



OPEN Debunking COVID-19 vaccine misinformation with an audio drama in Ghana, a randomized control trial

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Misinformation about COVID-19 vaccines has hampered their uptake worldwide. In Ghana, a belief that COVID-19 vaccines affect fertility is prevalent and difficult to counter. UNICEF Ghana co-produced a context-driven, behavioral science-based audio drama ('A shot of love') that aimed to debunk this misinformation narrative. In a randomized controlled trial, 13,000 young adults who had previously interacted with UNICEF's Agoo platform were randomized to either control (audio about nutrition) or intervention (audio drama debunking the COVID-19 misinformation). We found that the intervention had a strong protective effect against belief in misinformation, both directly after listening to the audio drama (adjusted Odds Ratio (aOR) 0.45, 95% Confidence Interval (CI) 0.34–0.59) as well as at the one-month follow-up (aOR 0.66, 95% CI 0.49–0.91). Similarly, the intervention had a strong effect on perceived safety of the COVID-19 vaccines directly after listening to the audio drama (aOR 1.56, 95% CI 1.22–2.00) and at one-month follow-up (aOR 1.53, 95% CI 1.13–2.07). Overall, our behavioral science-based, context-driven audio drama was effective in reducing the strength of belief in COVID-19 vaccine misinformation and increasing the perceived safety of the vaccines in Ghana.

Since the start of the COVID-19 pandemic in early 2020, a parallel 'infodemic' has overloaded the public with (mis)information^{1,2}. The rapid development of the COVID-19 vaccines was hailed by many as one of the greatest scientific achievements but was seen by others as a sign that the vaccines could not be trusted^{3,4}. The COVID-19 vaccines have been the target of rampant misinformation^{5,6}. From theories that vaccines contained microchips to rumors that they were deadly, misinformation about the COVID-19 vaccines reached every corner of our interconnected digital world. A viral video in South Africa portrayed an American naturopath saying that the vaccines were a form of population control⁷, while in Nigeria, viral messages claimed that Africans would be forcibly vaccinated⁸.

In West Africa, mis- and disinformation around COVID-19 and COVID-19 vaccines has been circulating widely since the beginning of the pandemic⁹. For instance, the national football coach in Ghana claimed that a game was lost because the vaccines made his players weak¹⁰. The Vaccination Demand Observatory has identified numerous vaccine-related misinformation narratives circulating in Ghana since 2021, including conspiracy theories from North America (e.g. QAnon)^{9,11}. COVID-19 vaccine uptake in the region has remained low, with less than 60% of the eligible population vaccinated across the majority of West African countries¹².

Ghana was the first country in the world to receive COVID-19 vaccines through the COVAX Facility in February 2021¹³. However, surveys measuring COVID-19 vaccine attitudes and vaccination intentions have shown mixed results^{14,15}. Belief in widely circulating misinformation was very common, as 44% believed in at least one piece of misinformation¹⁶. A qualitative study in the Greater Accra and Ashanti regions found that the main barriers to COVID-19 vaccination, in addition to long vaccination queues and vaccine shortages at vaccination centers, were fear of side effects and misconceptions surrounding the COVID-19 vaccines¹⁷.

Various efforts have been made to increase vaccination coverage in Ghana; however, ever-evolving misinformation has likely influenced COVID-19 vaccination decisions among Ghanaians^{10,18}. In response,

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UNICEF Ghana has developed a misinformation management system, both to track emerging rumors and enable swift responses¹⁰. A particularly stubborn piece of misinformation concerns fertility and COVID-19 vaccines, which has surfaced in many other countries as well¹⁹. Even before the COVID-19 pandemic, pervasive fears of infertility have been reported in various African countries, leading to lower uptake of vaccines (such as the HPV vaccine) and the use of family planning²⁰. According to insights from UNICEF Ghana and the fact-checking organization Ghana Fact, the rumor that COVID-19 vaccines will impact one's fertility is persistent and prevalent among Ghanaians²¹.

