Public Disclosure Authorized

Public Disclosure Authorized

Policy Research Working Paper 10275

The Evolution of COVID-19 Vaccine Hesitancy in Sub-Saharan Africa

Evidence from Panel Survey Data

Philip Wollburg
Yannick Markhof
Shelton Kanyanda
Alberto Zezza

WORLD BANK GROUP
Development Economics
Development Data Group
January 2023

Policy Research Working Paper 10275

Abstract

COVID-19 vaccination rates in Sub-Saharan Africa lag behind other world regions, with just over 20 percent of the population in Sub-Saharan Africa fully vaccinated. To reach widespread coverage, high willingness to get vaccinated for COVID-19 among the population is considered an important prerequisite. Drawing on two years of panel survey data, this paper studies the dynamics of vaccine acceptance, its correlates, and reasons for hesitancy over time. The data come from multiple rounds of national High-Frequency Phone Surveys in five countries in East and West Africa (Burkina Faso, Ethiopia, Malawi, Nigeria, and Uganda), covering the period between 2020 and 2022. The surveys are cross-country comparable and draw their samples from nationally representative sampling frames. The paper finds that COVID-19 vaccine acceptance has been high throughout the study period (68 to 98 percent). However, acceptance levels were lower in 2022 than in 2020 in three countries (Burkina Faso, Malawi, and Nigeria) and higher in one country (Uganda). Moreover, individuals are observed to change their stated vaccine attitudes between survey rounds, to a limited extent in some countries (Ethiopia) and more frequently in others (Burkina Faso, Malawi, Nigeria, and Uganda). Vaccine hesitancy is higher in richer households and among those residing in urban areas, women, and the better educated. Conversely, hesitancy is lower in larger households and among heads of the household. The main reasons for hesitancy are concerns about side effects of the vaccine, its safety and efficacy, as well as assessments of COVID-19 risk, although these reasons fluctuate over time. The findings suggest that vaccine hesitancy is not the primary obstacle to reaching greater vaccine coverage in Sub-Saharan Africa. Instead, low coverage rates may be related to access and delivery barriers as well as supply shortages. Nevertheless, vaccine attitudes appear malleable so that continued efforts are needed to retain high levels of vaccine acceptance.

This paper is a product of the Development Data Group, Development Economics. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at pwollburg@worldbank.org.

The Policy Research Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about development issues. An objective of the series is to get the findings out quickly, even if the presentations are less than fully polished. The papers carry the names of the authors and should be cited accordingly. The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the International Bank for Reconstruction and Development/World Bank and its affiliated organizations, or those of the Executive Directors of the World Bank or the governments they represent.

Produced by the Research Support Team

The Evolution of COVID-19 Vaccine Hesitancy in Sub-Saharan Africa: Evidence from Panel Survey Data

Philip Wollburg*, Yannick Markhof*^, Shelton Kanyanda*, Alberto Zezza* [1]

JEL codes: I14, I18, I100, O55

Keywords: COVID-19, vaccination, Africa, vaccine hesitancy

[1] * World Bank, Development Economics Data Group. ^ UNU-MERIT, United Nations University. This paper received funding support from the World Bank Research Support Budget grant "Understanding and estimating COVID-19 vaccination attitudes, uptake, and barriers in Sub-Saharan Africa" and the Global Financing Facility. The authors are grateful for support in collecting the data by the country teams: Marco Tiberti for Burkina Faso; Wilbert Drazi Vundru for Malawi; Asmelash Haile Tsegay and Manex Bule Yonis for Ethiopia; Akiko Sagesaka, Amparo Palacios-Lopez, Ivette Contreras Gonzalez, and Gbemisola Oseni for Nigeria; and Giulia Ponzini and Frederic Cochinard for Uganda. We are also grateful for support by Alemayehu Ambel, Talip Kilic, and Gero Carletto.

Background

On December 8, 2020, the first COVID-19 vaccine outside a clinical trial was administered.**[1]** Two years onwards, the COVID-19 vaccine drive has become the largest vaccination effort in history and has reached over 5.4 billion people globally.**[2, 3]**

Challenges for COVID-19 vaccination campaigns differ from past vaccination efforts. Instead of taking years or even decades of development, the first COVID-19 vaccines achieved emergency approval within less than a year of the first recorded cases of the disease.**[4, 5]** Such rapid development has given rise to concerns among members of the public regarding the safety of COVID-19 vaccines and has led to additional scrutiny.**[6]** Following the availability of COVID-19 vaccines, the severity of the pandemic that ensued over the course of 2020 has also put time pressure on the rollout of vaccination campaigns, has led to supply shortages and resulted in vastly heterogeneous availability of COVID-19 vaccines across the globe.**[7]** Consequently, many low- and middle-income countries that lack the ability to produce vaccines of their own have relied on donations of vaccine doses from vaccine-producing countries and face infrastructural challenges in the rollout of their vaccination campaigns. Some of these challenges have still not been completely overcome 2 years after.**[8]**

A region that has been of particular concern in the quest for global COVID-19 vaccine coverage has been Sub-Saharan Africa. Sub-Saharan Africa is the world's poorest region. Here, capacity to develop or procure COVID-19 vaccines is lowest and structural barriers that complicate vaccine delivery are pervasive. As a result, COVID-19 vaccine coverage in Sub-Saharan Africa is trailing other regions.**[9]** Furthermore, Sub-Saharan Africa is a data-scarce environment with typically little robust information on issues such as vaccine acceptance or barriers of access that can inform the rollout of vaccination campaigns. Yet, Sub-Saharan Africa is home to over 1.16 billion people, about 15% of the world's population. This makes it a systemically important region in the global effort to contain COVID-19 and end the pandemic.

The special status of COVID-19 vaccination campaigns in Sub-Saharan Africa has created the need for research to fill knowledge gaps around the effective mass delivery of COVID-19 vaccinations in the region.**[8–12]** In an effort to fill this gap, the World Bank supported a series of cross-country comparable high-frequency phone surveys (HFPS) in early 2020 that collect recurring information on vaccine hesitancy, uptake, barriers of access and information transmission in the context of COVID-19 vaccines in Sub-Saharan Africa.

In this paper, we bring together two years of data and findings from the HFPS across five Sub-Saharan African countries. We focus on COVID-19 vaccine acceptance as a prerequisite for widespread vaccine coverage in the region and a matter of particular concern given the special circumstances of COVID-19 vaccine development. COVID-19 vaccine hesitancy has been the subject of a number of studies across low- and middle-income countries, including in Sub-Saharan Africa, however, there is a lack of longitudinal evidence.**[9–11, 13–17]** Such longitudinal evidence is needed to understand the dynamics of vaccine acceptance in the region with some of the world's lowest COVID-19 vaccine coverage figures. By virtue of the recurring nature of the HFPS, we are able to study vaccine attitudes and their correlates at the country-level and among a panel of individuals over a 2-year time horizon.

Methods

Data

We use data from High-Frequency Phone Surveys (HFPS) in five countries in Sub-Saharan Africa: Burkina Faso, Ethiopia, Malawi, Nigeria, and Uganda. The surveys were conducted by study countries' national statistical organizations (NSOs), supported by the World Bank's Living Standards Measurement Study (LSMS). Since May 2020, the LSMS-supported HFPS have collected cross-country comparable longitudinal data on a wide range of topics, focused on COVID-19 impacts on households and individuals.

