Behaviorally Informed Messages Boost COVID-19 Vaccination Intentions: Global Insights from a Meta-Analysis with 23 Countries and Territories

Overview

The code in this replication package constructs the analysis file, tables, and figures for Pinzon et al. (2024) from the primary data sources using Stata. One main do file runs all of the code to generate the data, 4 tables, 7 figures, and appendices in the paper. The replicator should expect the code to run for about 20-30 minutes.

Data Availability and Provenance Statements

Data Availability

The data for this project are confidential, but may be obtained with Data Use Agreements with Pinzon et al. (2024) and the World Bank's Development Impact (DIME) Mind, Behavior, and Development (eMBeD) unit. Researchers interested in access to the data may contact eMBeD at eMBeD@worldbank.org. It can take some months to negotiate data use agreements and gain access to the data. The authors will assist with any reasonable replication attempts for two years following publication.

Data Provenance

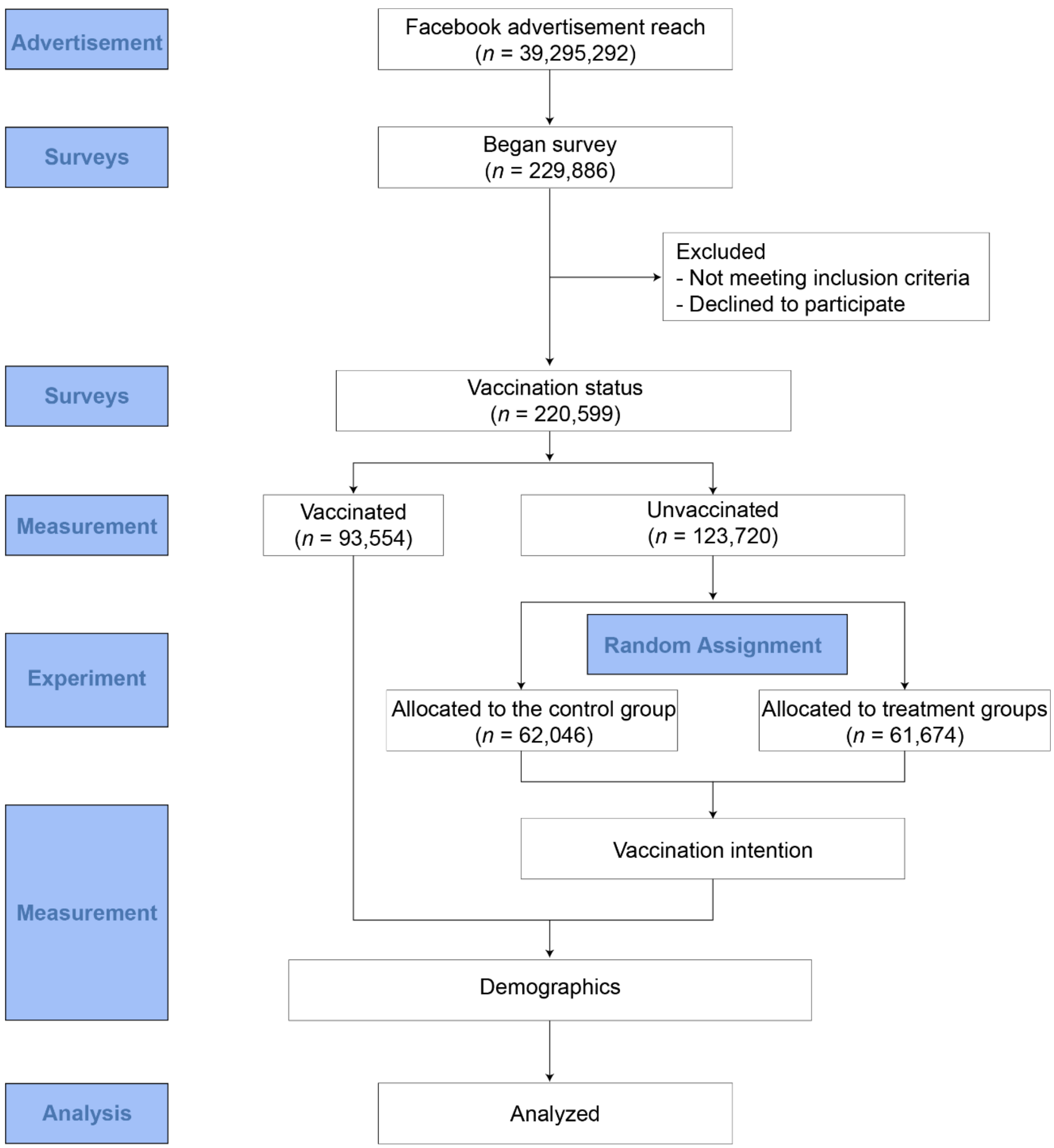
We conducted survey-experiments using Facebook. This study was approved by the Health Media Lab Institutional Review Board (HML IRB) approval number # 1017TWBG21. We closely coordinated with the Ministries of Health during the design, implementation, and analyses of the study.