Misinformation is problematic because it could lead to the creation of false memories^{22–24}. In one study, between 41–55% of participants reported at least one false memory after being presented with false claims around COVID-19²⁵. Exposure to misinformation and subsequent creation of false memories, can affect behaviors as well. In health emergencies such as disease outbreaks this may be particularly problematic, as it could increase vaccine hesitancy, obstruct containment measures and cause misallocation of resources^{3,4,26–29}. However, studies commonly rely on self-reported behavioral data, effect sizes may be small, and behavioral effects are not observed in all settings^{26,30}.

Misinformation is highly sticky, and debunking vaccine misinformation should be done with great care^{31,32}. Debunking persistent misinformation is difficult, as multiple cognitive and social barriers prevent people from updating their beliefs³². For instance, the credibility of the source of the misinformation, as well as how the misinformation fits into people's existing worldviews, play important roles in the acceptance of the misinformation^{32–34}. Source credibility is of particular importance, because when asked to verify information, people mostly try to assess the trustworthiness of sources³⁵. Therefore, for debunking efforts to be successful, it is imperative that the debunking material is delivered by trusted messengers and is in line with people's worldviews and context-driven³⁶. Furthermore, when misinformation is repeated in debunking material, it is important to clearly highlight why the misinformation is not correct and give a plausible explanation of the correct fact^{36,37}. In Ghana, religious leaders are trusted members of their communities and have played a vital role in community engagement activities around routine immunization and education in both urban and rural settings³⁸. In other West-African settings, risk communication messaging by religious leaders has been shown to increase self-reported protective behaviors in health emergencies³⁹. Similarly, community health workers are regarded as trusted sources of information in Ghana and are commonly part of social- and behavior change programs^{38,40}.

To date, few studies on the countering of misinformation have been conducted in low- and middle-income countries (LMICs)^{41–44}. The scope and speed at which misinformation has emerged during the infodemic has posed a significant challenge to debunking efforts and has hampered researchers' ability to test the effectiveness of various interventions⁴⁵. Our randomized controlled trial aims to dispel misinformation about COVID-19 vaccines and fertility in Ghana using a co-created, context-driven, and behavioral science-based audio drama.

Methods

Study design

To test whether an intervention in the form of an audio drama could decrease the belief in misinformation around COVID-19 vaccines and fertility in Ghana, we deployed a randomized controlled trial using an Interactive Voice Response (IVR) system. Participants were called on their mobile phones, through which they listened to the survey questions and answered using their phone's keypad. Such methods have been successfully used in Ghana for previous health information messenger tests⁴⁶. We tested the effect of the intervention (i.e., the audio drama) on participants' beliefs in COVID-19 vaccine misinformation both immediately after exposure, and at one-month post-exposure.

Given how widespread the misinformation about COVID-19 vaccines and fertility was¹⁹, we assumed a baseline prevalence belief in the misinformation of 40%. To be able to detect a difference of 10% between control and intervention with 80% power, we calculated that we would need 388 participants per randomized group. Based on the team's experience with IVR in other studies, the phone pick-up rate was expected to be around 60% and the completion rate of the survey after pick-up was expected to be 20%. We increased this further to adjust for an estimated 50% loss to follow-up between the baseline study and the one-month follow-up. As a result, the sample size was inflated to 6,470 participants per group, which we rounded to 6,500 participants per group.

Before the start of the study, all participants listened to the consent audio clip, which contained information about the study. It also contained the phone number of a special hotline that could be reached in case participants had further questions about the study. A total of 49 calls were received, with questions ranging from where one can get vaccinated ($n = 9$) to how many times one should take a COVID-19 vaccine ($n = 5$). After all participants gave their informed consent (using their keypad), the study started. Ethical approval for the study was obtained from the Yale Institutional Review Board (protocol number: 2000033688) as well as from the Ghana Institute of Journalism, Directorate of Research, Innovations and Development in Accra (no protocol number available). All research was performed in accordance with the relevant guidelines and regulations.