Vaccine hesitancy related information was collected from in 2020, 2021, and recently in 2022, depending on the study country. This study uses four rounds of data for Malawi (Oct-Nov 2020, Apr 2021, Feb 2022, Jul-Aug 2022) and Uganda (Oct-Nov 2020, Feb 2021, Sep-Nov 2021, Aug-Sep 2022), three rounds in Burkina Faso (Dec 2020, May-Jun 2021, Apr-May 2022) and Nigeria (Oct 2020, Feb 2021, Dec 2021-Jan 2022), and two rounds of data for Ethiopia (Sep-Oct 2020, Feb 2021).

Sampling and sample representativeness

The HFPS have national coverage and draw their samples from nationally representative samples of households interviewed in pre-pandemic face-to-face surveys of the LSMS-Integrated Survey on Agriculture (LSMS-ISA) series. In the settings at hand, mobile phone coverage is not universal, and the sample selection of phone surveys may not yield samples fully representative of the general population. Phone surveys also experience an extent (albeit limited) of non-response and attrition. The HFPS therefore use recalibrated sampling weights (based on propensity score and post-stratification methods), which mitigate sample selection biases.**[18–20]** In each household, one main respondent over the age of 15 was interviewed, selected to be knowledgeable of the household and its members. This purposive selection has been found to overrepresent certain population groups.**[20]** The sample sizes for each country are shown in Table A1.

Survey instrument and variables

Survey instruments were harmonized across countries while allowing for a degree of contextualization where necessary. In the early rounds, before COVID-19 vaccines were available, vaccine acceptance questions were posed in the hypothetical, asking respondents if they would be willing to get vaccinated if an approved COVID-19 vaccine was available. When vaccines became more widely available, questions were changed to reflect this development, asking respondents if they were planning to be vaccinated. Whenever respondents said they were unsure or unwilling to be vaccinated, the survey enquired about the reasons for their hesitancy or unwillingness.

Estimation methods

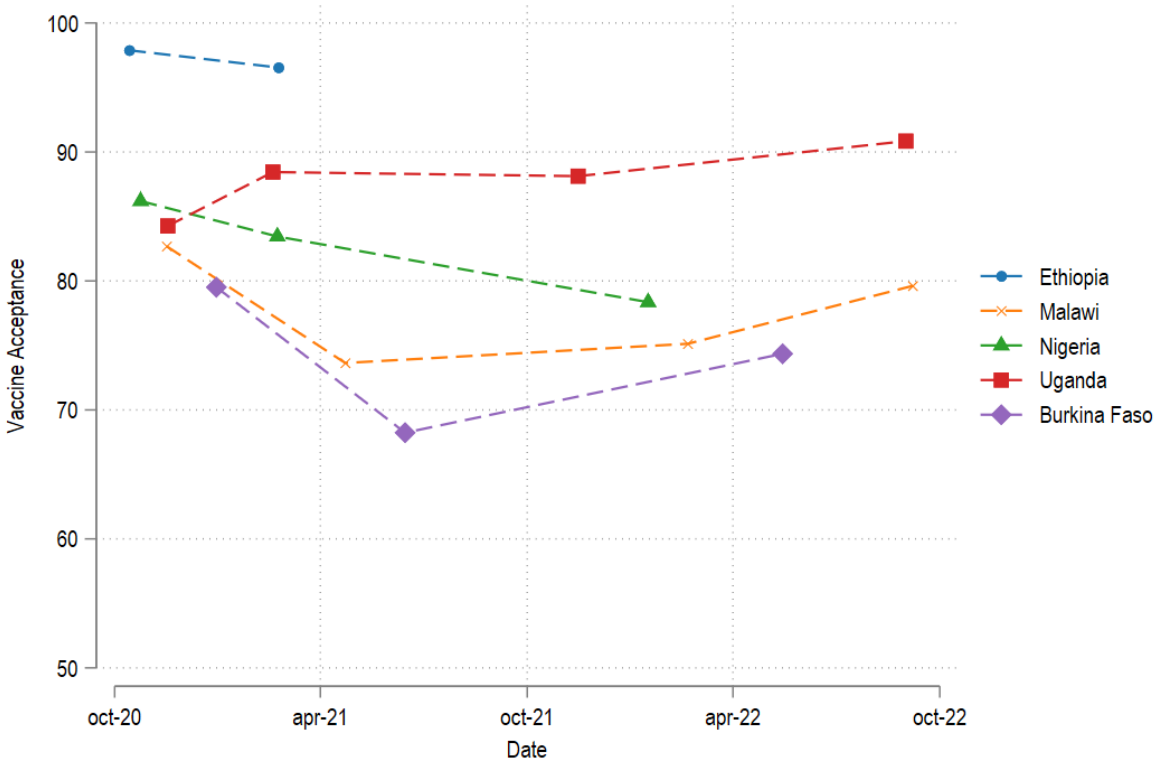
Reported estimates are population-weighted means with their 95% confidence intervals where applicable, computed using the recalibrated phone survey weights. To explore how individual and household characteristics correlate with the willingness to get vaccinated, we make use of a multivariate logit regression setup, again using recalibrated phone survey weights.

Results

Vaccine acceptance over time

We show reported vaccine acceptance rates in our study countries in 2020, 2021, and 2022 in Figure 1. Broadly speaking, we find sustainedly high levels of vaccine acceptance, remaining well above 70% in almost all cases. However, there is considerable country and time heterogeneity. In Ethiopia and Nigeria, we observe vaccine acceptance rates to be declining over time. In Ethiopia, support remains nevertheless very high, starting at 97.9% in 2020 and declining to 96.5% in 2021. In Nigeria, there is a stronger decline from 86.2% in 2020 to 83.4% in 2021 to 78.4% in 2022. In Malawi and Burkina Faso, there are steeper declines in acceptance from 2020 to 2021 (Malawi: from 82.7% in 2020 to 73.6% in 2021; Burkina Faso: 79.5% in 2020 to 68.2% in 2021) – but acceptance rates rebounded in 2022, to stabilize slightly below the initial rates of 2020 (Malawi: 75.1%; Burkina Faso: 74.4%). Finally, in Uganda, acceptance rates have increased overall between 2020 and 2022 (from 84.3% in 2020 to 90.8% in 2022).