Recruitment

To identify whether different behaviorally informed vaccine messages can increase intent to vaccinate, we conducted 28 randomized survey experiments using social media in 23 countries and territories between January 2021 (when vaccines were not widely available) and June 2022 (when vaccine supply was widely available). Participants were recruited through Facebook using quota sampling by displaying ads inviting participants to interact with a chatbot in Facebook Messenger to complete the survey (using languages of preference) for a chance to win a lottery reward. The sample in each country was drawn from all Facebook accounts 18 years and older in the country. We used quota sampling by exposing the recruitment ads to pre-defined demographic groups based on age, gender, and region to mirror the country's populations. Across all studies, the final sample included 229,886 responses in 28 studies with an average of 7,800 responses per online study. Only participants who had not received the COVID 19 vaccine were included in the experiment (n = 123,720), which is the focus of the results reported in this paper. No additional data cleaning was necessary because the Facebook Messenger chatbot ensures that only one survey is recorded per Facebook account and discards responses that deviate from the questions asked.

Participants who clicked on the study advertisement were redirected to Facebook Messenger, where the survey was conducted via chatbot. Participants selected their preferred language and gave informed consent at the beginning of the survey before proceeding to the survey modules. See Figure 1 for a summary of participant inclusion and exclusion at each step of the studies.

Figure 1. Study flow diagram.



Randomization. After answering a question about their COVID-19 vaccination status, unvaccinated participants were randomized to study arms with different behaviorally-informed message framings about the COVID-19 vaccine. Randomization was stratified such that participants had a greater probability of being allocated to the control message compared to other arms, and all treatment message arms had an equal probability of assignment.

Stimuli: Message Framings

Message framings were informed by prior research and leveraged principles like the messenger effect, targeting beliefs about the safety and efficacy of the vaccine, and social norms. Reflecting unique country contexts and the evolving pandemic circumstances, the content of messages varied across countries and over time. For example, messages highlighting variants and COVID-19 becoming endemic were tested only at later stages of the pandemic, whereas framings about expert endorsement and safety were tested early and throughout much of the pandemic. In addition, the selection of messages to be tested in each country was informed by expectations of what would be most effective in a given context—for instance, messages relating to religious leader endorsement were tested in contexts where religion was expected to have greater impacts such as religious countries in the Middle East and North Africa. As such, direct comparisons of the magnitude of impacts across different framings should be interpreted with caution—as differences in impacts may reflect systematic differences in country and timeline of rollout. Two framings (financial incentives, mortal risk of COVID-19) were tested in fewer than three studies and were thus excluded from the meta-analysis. See Appendix C for the operationalization of message framings used in each study.

Control framing (k = 28, n = 62,046). The control framing was a pure control with no additional text before the vaccine intention question.

Experts framing (k = 16, n = 14,152). This framing aimed to leverage a messenger effect by emphasizing that experts consider the vaccines safe and effective (e.g., '*The COVID-19 vaccines available in {country} ({type of vaccines}) are considered safe and highly effective by national and international experts*').

Experts + celebrities framing (k = 7, n = 9,492). This framing leveraged the messenger effect by alluding to endorsements of experts as well as celebrities, who have also been demonstrated to have an influential effect on health behavior (Alatas et al., 2024; Chu et al., 2021) (e.g., '*The COVID-19 vaccines available in {country} ({type of vaccines}) are considered safe and highly effective by national and international experts, and celebrities and famous athletes get it themselves*').