Data collection for the baseline and intervention took place between November 19 and December 14, 2022. The follow-up survey was launched on December 17, 2022, and ran until January 14, 2023. The study protocol and analysis plan were registered on Open Science Framework prior to data analysis: <https://osf.io/ag4eu>.

Participants

Participants were people who had previously interacted with the Agoo platform - a UNICEF- and government-led interactive, multilingual platform that gives information about health issues and topics to young people. It is part of UNICEF's first line of emergency deployment during disease outbreaks, aiming to provide information and to empower young people to take up protective behaviors. It has a call center staffed with trained agents who operate in six local languages⁴⁷. In their previous interaction with the platform, participants had agreed to have their phone numbers and basic demographic information (age group, gender, region) stored and used for

future research purposes such as ours. This database contains data from more than 125,000 people. However, as the Agoos platform is targeted at a younger population, around 60% of the database comprised callers younger than 20 years of age. The remaining 47,983 participants were aged 20 years and older and therefore formed a suitable pool of potential participants for the study. Random numbers between 0 and 1 were created and added to the database. Next, based on this list of random numbers, the dataset was ordered in an ascending way. The first 6,500 participants were then enrolled in the control group, the second 6,500 participants in the intervention group.

Intervention

The intervention, an audio drama, was co-produced by UNICEF Ghana, Viamo, Ghana Health Service, Ghana Fact, and the Yale Institute for Global Health (YIGH). An initial script of the drama was developed by YIGH and UNICEF Ghana. This script formed the basis of a co-creation meeting that UNICEF Ghana hosted with officials from Ghana Health Service, Ghana Fact, Viamo and with young social media influencers. In this meeting, the script went through several rounds of editing for cultural appropriateness and context. The script incorporated key social and behavioral change elements – for instance trusted sources of information spoke in the drama (such as a religious leader and a doctor) and was in line with people's experiences and worldviews around COVID-19 vaccination. Debunking the misinformation was done by explaining why it was false and by offering the correct information in an understandable and plausible way^{32,37}.

In the final script, named 'A shot of love', a young Ghanaian couple discusses the misinformation they have heard around the COVID-19 vaccines and fertility. Since they have plans to have children later, they want to be sure that taking the COVID-19 vaccine will not affect their fertility. They decide to first talk to their religious leader. The religious leader is delighted by the news that they plan to have children and assures them that the vaccines are safe - he and his wife recently welcomed another baby after vaccination. The religious leader recommends that the couple also speaks with a medical doctor. The couple visits the doctor at a local clinic who similarly tells them that the COVID-19 vaccines are safe and that it will protect any future children. Outside of the clinic, the couple discusses what they have learned, and both decide to get vaccinated, calling it 'a shot of love'. The audio drama was recorded in both English and Twi and was around 3.5 minutes long. The full English script can be found in the Supplementary Materials.

The control group was similarly asked to listen to an audio piece, which was about nutrition for children and was around two minutes long. This audio had been previously produced by UNICEF Ghana and Viamo and was repurposed for this study.

Procedures

Viamo, a social enterprise providing mobile-based technological solutions and the technical content manager of the UNICEF Ghana's Agoos platform, carried out the IVR study. The randomly selected 13,000 participants were automatically called. If people did not pick up, the system tried again after one hour. As previously mentioned, the entire survey (questions and answers) as well as the audio drama were pre-recorded in both Twi and English. Participants simply followed the audio and used the keypads on their mobile phones to answer the questions.

All participants received an incentive of 5 Ghanaian Cedi (GHS, around 0.5 USD) in data credit upon completion of the survey. They were also asked whether they would like to be called back after around four weeks for the follow-up survey, which would again give them GHS 5 in data credit upon completion. The baseline survey took around 12–14 minutes to complete, and the follow-up between six to eight minutes.