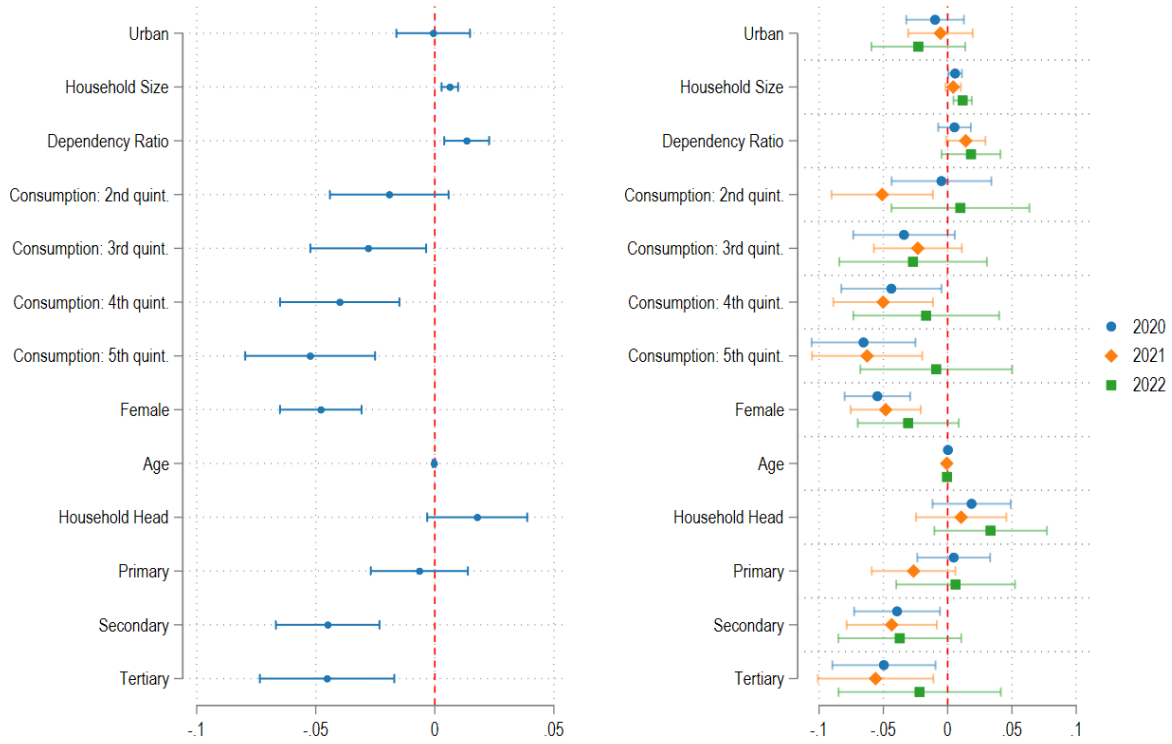
Figure 1. Vaccine acceptance over time



Correlates of vaccine acceptance

There are some differences in COVID-19 vaccine acceptance according to the socioeconomic characteristics of respondents. Using a multivariate logit regression with country fixed effects on a sample pooled across waves, we find that vaccine acceptance is more common among poorer and less well-educated individuals (Table A. 2): We find higher levels of education and higher household income quintiles to be significantly negatively correlated with vaccine acceptance. Household size and household dependency ratio, both proxies for lower household welfare outcomes, are significantly positively associated with vaccine acceptance. Moreover, women are around five percent less likely to be willing to be vaccinated than men (Figure 2, left panel**Error! Reference source not found.**).

Figure 2. Correlates of vaccine acceptance across countries and across years



Note: Marginal effects from multivariate logit regressions. Country fixed effects included in regression model but omitted from graph. Bars are 95% confidence intervals.

There is also some variation across countries in the socioeconomic correlates of vaccine acceptance (Figure A. 2). In Burkina Faso, Malawi, and Uganda, we find that respondents resident in urban areas are less likely to be willing to be vaccinated, but not in the other countries. Women are less likely to report vaccine acceptance than men in Ethiopia, Malawi, and Nigeria, while there is no difference between women and men in Uganda and Burkina Faso. Better educated individuals are less willing to be vaccinated in Nigeria and Burkina Faso, but not elsewhere.

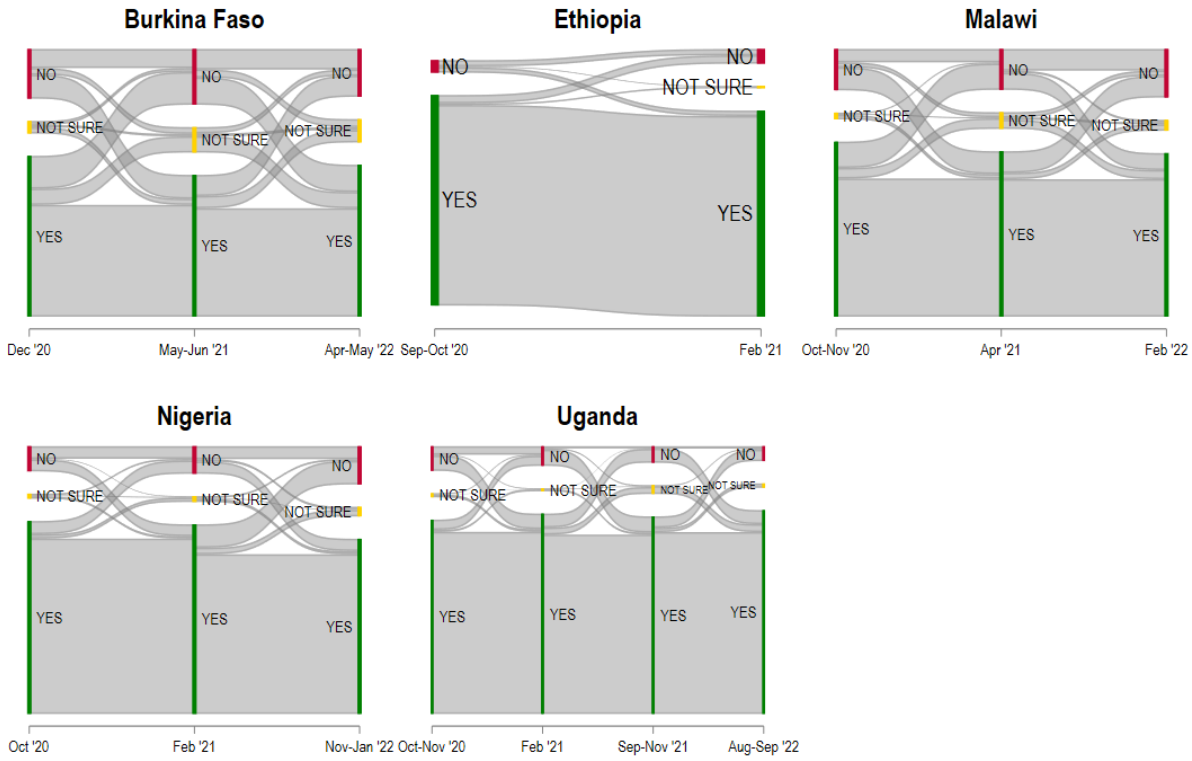
Next, we turn to the evolution of the correlates of vaccine acceptance over time. The right-hand-side panel of Figure 2 shows the coefficients of multivariate logit regressions separately for years 2020, 2021, 2022, facilitating their comparison over time. By and large, the characteristics associated with vaccine willingness are similar across the three years. However, we note some dynamic changes. Women were more likely

hesitant than men, but this difference reduces over time: from 5.5% in 2020, to 4.8% in 2021, to 3% in 2022, at which point that difference is no longer statistically significant. There is also a reduction in the income gradient of vaccine hesitancy. In 2022, wealthier households are no longer more hesitant than less wealthy households.

Individuals changing vaccine attitudes

Underlying the aggregate acceptance figures in Figure 1, individuals are changing their vaccine attitudes over time, from accepting to hesitant and vice versa. In our data, we can track individual respondents over time and so observe attitude changes between survey rounds. Figure 3 summarizes these observations. Overall, we find that a sizeable share of respondents changed their stated attitude at least once: In Burkina Faso, this is the case for 52.3% of respondents, in Ethiopia for 6.9%, in Malawi for 40.1%, in Nigeria for 28.5%, and in Uganda for 31.6%. It is moreover evident from Figure 3 that there is switching both from hesitant to willing and from willing to hesitance, happening between all survey rounds.