Experts + religious leaders framing (k = 8, n = 10,082). This framing leveraged the messenger effect by alluding to endorsement of religious leaders as well as experts, as religious leaders also play an important role in shaping health behaviors in many contexts (Rakotoniana et al., 2014) (e.g., '*If a COVID-19 vaccine is considered safe and effective by* *national and international experts, and religious leaders in your community get it themselves, would you plan to take the vaccine?*').

Safety framing (*k = 12, n = 6,298).* This framing contrasted the safety of the COVID-19 vaccines to the dangers of COVID-19 infection, addressing concerns about the safety of vaccination (e.g., '*COVID-19 vaccines are safe - there have been no reported hospitalizations in {Country} due to vaccinations compared to {number} deaths due to COVID-19'*).

Efficacy and pro-social framing (*k = 14*, *n* = 8,841). This framing emphasized the efficacy of COVID-19 vaccines for protecting the vaccinated person and their family and friends from serious health complications. (e.g., '*The latest studies from around the world confirm that the COVID-19 vaccines protect you, your friends and family from COVID-19 by substantially reducing or eliminating hospitalizations and deaths*).

Dynamic social norms framing (*k = 12*, *n* = 6,258) This framing used messaging to convey that descriptive norms were shifting toward a growing number of people getting vaccinated against COVID-19 (e.g., *'{Nationality} are getting vaccinated against COVID-19! More than {number} have done it so far, with {number} just in the past 2 weeks alone'*). Messages used data available from governments or external sources to ensure the numbers provided were credible.

Endemic framing (*k = 7*, *n* = 3,215). This framing emphasized the vaccination needs for the future, as the COVID-19 will continue to exist (e.g., *'As we learn to live with COVID-19, it's likely we will all be exposed to the virus eventually. The best way to prepare yourself is to get fully vaccinated because it greatly reduces the risk of hospitalization and death'*).

Variants framing (*k = 6*, *n* = 3,336). This framing focused on the vaccine's efficacy against new variants, to account for concerns at the time about whether the vaccines would be protective against different strains of the virus (e.g., *'New variants like Omicron and Delta can be worrying, but the best evidence so far indicates that vaccines are still highly protective against serious illness and death from COVID-19'*).

Measures and Indices

Primary Outcome

Vaccine Intention*.* The outcome of interest is self-reported vaccination intention, which was measured for respondents who reported that they were not yet vaccinated at the time of the study. Vaccine intention was measured as a categorical outcome by asking a question "*Are you willing to/do you plan to get the COVID-19 vaccine*?" Response options included "Yes," "Unsure," and "No". For our main analysis, we recode these responses into a binary classification of "Yes" or "No/Unsure".

Potential Individual-Level Moderators

Gender. Participants were asked to indicate whether their gender was male, female, or other. In some country contexts, it was considered inappropriate to include the 'other' category, and participants were simply asked if they were male or female.

Age. Age was measured categorically, asking participants to indicate whether they were 18-29, 30-39, 40-49, 50-59, or 60+.

Education. Participants were asked to indicate the highest level of education they had completed – No Education, Primary Education, Secondary Education, or Tertiary Education.

Health worker. Participants were asked to indicate whether they were employed as a health worker or not.

Potential Study-Level Moderators

Based on discussion with public health and behavioral science experts and a review of the literature, we explore the following potential moderators: the month of study launch, the GDP per capita of the study country, the vaccination rate in the country at the time of the study, and trust and vaccine perception measures from the Wellcome Global Monitor Survey (2018). The Wellcome Global Monitor survey is a survey of attitudes toward science and health based on a survey with over 140,000 people in more than 140 countries. Since these data from the Wellcome Global Monitor survey are measured at the individual level, we aggregate these measures to the country level by taking their mean value. This approach is consistent with practices in cross-cultural and health research (e.g., Gelfand et al., 2011; Weinberg et al., 2021), including research estimating generalized trust at the country level (e.g., Marozzi, 2014; Reeskens & Hooghe, 2008; Robbins, 2012). See Appendix D for more details on the empirical rationale for country-level aggregation of the Wellcome Global Monitor survey indicators. The Wellcome Global Monitor 2018 data were not available for Belize, Djibouti, Jamaica, Papua New Guinea, and West Bank and Gaza.