Statistical analysis

Our primary outcome was belief in COVID-19 vaccine misinformation, measured with the question: 'How much do you believe that COVID-19 vaccines can cause infertility?' Participants could answer: 'Not at all', 'A little', 'A moderate amount', 'A lot' or 'A great deal'. This was asked at three time points: before the intervention, directly after the intervention and at one-month follow-up. We analyzed the effect of the intervention on this belief through ordinal logistic regression models, both crude and adjusted for age (18–24, 25–29, 30–34, 35–39, 40–44, 45+), gender (male, female), language (Twi, English), education (no formal education, primary, secondary, tertiary education), COVID-19 vaccination status (unvaccinated, plan to get vaccinated, vaccinated) and baseline levels of belief in the misinformation.

As part of the secondary outcomes, we analyzed whether the intervention affected perceived safety of the COVID-19 vaccines. We ascertained this by asking participants to what extent they agreed with the following statement: 'I think the COVID-19 vaccines are safe'. Participants could answer on a 5-point Likert scale (from 'I strongly disagree' to 'I strongly agree'). This question was asked directly after the intervention and at one-month follow-up. We analyzed the effect of the intervention on perceived safety by specifying both crude and adjusted ordinal logistic regression models, adjusted for age, gender, region, language, education, and COVID-19 vaccination status.

We also administered the six-item Vaccine Trust Indicator (VTI), which measures trust in various aspects of vaccines and vaccination⁴⁸. While the scales of these questions usually range between 0 and 10, we adapted it here to a 5-point scale, to accommodate the IVR method, where each answer must be said out loud. The VTI was administered directly after the intervention and at one-month follow-up. Scores on the six questions were summed and the mean was calculated. Linear regression models were then used to investigate whether the intervention affected the score on the VTI.

Before the audio dramas were played, we asked participants whether they had been vaccinated against COVID-19 ('Yes', 'No', 'No, but I plan to', 'I prefer not to say'). We asked a follow-up question to those who were not vaccinated: 'How likely is it that you will get vaccinated against COVID-19?', with answers on a 5-point Likert scale ('Extremely unlikely' to 'Extremely likely'). We asked this question again after the audio dramas were

played, again limited to those who were not vaccinated. To analyze the effect of the intervention on intention to get vaccinated among the unvaccinated, we built ordinal logistic regression models.

Results

Out of 2,087 participants who picked up the phone (out of 13,000 targeted, 16%), a total of 991 participants completed the survey (see Fig. 1). This group was slightly more male (52%), and a majority (70%) was aged between 18 and 24 years, see Table 1. Most people (76%) did the study in Twi, and more than half the participants (57%) completed secondary education or higher. The study population had a high COVID-19 vaccination coverage, with 73% of the sample indicating that they had been vaccinated. Out of the 991 participants who completed the baseline study, 750 (76%) agreed to be called back for the follow-up survey after one month. A total of 658 participants completed the follow-up survey (88% of those who agreed to be called back).

Primary outcome

The primary outcome was the strength of belief in the COVID-19 vaccine misinformation. At baseline, 47% of the participants (48% in control, 46% in intervention) did not believe in this misinformation at all. Directly after the intervention, this increased in the intervention group to 69%, while it remained 48% in the control group (see Fig. 2 and Table S1). At the one-month follow-up, 58% of the intervention did not believe in the misinformation at all, compared to 50% in the control group. Ordinal logistic regression models showed that the intervention had a strong protective effect on belief in misinformation (adjusted Odds Ratio (aOR) 0.45, 95% Confidence Interval (CI) 0.34–0.59), see Table 2. At one-month follow-up there was still a strong protective effect of the intervention (aOR 0.66, 95% CI 0.49–0.91). Having completed primary education was significantly associated with belief in the misinformation, compared to those who had not received formal education (aOR 1.62, 95% CI 1.04–2.51), see Table S2. This effect disappeared at the one-month follow-up.

Secondary outcomes

Directly after the intervention, 66% of the participants in the intervention agreed that the COVID-19 vaccines were safe, compared to 59% in the control group. At the one-month follow-up, 69% in the intervention and 59% in the control group judged the COVID-19 vaccines to be safe. Ordinal logistic regression models showed that those in the intervention group were 56% more likely to agree that the COVID-19 vaccines are safe (aOR 1.56, 95% CI 1.22–2.00). At one-month follow-up this was 53% (aOR 1.53, 95% CI 1.13–2.07), see Table 3 and Figure S1.