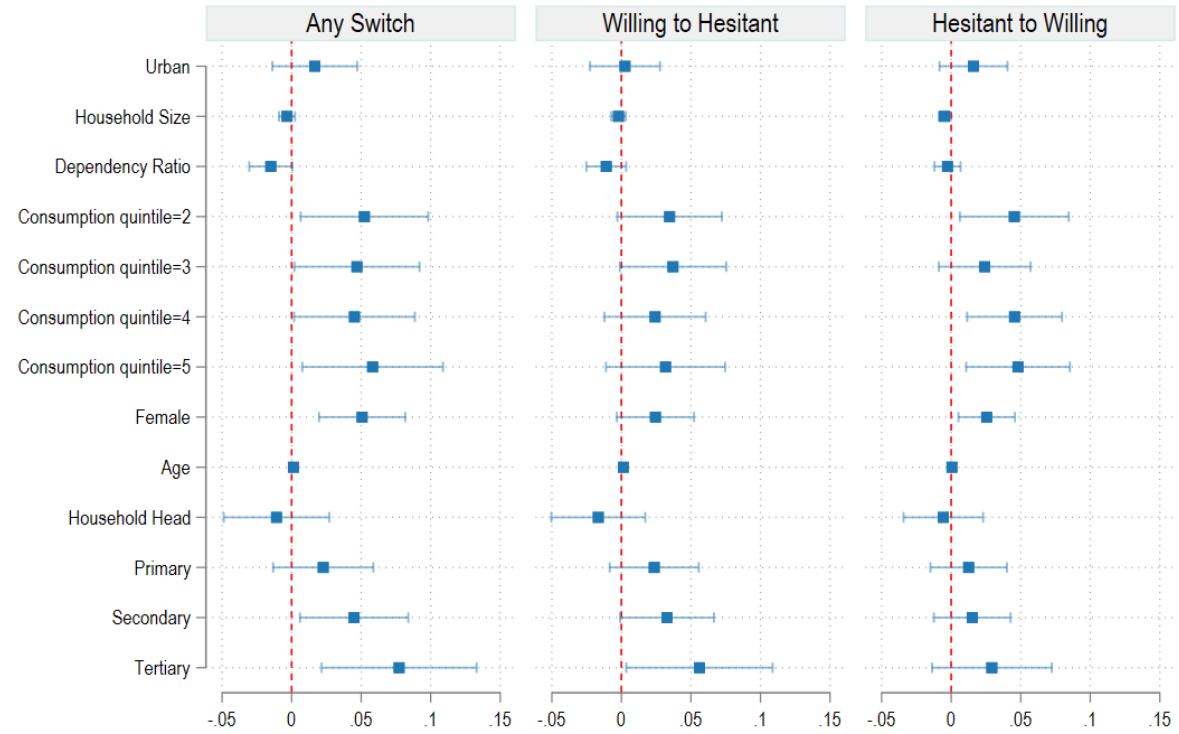
Figure 3. Individual-level switching of vaccine acceptance attitudes



To study the socio-economic profiles of those likely to switch vaccine attitudes, we run a series of multivariate logit regressions with country fixed effects across a pooled sample of respondents that were interviewed at least twice over the course of the COVID-19 pandemic (Figure 4 and Table A.4). We observe that those switching attitudes are more likely to live in richer households compared to the lowest consumption quintile and are more likely to be female, older, and better educated. We subsequently distinguish between those respondents becoming more hesitant and those becoming more willing to get vaccinated. There are some similarities in the profiles of those who change attitudes from willing to hesitant

and those who change attitudes from hesitant to willing. But there are also some small differences: Changing attitudes toward higher hesitancy concerning COVID-19 vaccination is associated with a higher level of education and higher age. In contrast, those becoming willing to get vaccinated over time are more likely to live in richer households and more likely to be female.

Figure 4: Correlates of switching COVID-19 vaccine attitudes, pooled across countries

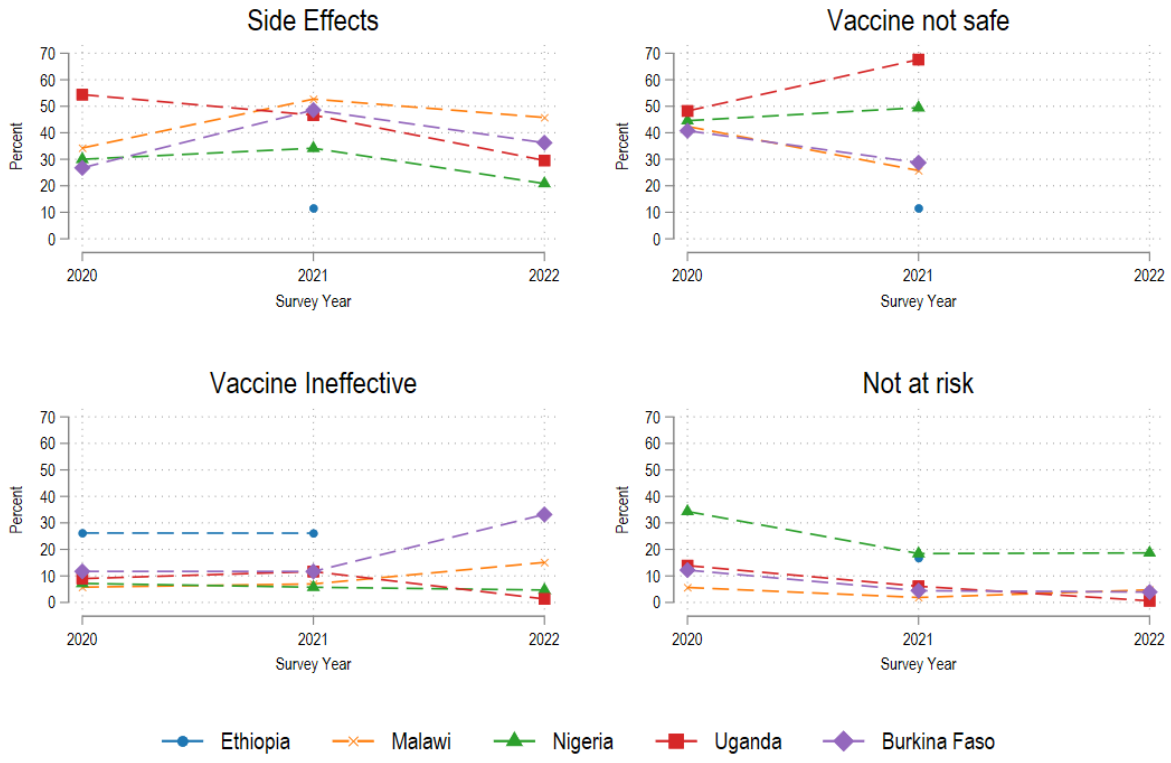


Note: Marginal effects from multivariate logit regressions. Bars are 95% confidence intervals. Country fixed effects included in regression model but omitted from graph.