Country-level vaccination rate (at least one dose). We include an estimate of the proportion of the country's population that received at least one dose of a COVID-19 vaccine. Country level data was obtained at the time of data collection from Our World in Data (2024), which collected data from public official sources. It might also reflect the level of deployment of the vaccine as well as the general acceptance of the vaccine. The effect of the intervention will be smaller in countries with higher vaccination rate because the remaining unvaccinated sample may be particularly reluctant to receive the vaccine.

Intervention start date. We included the start month of the data collection. The dates were centered so that the starting month of the first intervention (i.e., January 2021) was set to month 0, and so on until month 16, corresponding to the start of the last intervention (May 2022). The intervention start date might also reflect the available knowledge about the virus and availability of the vaccine at the time of the intervention.

GDP per capita PPP. We also explore country wealth using gross domestic product (GDP) converted to international dollars using purchasing power parity (PPP) rates from the World Bank (2024). An international dollar possesses equivalent purchasing power relative to GDP as the U.S. dollar does within the United States). The GDP per capita has been shown to correlate with a large number of social and health outcomes across countries (Bloom & Canning, 2000), which may influence the effectiveness of the behaviorally informed messages targeting vaccine intentions. When including this variable in the study-level moderator analysis, we center the data by subtracting the median GDP per capita PPP of the sample countries from the GDP per capita PPP of each country.

Trust in healthcare workers. We explore whether trust in healthcare worders (e.g., doctors and nurses) before the onset of the pandemic moderates impacts of message framings. We use data from the Wellcome Global Monitor (Wellcome Trust & Gallup, 2018), which assessed trust in healthcare workers with an item rating "*How much do you trust each of the following?*" for "*Doctors and nurses in this country*" on a 1-4 scale, with response options of "A lot", "Some," "Not much," "Not at all". Respondents could also respond with "Dont' know," and "Refused"—such responses were dropped from our analysis. For ease of interpretation, we reverse-coded the responses, so higher values indicate stronger trust such that 1 = *Not at all* and 4 = *A lot*. We aggregate trust to the country level by calculating the mean response within each country. We then center country-level trust measures by subtracting the median country-level trust measure from each country-level mean.

Perceived vaccine safety. We included perceived vaccine safety before the COVID-19 pandemic. We used data from the Wellcome Global Monitor (Wellcome Trust & Gallup, 2018). Perceived vaccine safety was measured by asking "Do you agree, disagree, neither agree nor disagree with the following statement? Vaccines are safe." on a 1-5 scale, with response options of "Strongly agree," "Somewhat agree," "Neither agree nor disagree," "Somewhat disagree," "Strongly disagree," "Don't know," and "Refused." We reverse-coded the responses, so higher values indicate stronger agreement, such that 1 = *Strongly disagree* and 5 = *Strongly agree*. We aggregate perceived vaccine safety to the country level by calculating the mean response within each country. We then center country-level vaccine safety perceptions by subtracting the median country-level trust measure from each country-level mean.

Perceived vaccine effectiveness. We included perceived vaccine effectiveness before the COVID-19 pandemic using data from the Wellcome Global Monitor (Wellcome Trust & Gallup, 2018). Perceived vaccine effectiveness was measured by asking "Do you agree, disagree, neither agree nor disagree with the following statement? Vaccines are effectiveness." on a 1-5 scale, with response options of "Strongly agree," "Somewhat agree," "Neither agree nor disagree," "Somewhat disagree," "Strongly disagree," As with the measure of vaccine safety, we reverse-coded the responses, so higher values indicate stronger agreement, and responses of "Don't know" and "Refused" were dropped. We aggregate perceived vaccine effectiveness to the country level by calculating the mean response within each country. We then center country-level vaccine safety perceptions by subtracting the median country-level trust measure from each country-level mean.

Statement about Rights

We certify that the author(s) of the manuscript have legitimate access to and permission to use the data used in this manuscript.

Summary of Availability

No data can be made publicly available.