On the six items of the Vaccine Trust Indicator (VTI), participants in the control group scored a mean of 3.24 (Standard Deviation (SD) 1.09). The intervention group had a mean of 3.46 (SD: 1.08). Linear regression models showed that the intervention was associated with a 0.23-point increase on the VTI (adjusted Coefficient: 0.23,

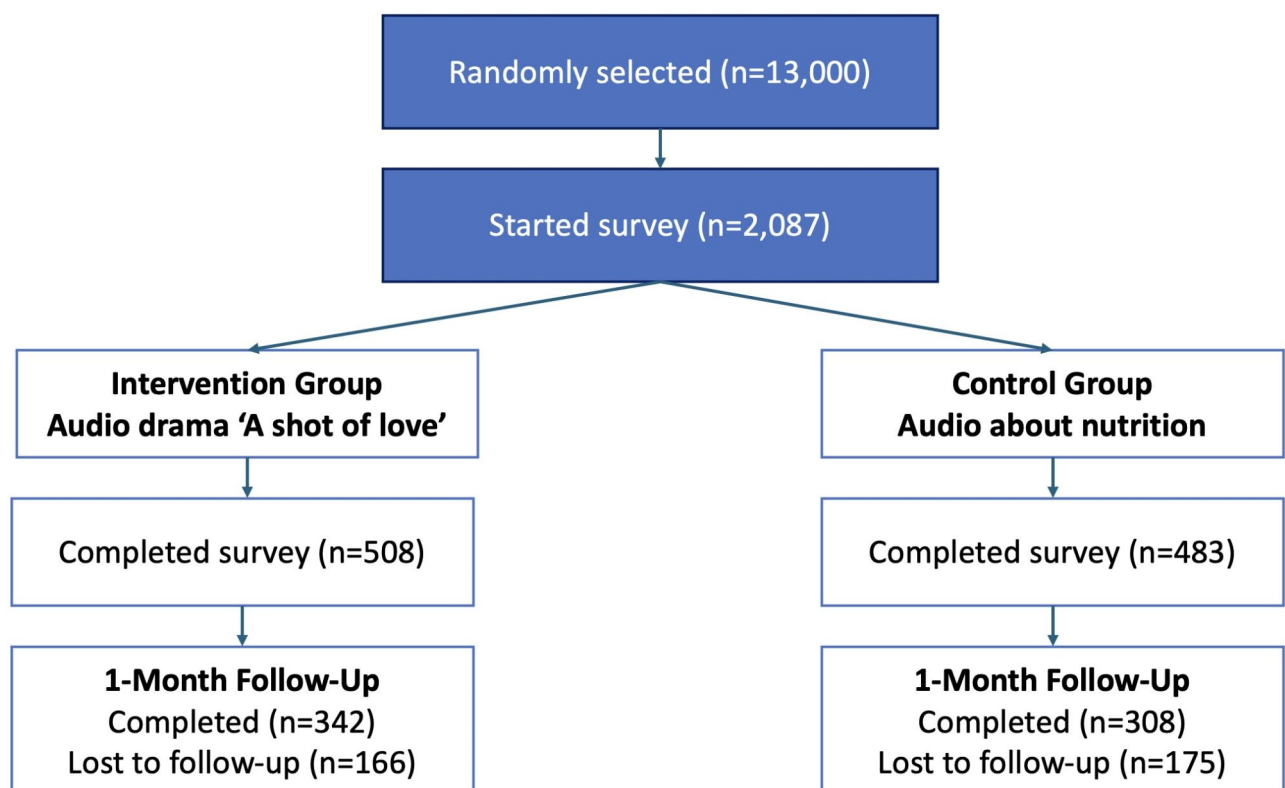


Fig. 1. Study flowchart.

