.24	100
Worries about COVID-19	0.18	0.39	100

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V. Appendix

Phone Survey Follow-Up for SMS Experiment — Kisumu County

Introduction and Verbal Consent

Hello, my name is [surveyor name] and I am calling on behalf of researchers from the University of Chicago in the United States and the Busara Center in Nairobi. May I speak with [participant name]?

We are conducting a brief phone survey aimed to understand experiences with receiving the COVID-19 vaccine as well as mobile phone use. The survey today will take approximately 5 minutes to complete. For your time, we will offer you Kes300, paid through M-PESA.

I would like to invite you to participate in our phone survey. Your participation is voluntary. If you consent, I will share the data I collect today with the research team for research purposes only. If you do not consent, I will not administer the survey or collect any data from you. You may withdraw from this research at any time.

Do you agree to participate in this survey?

[1] Yes
[0] No → END SURVEY

On our SMS

1. Do you recall receiving any SMS about the covid-19 vaccines being available in your area?
   [1] Yes
   [0] No

2. *[if 1=yes]* How many times did you receive the SMS?
   [1] Once
   [2] Twice
   [3] Many times

3. *[if 1=yes]* Do you remember what it said?
   [1] Yes
   [0] No

4. *[if 3=yes]* What did it say?
   [Enter text]

5. *[if 1=yes]* Do you remember who sent the SMS?
   [1] Yes
   [0] No

6. *[if 5=yes]* Who sent it?
   [Enter text]

7. *[if 1=yes]* What did you think when you received this sms? (Select all that apply)

[1] Thought it was a scam/spam
[2] Didn't think it was true
[3] Didn't trust the source
[4] Thought it was too little money
[5] Other

8. *[if 1=yes]* Did the SMS you receive mention any offer for getting vaccinated?
[1] Yes
[0] No

9. *[if 8=yes]* What was that offer?
[1] Airtime
[0] Other

10. *[if 9=other]* Specify:

11. *[if 9=airtime]* How much airtime was offered?
[Enter integer]

12. *[if 8=yes]* What did you think about this offer? (Select all that apply)
[1] Thought it was a scam/spam
[2] Didn't think it was true
[3] Didn't trust the source
[4] Thought it was too little money
[5] Other

13. [If 12=other] Specify:

14. [if 8=yes] Did you believe that you would receive the airtime if you got vaccinated?
[1] Yes
[0] No

15. *[if 1=yes]* Did you believe the information shared in the SMS?
[1] Yes
[0] No

16. *[if 1=yes]* Did you think this SMS was spam or from scammers?
[1] Yes
[0] No

On mobile use in general

17. How many times a day do you check your phone?
    [Enter integer, -99 = don't know]

18. Does your phone usually vibrate or make noise when you receive an SMS?
    [1] Yes
    [0] No

19. How many SMS do you send during an average [day]?
    [Enter integer]

20. How many SMS do you receive during an average [day]?
    [Enter integer]

21. How many phone calls do you receive during an average [day]?
    [Enter integer]

22. How many spam SMS (unsolicited, undesired commercial messages) do you receive during an average day?
    [Enter integer]

23. Does the phone you are using belong to you?
    [1] Yes
    [0] No

24. *[if 23=no]* Who does this phone belong to? (Select all that apply)
    [1] Spouse/partner
    [2] My sibling
    [3] My child
    [4] My parent
    [5] My grandparent
    [6] Other family member
    [7] A (non-family) friend or acquaintance

25. Do you share this phone with somebody else?
    [1] Yes
    [0] No

26. *[if 25=yes]* Who do you share this phone with? (Select all that apply)

[1] Spouse/partner
[2] My sibling
[3] My child
[4] My parent
[5] My grandparent
[6] Other family member
[7] A (non-family) friend or acquaintance

General COVID questions

27. Have you received any COVID-19 vaccine yet?
[1] Yes
[0] No

28. *[if 27=yes]* How many COVID-19 shots have you had so far?
[Enter integer]

29. *[if 28=yes]* Did you have any side effects after the vaccine?
[1] Yes
[0] No

30. Have you had COVID-19?
[1] Yes
[0] No

31. *[If 30=yes]* Did you confirm this with a COVID-19 test?
[1] Yes
[0] No

32. *[If 30=yes]* Did you seek any treatment for COVID-19?
[1] Yes
[0] No

33. How worried are you about getting COVID-19
[1] Very worried
[2] Moderately worried
[3] A little worried
[4] Not at all worried

End

Thank you for your time. We will provide you with Kes 300 to thank you for your participation. Would you like to receive this benefit to the number I called you on?

[1] Yes
[0] No

[If no] What number should I send the funds to?

[Enter integer]