Reasons for vaccine hesitancy

Overall, the most important reasons for not wanting to take a COVID-19 vaccine or being unsure of it are concerns about side effects (32.3%), concerns for vaccine safety (28.1%), and thinking that one is not at risk enough to warrant vaccination (15.3%; Table A.5). There is some variation across countries. Concerns about side effects are much lower in Ethiopia (7.2% relative to an average of 32.3%) than in the other countries, while concerns that vaccines do not work are more common in Ethiopia and Burkina Faso than in the other countries (26.1% in Ethiopia, 20.8% in Burkina Faso relative to 8.3% overall). There is a lot of heterogeneity in hesitancy reasons over time across countries. In Burkina Faso, Nigeria, and Uganda, concerns about vaccine side effects are considerably lower in 2022 than they were in 2020. At the same time, the prevalence of respondents thinking they are not at risk enough to warrant vaccination has declined decidedly from 2020 to 2021 to 2022 (Figure 5).

Figure 5: Main reasons for vaccine hesitancy over time.



Discussion

Using data from high-frequency phone surveys, we find that rates of vaccine acceptance are high across the five countries in Sub-Saharan Africa that we study. Acceptance rates were high and 2020 and remained high in 2022. However, in three of four countries in which we have data to compare 2020 with 2022, acceptance was several percentage points lower in 2022 than in 2020, while it increased in the fourth. At the same time, COVID-19 vaccination campaigns in the region are struggling to pick up pace, as just over 20% of the population has received at least two doses.**[9, 21]** The latest vaccination rates in our study countries are 11.7% in Burkina Faso, 14.4% in Malawi, 20.2% in Nigeria, and 27.0% in Uganda (29.75% in Ethiopia for which we do not have data from 2022). This contrasts with our findings of COVID-19 vaccine willingness ranging between 74.4% and 90.8% in these countries, suggesting that vaccine hesitancy is not a primary cause for lack of vaccine take-up.

The large gulf between declared willingness to be vaccinated and actual vaccination rates indicates that there is scope to dramatically increase vaccination rates in the region and that other factors are holding back vaccination campaigns. These include ease of access, last-mile delivery barriers, as well as vaccine supply shortages, though these appear to have eased recently – a series of recent studies has begun to explore the role these factors play in limiting take-up.**[7–9, 12, 22]**

Despite high acceptance rates, our analysis finds that vaccine attitudes can and do change over time in a significant share of the population. For vaccine campaigns, this means that efforts to resolve misinformation and address concerns regarding the safety and effectiveness of vaccines among hesitant population groups

need to be ongoing and effectively targeted. Lastly, our findings also highlight that vaccine hesitancy is a country-specific phenomenon with at times substantial variation in vaccine attitudes and their dynamics, correlates of hesitancy and hesitancy reasons. Any policy recommendations thus need to take into account the specific country context.

Our study faces the challenges and limitations of phone survey data collection on vaccination. There is some sample selection at the household level due to under-coverage, non-response, and attrition, whose potential impacts however our recalibrated sampling weights limit.[19] The purposive selection of respondents leads to the over-representation of certain population groups and the under-representation of others.[20] Survey data relies on respondent declarations, a method that is vulnerable to respondents' incentives, misreporting, and misperceptions. Finally, our estimates cover five countries with a population of around 433 million, but they need not be representative of the entire region.

Conclusions

We find overall high rates of vaccine acceptance across our study countries and over a 2-year time horizon, never dipping below 68%. Yet, we notice a decline of several percentage points in the willingness to be vaccinated in three countries from 2020 to 2022, while in one country vaccine acceptance increases. Overall, women, better educated individuals and those living in better-off households are more likely to express vaccine hesitancy, though these differences reduce over time. Vaccine hesitancy is lower in larger households and among heads of the household. Underlying vaccine acceptance and its correlates, there are important country differences. The main reasons for vaccine hesitancy are concerns about side effects and vaccine safety as well as perceptions around COVID-19 risk.

While this is not the only study analyzing COVID-19 vaccine attitudes in Sub-Saharan Africa, there has been lack of longitudinal evidence to assess dynamics over time. This study fills this gap by using panel survey data collected in high-frequency phone surveys over the span of almost two years.

References

1. Watson OJ, Barnsley G, Toor J, Hogan AB, Winskill P, Ghani AC. Global impact of the first year of COVID-19 vaccination: a mathematical modelling study. The Lancet Infectious Diseases. 2022;22:1293–302.

2. Tatar M, Wilson FA. The largest vaccination campaign in history: A golden opportunity for bundling public health interventions. J Glob Health. 2021;11:03076.

3. Mathieu E, Ritchie H, Ortiz-Ospina E, Roser M, Hasell J, Appel C, et al. A global database of COVID-19 vaccinations. Nat Hum Behav. 2021;5:947–53.

4. Graham BS. Rapid COVID-19 vaccine development. Science. 2020;368:945–6.

5. Ball P. The lightning-fast quest for COVID vaccines — and what it means for other diseases. Nature. 2021;589:16–8.

6. Wu Q, Dudley MZ, Chen X, Bai X, Dong K, Zhuang T, et al. Evaluation of the safety profile of COVID-19 vaccines: a rapid review. BMC Med. 2021;19:173.

7. Mobarak AM, Miguel E, Abaluck J, Ahuja A, Alsan M, Banerjee A, et al. End COVID-19 in low- and middle-income countries. Science. 2022;375:1105–10.

8. Reza A, Sultana F, Bari R, Mobarak AM. Why Vaccination Rates are Lagging in Low- and Middle-Income Countries, and What Can We Do About It? BMJ. 2022.

9. Wollburg P, Markhof Y, Kanyanda S, Zezza A. Turning COVID-19 Vaccines into Vaccinations: New Evidence from Sub-Saharan Africa. Policy Research Working Paper Series. Washington, DC: World Bank; 2022.

10. Kanyanda S, Markhof Y, Wollburg P, Zezza A. Acceptance of COVID-19 vaccines in sub-Saharan Africa: evidence from six national phone surveys. BMJ Open. 2021;11:e055159.

11. Mutombo PN, Fallah MP, Munodawafa D, Kabel A, Houeto D, Goronga T, et al. COVID-19 vaccine hesitancy in Africa: a call to action. The Lancet Global Health. 2022;10:e320–1.

12. Nachega JB, Sam-Agudu NA, Masekela R, van der Zalm MM, Nsanzimana S, Condo J, et al. Addressing challenges to rolling out COVID-19 vaccines in African countries. The Lancet Global Health. 2021;9:e746–8.

13. Lazarus JV, Wyka K, White TM, Picchio CA, Rabin K, Ratzan SC, et al. Revisiting COVID-19 vaccine hesitancy around the world using data from 23 countries in 2021. Nat Commun. 2022;13:3801.

14. Solís Arce JS, Warren SS, Meriggi NF, Scacco A, McMurry N, Voors M, et al. COVID-19 vaccine acceptance and hesitancy in low- and middle-income countries. Nat Med. 2021. https://doi.org/10.1038/s41591-021-01454-y.

15. Africa CDC. COVID-19 Vaccine Perceptions: A 15 country study. 2021.

16. Aborode AT, Fajemisin EA, Ekwebelem OC, Tsagkaris C, Taiwo EA, Uwishema O, et al. Vaccine hesitancy in Africa: causes and strategies to the rescue. Therapeutic Advances in Vaccines and Immunotherapy. 2021;9:25151355211047510.

17. Afolabi AA, Ilesanmi OS. Dealing with vaccine hesitancy in Africa: the prospective COVID-19 vaccine context. Pan Afr Med J. 2021;38.