	Control (%)	Intervention (%)	Overall (%)	Chi2 P-value
Gender				0.550
Female	229 (48)	251 (49)	480 (48)	
Male	253 (52)	257 (51)	510 (52)	
Age				0.433
18–24	346 (72)	339 (68)	685 (70)	
25–29	63 (13)	70 (14)	133 (14)	
30–34	23 (5)	33 (6)	56 (6)	
35–39	13 (3)	22 (4)	35 (4)	
40–44	16 (3)	13 (3)	29 (3)	
45+	17 (4)	21 (4)	38 (4)	
Language				0.712
English	114 (24)	125 (25)	239 (24)	
Twi	369 (76)	383 (75)	752 (76)	
Education				0.603
No formal	67 (14)	59 (12)	126 (13)	
Primary	150 (32)	147 (30)	297 (31)	
Secondary	193 (41)	211 (43)	404 (42)	
Tertiary	66 (14)	77 (16)	143 (15)	
COVID-19 Vaccination				0.368
No	82 (18)	100 (20)	182 (19)	
No but plan to	42 (9)	35 (7)	77 (8)	
Yes	343 (73)	362 (73)	705 (73)	
Belief in misinformation				0.395
Not at all	230 (48)	236 (46)	466 (47)	
A little	152 (31)	177 (35)	329 (33)	
Moderate	56 (12)	59 (12)	115 (12)	
A lot	21 (4)	22 (4)	43 (4)	
A great deal	24 (5)	14 (3)	38 (4)	

Table 1. Demographics of the study population at baseline. Missing: gender: 1 (0.1%), age: 15 (1.5%), education: 21 (2.1%), COVID-19 vaccination status: 27 (2.7%).

95% CI 0.10–0.37), see Table S4. At the one-month follow-up, this effect disappeared (adjusted Coefficient: 0.14, 95% CI -0.04–0.31).

Out of the 182 participants who, at baseline, indicated that they were not vaccinated against COVID-19, 114 answered the question about intention to vaccinate against COVID-19. Among those, 38% were unlikely to get vaccinated. After listening to the audio drama, there was no difference in vaccination intentions between the control and intervention group (aOR 0.84, 95% CI 0.40–1.76), see Table S5 and Figure S2.

Discussion

We found that an evidence-based, context-driven audio drama was an effective way to dispel misinformation about COVID-19 vaccines and fertility in Ghana, with an effect that lasted for at least one month. Apart from decreased beliefs in the misinformation, we also found that the intervention increased the perceived safety of COVID-19 vaccines. Our findings add to the growing evidence base around misinformation management strategies in LMICs.

In the audio drama the misinformation was explicitly mentioned, which could have increased the risk of a backfire effect^{31,49}. Our findings show that the drama did not backfire and was effective in reducing the strength of belief in misinformation. This is in line with evidence from Sierra Leone, where an audio drama that explicitly mentioned prevalent health misinformation effectively debunked the misinformation, without backfire effects⁴⁴.

While an audio drama requires thoughtful production, the finished product has the potential to be distributed at low-cost on a large scale on various social media and other messaging platforms^{50,51}. Future studies should aim to measure the real-world effects of these types of interventions on people's misinformation beliefs, as well as vaccination intentions.

The effect of the intervention on trust in various aspects of vaccines (as measured through the VTI) disappeared at the one-month follow-up. This may be explained by the fact that the VTI is not vaccine-specific, and our intervention specifically targeted COVID-19 vaccine misinformation. It also shows that apart from debunking vaccine-specific misinformation, more work may be needed to increase general trust in vaccines. The COVID-19 pandemic has eroded trust in public health and vaccines across the world, and work is needed to rebuild this^{52–55}. The finding that our audio dramas did not affect vaccination intentions may be due to a low sample size. But taken together with the results on the temporary effect on vaccine trust, it could also indicate