Details on Data Source

Data.Name	Data.Files	Location	Provided	Citation
"Dataset"	moderator_individual_level.dta Summary_country.xlsx Tunisia_w3_raw.dta Tunisia_w2_raw.dta Tunisia_w1_raw.dta Ukraine_sm_raw.dta Gambia_raw.dta Zambia_raw.dta XK_raw.dta Wbg_raw.dta Ukraine_raw.dta Serbia_raw.dta Png_raw.dta MK_raw.dta Libya_raw.dta Lebanon_w2_raw.dta Lebanon_w1_raw.dta Kuwait_raw.dta Ksa_raw.dta Jordan_w2_raw.dta Jordan_w1_raw.dta Iraq_w2_raw.dta Jamaica_raw.dta Honduras_raw.dta Iraq_w1_raw.dta DJ_raw.dta Haiti_raw.dta Congo_raw.dta Cmr_raw.dta	/Datasets	TRUE	Pinzon et al. (2024)

Chad_raw.dta
Belize_raw.dta

Computational requirements

Software

Stata (code was last run with version 18)

- `metan` (as of 2024-07-07)
- `stripplot` (as of 2024-07-07)
- `outreg2` (as of 2024-07-07)
- `ipdmetan` (as of 2024-07-07)
- `rsort` (as of 2024-07-07)

- The initial code of "reproducibility_do.do" at the beginning will install all dependencies locally, and should be run once.

Memory and Runtime Requirements

Summary

Approximate time needed to reproduce the analyses on a standard (2024) desktop machine:

- About 60 minutes

Details

The code was last run on an **Intel-based laptop with Windows 10, 16.0 GB RAM.** Computation took about 1 hour.

Description of programs/code

- Programs in `reproducibility.do` will run all analyses and generate all tables and figures in the main body of the article and the appendix, except Table 2 in the main body. The file `programs/reproducibility_do.do` will run them all. Each program called from `main.do` identifies the table or figure it creates. Output files are called appropriate names (`table3.xlsx`, `figure1.png`) and should be easy to correlate with the manuscript.

License for Code

The code is licensed under an MIT license. See the "license.rtf".

Instructions to Replicators

- Edit "`global dir`" to adjust the default path
- Run "reproducibility_do`.do`" once on a new system to set up the working environment and to run all steps in sequence. Download the confidential data files referenced above in the same default folder along with the do file. Each should be stored in the format that you download them. No further action is needed on the replicator's part.

Details

- reproducibility_do.do: will create all output (figures and tables).
    - These programs were last run at various times in 2024.

List of tables and programs

The provided code reproduces:

- All numbers provided in text in the paper
- All tables and figures in the paper

Figure/ Table #	Program	Line Number	Output file	Note
	Reproducibility_do.do			All requires confidential data
Figure 1		385		Created separately with the Adobe Illustrator using the numbers from console
Table 1		414		Created using the numbers from the console
Table 2		435		Directly from the dataset, Manually calculated from Appendix A
Figure 2		457	Figure2 T5.png, Figure2 T6.png, Figure2 T7.png, Figure2 T8.png	
Figure 3		457	Figure2 T1.png, Figure2 T2.png, Figure2 T3.png, Figure2 T4.png	
Table 3		474	Table 3.xlsx	

Figure 4	540	Figure 4 health worker.png Figure 4 i_age.png Figure 4 i_education.png Figure 4 i_gender.png	
Table 4	540	Table 4.xlsx	
Figure 5	916	Figure 5_6 young T8.png Figure 5_6 old T8.png	
Figure 6	916	Figure 5_6 young T5.png Figure 5_6 old T5.png	
Figure 7	931	Figure 7 female T4.png Figure 7 male T4.png	
Appendix A	946		Directly from the dataset
Appendix B	952		Directly from the console
Appendix C			Not part of the code. Manually added by the authors
Appendix D	960		ICCs were added directly from the console with half rounding up
Appendix E	314	Appendix E.xlsx	

Appendix F	1004	Appendix F.xlsx	Effects by study are in tab "int1" and combined effects are in tab "int5". The odds ratio is in column C (_EFFECT) and the p-value is in column E (_pval).
Appendix G	1052	Appendix G.xls	
Appendix H	540	Table 4.xlsx (Appendix H is from Table 4)	

Acknowledgements

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