18. Himelein K. Weight Calculations for Panel Surveys with Subsampling and Split-off Tracking. Statistics and Public Policy. 2014;1:40–5.

19. Ambel A, McGee K, Tsegay A. Reducing Bias in Phone Survey Samples. Effectiveness of Reweighting Techniques Using Face-to-Face Surveys as Frames in Four African Countries. Washington D.C.: World Bank; 2021.

20. Brubaker J, Kilic T, Wollburg P. Representativeness of individual-level data in COVID-19 phone surveys: Findings from Sub-Saharan Africa. PLoS ONE. 2021;16:e0258877.

21. Mathieu E, Ritchie H, Rodés-Guirao L, Appel C, Giattino C, Hasell J, et al. Coronavirus Pandemic (COVID-19). Our World in Data. 2020.

22. Seytre B. Misunderstanding poor adherence to COVID-19 vaccination in Africa. The Lancet Global Health. 2022;10:e794.

23. Bradley VC, Kuriwaki S, Isakov M, Sejdinovic D, Meng X-L, Flaxman S. Unrepresentative big surveys significantly overestimated US vaccine uptake. Nature. 2021;600:695–700.

24. Bloland P, MacNeil A. Defining & assessing the quality, usability, and utilization of immunization data. BMC Public Health. 2019;19:380.

25. Sandefur J, Glassman A. The Political Economy of Bad Data: Evidence from African Survey and Administrative Statistics. The Journal of Development Studies. 2015;51:116–32.

Appendix

Table A. 1. Vaccine Acceptance Over Time

Survey Period	Ethiopia	Malawi	Nigeria	Uganda	Burkina Faso
Sep-Dec 2020	97.9	82.7	86.2	84.3	79.5
	(97.2 to 98.6)	(80.0 to 85.4)	(83.9 to 88.5)	(82.0 to 86.5)	(76.9 to 82.1)
Feb-Jun 2021	96.5	73.6	83.4	88.4	68.2
	(95.4 to 97.7)	(70.3 to 77.0)	(80.7 to 86.2)	(86.4 to 90.5)	(63.9 to 72.5)
Sep-Nov 2021				88.1	
				(86.0 to 90.3)	
Jan-Sep 2022		75.1	78.4	90.8	74.4
		(71.6 to 78.7)	(76.1 to 80.6)	(88.9 to 92.8)	(71.5 to 77.2)
N (2020)	2,704	1,589	1,762	2,135	1,944
N (2021 - Spring)	2,178	1,517	1,700	2,121	1,030
N (2021 - Fall)				1,885	
N (2022)		1,447	2,983	1,872	1,847

Note: Vaccine acceptance over time. Survey dates: Burkina Faso (Dec '20, May-Jun '21, Apr-May '22), Ethiopia (Sep-Oct '20, Feb '21), Malawi (Oct-Nov '20, Apr '21, Feb '22), Nigeria (Oct '20, Feb '21, Dec'21-Jan'22), Uganda (Oct-Nov '20, Feb '21, Sep-Nov '21, Aug-Sep '22). 95% confidence intervals in parentheses.

Table A. 2. Correlates of vaccine acceptance

Correlates of Vaccine Acceptance

VARIABLES	(1) Pooled
Urban	-0.000235
	(0.00792)
Household Size	0.00645***
	(0.00177)
Dependency Ratio	0.0129***
	(0.00474)
Consumption quintile = 2	-0.0204
	(0.0125)
Consumption quintile = 3	-0.0327***
	(0.0123)
Consumption quintile = 4	-0.0440***
	(0.0126)
Consumption quintile = 5	-0.0547***
	(0.0138)
Female	-0.0501***
	(0.00860)
Age	-0.000220
	(0.000277)
Household Head	0.0190*
	(0.0106)
Highest education completed = 1, Primary	-0.00555
	(0.0103)
Highest education completed = 2, Secondary	-0.0424***
	(0.0108)
Highest education completed = 3, Tertiary	-0.0442***
	(0.0145)
Observations	29,138
Country FE	YES
Pseudo R2	0.101

Note: Marginal effects from multivariate logistic regression, pooled across countries and survey rounds. Malawi only has quintiles of a household wealth index instead of total household consumption. Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1

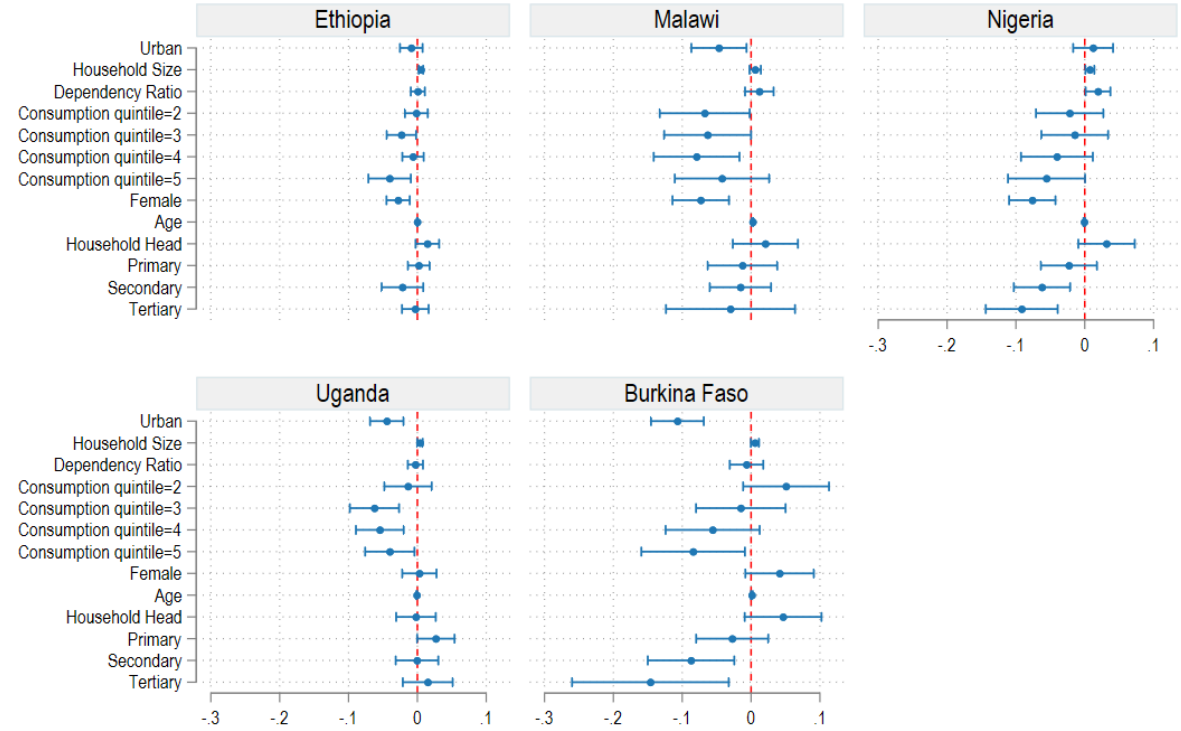
Table A. 2. Correlates of vaccine acceptance by country

Correlates of Vaccine Acceptance (By Country)

	(1) Ethiopia	(2) Malawi	(3) Nigeria	(4) Uganda	(5) Burkina Faso
Urban	-0.00886	-0.0467**	0.0121	-0.0444***	-0.107***
	(0.00839)	(0.0204)	(0.0148)	(0.0124)	(0.0195)
Household Size	0.00527***	0.00597	0.00747**	0.00376*	0.00562*
	(0.00164)	(0.00420)	(0.00332)	(0.00204)	(0.00304)
Dependency Ratio	0.000656	0.0120	0.0193**	-0.00285	-0.00660
	(0.00521)	(0.0106)	(0.00916)	(0.00562)	(0.0124)
Consumption quintile = 2	-0.00142	-0.0673**	-0.0219	-0.0136	0.0509
	(0.00845)	(0.0333)	(0.0250)	(0.0175)	(0.0318)
Consumption quintile = 3	-0.0231**	-0.0631*	-0.0145	-0.0624***	-0.0149
	(0.0109)	(0.0322)	(0.0247)	(0.0182)	(0.0332)
Consumption quintile = 4	-0.00634	-0.0791**	-0.0404	-0.0545***	-0.0558
	(0.00791)	(0.0318)	(0.0266)	(0.0177)	(0.0348)
Consumption quintile = 5	-0.0403**	-0.0422	-0.0555*	-0.0400**	-0.0841**
	(0.0157)	(0.0350)	(0.0286)	(0.0183)	(0.0384)
Female	-0.0280***	-0.0731***	-0.0762***	0.00292	0.0415
	(0.00861)	(0.0209)	(0.0172)	(0.0127)	(0.0254)
Age	-7.20e-05	0.00245***	-0.000728	-0.000815**	0.00114*
	(0.000183)	(0.000704)	(0.000563)	(0.000387)	(0.000675)
Household Head	0.0145*	0.0207	0.0316	-0.00204	0.0465
	(0.00872)	(0.0241)	(0.0209)	(0.0147)	(0.0284)
Highest education completed = 1, Primary	0.00207	-0.0125	-0.0230	0.0269*	-0.0274
	(0.00805)	(0.0258)	(0.0208)	(0.0139)	(0.0267)
Highest education completed = 2, Secondary	-0.0217	-0.0154	-0.0621***	-0.000533	-0.0872***
	(0.0154)	(0.0227)	(0.0209)	(0.0158)	(0.0320)
Highest education completed = 3, Tertiary	-0.00301	-0.0299	-0.0916***	0.0151	-0.146**
	(0.00986)	(0.0478)	(0.0267)	(0.0185)	(0.0581)
Observations	4,807	5,895	6,094	7,638	4,704
Survey Wave FE	YES	YES	YES	YES	YES
Pseudo R2	0.126	0.0713	0.0617	0.0267	0.0854

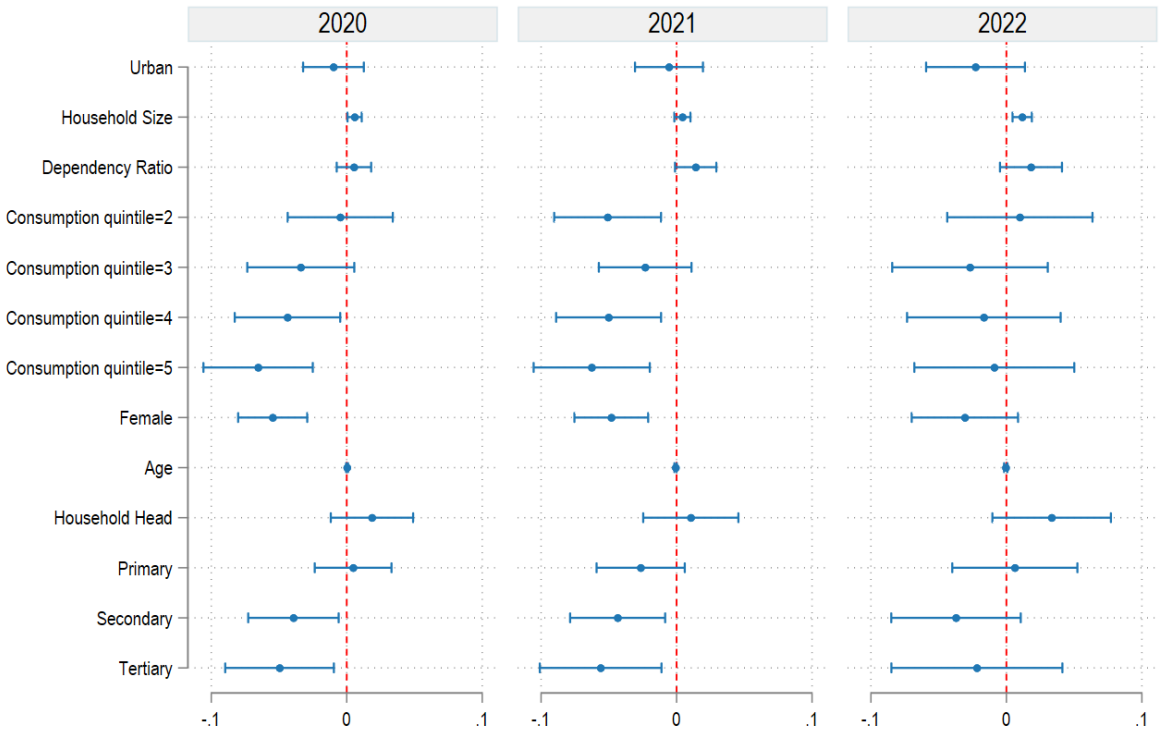
Note: Marginal effects from multivariate logistic regression, by country. Malawi only has quintiles of a household wealth index instead of total household consumption. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Figure A. 1. Correlates of vaccine acceptance by country, pooled across time



Note: Marginal effects from multivariate logit regressions. Bars are 95% confidence intervals. Wave fixed effects included in regression model but omitted from graph.

Figure A. 2. Correlates of vaccine acceptance by year



Note: Marginal effects from multivariate logit regressions. Bars are 95% confidence intervals. Country fixed effects included in regression model but omitted from graph.

Table A. 3. Correlates of vaccine acceptance by year

Correlates of Vaccine Acceptance (By Year)

VARIABLES	(1) 2020	(2) 2021	(3) 2022
Urban	-0.00978	-0.00561	-0.0228
	(0.0114)	(0.0128)	(0.0186)
Household Size	0.00581**	0.00430	0.0116***
	(0.00268)	(0.00303)	(0.00363)
Dependency Ratio	0.00532	0.0141*	0.0182
	(0.00649)	(0.00778)	(0.0117)
Consumption quintile = 2	-0.00480	-0.0509**	0.00992
	(0.0198)	(0.0201)	(0.0273)
Consumption quintile = 3	-0.0339*	-0.0232	-0.0269
	(0.0202)	(0.0175)	(0.0293)
Consumption quintile = 4	-0.0438**	-0.0502**	-0.0167
	(0.0199)	(0.0198)	(0.0289)
Consumption quintile = 5	-0.0654***	-0.0626***	-0.00893
	(0.0206)	(0.0219)	(0.0301)
Female	-0.0546***	-0.0482***	-0.0307
	(0.0130)	(0.0139)	(0.0200)
Age	0.000246	-0.000714	-0.000450
	(0.000366)	(0.000460)	(0.000640)
Household Head	0.0186	0.0105	0.0334
	(0.0155)	(0.0179)	(0.0223)
Highest education completed = 1, Primary	0.00472	-0.0265	0.00622
	(0.0145)	(0.0166)	(0.0236)
Highest education completed = 2, Secondary	-0.0393**	-0.0435**	-0.0372
	(0.0170)	(0.0179)	(0.0244)
Highest education completed = 3, Tertiary	-0.0496**	-0.0560**	-0.0218
	(0.0205)	(0.0229)	(0.0322)
Country = 2, Malawi	-0.142***	-0.218***	
	(0.0147)	(0.0208)	
Country = 3, Nigeria	-0.115***	-0.131***	0.0369
	(0.0136)	(0.0155)	(0.0237)
Country = 4, Uganda	-0.108***	-0.0618***	0.165***
	(0.0118)	(0.0106)	(0.0219)
Country = 5, Burkina Faso	-0.231***	-0.313***	-0.0306
	(0.0191)	(0.0291)	(0.0257)
Observations	9,914	10,098	7,624
Survey Wave FE	YES	YES	YES
Pseudo R2	0.129	0.102	0.0477

Note: Marginal effects from multivariate logistic regression, by year. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A 4: Correlates of switching vaccine attitudes, pooled across countries.

Correlates of switching vaccine attitudes

VARIABLES	(1) Any Switch	(2) Willing to Hesitant	(3) Hesitant to Willing
Urban	0.0166	0.00257	0.0161
	(0.0156)	(0.0128)	(0.0125)
Household Size	-0.00334	-0.00207	-0.00477**
	(0.00296)	(0.00267)	(0.00217)
Dependency Ratio	-0.0150*	-0.0109	-0.00265
	(0.00790)	(0.00730)	(0.00478)
Consumption quintile = 2	0.0523**	0.0346*	0.0454**
	(0.0234)	(0.0192)	(0.0200)
Consumption quintile = 3	0.0470**	0.0371*	0.0241
	(0.0230)	(0.0195)	(0.0168)
Consumption quintile = 4	0.0452**	0.0242	0.0456***
	(0.0222)	(0.0186)	(0.0174)
Consumption quintile = 5	0.0582**	0.0317	0.0480**
	(0.0258)	(0.0219)	(0.0190)
Female	0.0507***	0.0245*	0.0255**
	(0.0158)	(0.0142)	(0.0104)
Age	0.00127***	0.00140***	0.000537
	(0.000464)	(0.000429)	(0.000345)
Household Head	-0.0109	-0.0167	-0.00565
	(0.0194)	(0.0172)	(0.0146)
Highest education completed = 1, Primary	0.0227	0.0236	0.0126
	(0.0184)	(0.0163)	(0.0141)
Highest education completed = 2, Secondary	0.0449**	0.0328*	0.0151
	(0.0199)	(0.0172)	(0.0141)
Highest education completed = 3, Tertiary	0.0773***	0.0561**	0.0292
	(0.0284)	(0.0269)	(0.0219)
Observations	8,995	8,995	8,995
Country FE	YES	YES	YES
Pseudo R2	0.129	0.102	0.139

Note: Marginal effects from multivariate logistic regression, pooled across countries and survey rounds. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A. 5. Reasons for vaccine hesitancy

Reasons for Vaccine Hesitancy

Hesitancy Reason	Ethiopia	Malawi	Nigeria	Uganda	Burkina Faso	Pooled
Vaccine does not work	26.1	7.6	5.7	7.8	20.8	8.3
	(14.2 to 38.1)	(5.7 to 9.6)	(3.7 to 7.6)	(5.2 to 10.5)	(17.3 to 24.3)	(7.0 to 9.7)
Vaccine is not safe	35.7	27.4	27.6	32.0	20.6	28.1
	(24.6 to 46.8)	(24.3 to 30.5)	(23.1 to 32.0)	(27.6 to 36.4)	(17.4 to 23.9)	(25.4 to 30.8)
Concerned about side effects	7.2	43.2	27.5	42.0	36.0	32.3
	(1.5 to 12.8)	(39.8 to 46.7)	(23.3 to 31.7)	(37.4 to 46.6)	(32.1 to 39.8)	(29.7 to 34.8)
Not enough at risk	10.4	3.8	22.8	7.1	6.9	15.3
	(2.9 to 17.9)	(2.5 to 5.2)	(18.8 to 26.7)	(4.7 to 9.4)	(4.6 to 9.1)	(13.0 to 17.6)
Do not trust vaccines in general	2.6	11.6	10.6	15.7	5.4	10.9
	(0.3 to 4.9)	(9.2 to 13.9)	(7.6 to 13.6)	(12.3 to 19.1)	(3.6 to 7.1)	(9.1 to 12.7)
Religious reasons	22.3	1.8	2.6	0.5	0.2	10.1
	(10.9 to 33.8)	(0.9 to 2.7)	(1.6 to 3.6)	(0.0 to 1.0)	(0.0 to 0.6)	(8.4 to 11.8)
Had COVID already			0.1	0.5	0.1	2.8
			(0.0 to 0.3)	(0.0 to 1.2)	(0.0 to 0.3)	(2.0 to 3.6)
Would get infected at vax site		0.0	0.7	0.4	0.1	0.2
		(0.0 to 0.1)	(0.1 to 1.3)	(0.0 to 0.7)	(0.0 to 0.3)	(0.0 to 0.3)
Vaccination site too far away		0.2	0.6	1.2	0.0	0.5
		(0.0 to 0.4)	(0.0 to 1.4)	(0.1 to 2.4)		(0.1 to 0.8)
No time to get vaccinated		0.6	0.8	0.8	0.9	0.6
		(0.0 to 1.3)	(0.0 to 1.7)	(0.0 to 1.5)	(0.3 to 1.5)	(0.1 to 1.0)
Vaccines available are inferior		0.3	1.2	0.2	4.4	0.7
		(0.0 to 0.8)	(0.6 to 1.9)	(0.0 to 0.6)	(2.9 to 5.8)	(0.2 to 1.2)
Wouldn't get preferred vaccine		1.4	0.6	0.4	1.1	1.1
		(0.6 to 2.2)	(0.2 to 1.0)	(0.0 to 1.0)	(0.4 to 1.8)	(0.7 to 1.5)
Not a priority		4.4	4.6	2.6	3.6	0.7
		(2.8 to 6.1)	(2.7 to 6.5)	(1.2 to 4.0)	(2.2 to 4.9)	(0.4 to 1.0)
COVID does not exist here		0.0	6.8	0.4	3.8	4.0
		(0.0 to 0.1)	(4.7 to 8.9)	(0.0 to 1.2)	(2.2 to 5.3)	(2.9 to 5.1)
Medical reasons		0.4	0.9	3.4	0.0	4.1
		(0.0 to 0.8)	(0.3 to 1.5)	(1.6 to 5.3)	(0.0 to 0.1)	(2.9 to 5.3)
Distrust the government			2.1		2.6	1.1
			(1.1 to 3.1)		(1.4 to 3.8)	(0.7 to 1.6)
Other	4.1	0.3	16.0	4.7	4.0	1.3
	(0.0 to 8.2)	(0.0 to 0.6)	(13.0 to 19.0)	(2.7 to 6.8)	(2.5 to 5.5)	(0.8 to 1.9)
N	307	1,844	1,164	887	1,347	5,493

Note: Reasons for vaccine hesitancy, by country and pooled across countries. All values in percent. 95% confidence intervals in parentheses.