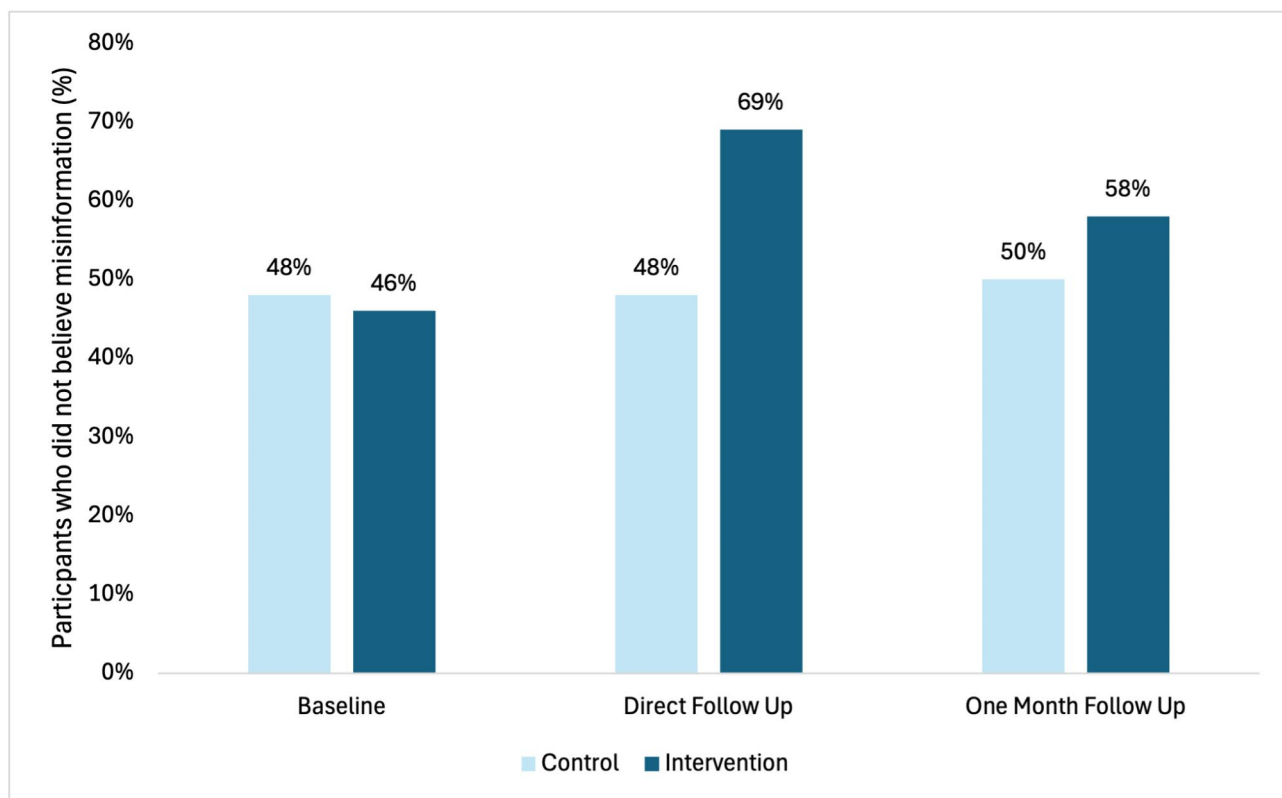


Fig. 2. Percentage of participants who did not believe in the misinformation at baseline, direct follow up and one-month follow up.

	Crude OR (95% CI)	P-value	Adjusted* OR 95% CI	P-value
Directly after intervention				
Control	Reference	-	Reference	-
Intervention	0.45 (0.35–0.57)	<0.001	0.45 (0.34–0.59)	<0.001
One-month follow-up				
Control	Reference	-	Reference	-
Intervention	0.66 (0.49–0.88)	0.005	0.66 (0.49–0.91)	0.011

Table 2. Effect of the intervention on strength of belief in COVID-19 vaccine misinformation. *Adjusted for: gender, age, language, education, COVID-19 vaccination status, baseline belief in misinformation.

	Crude OR (95% CI)	P-value	Adjusted* OR 95% CI	P-value
Directly after intervention				
Control	Reference	-	Reference	-
Intervention	1.48 (1.18–1.87)	0.001	1.56 (1.22–2.00)	<0.001
One-month follow-up				
Control	Reference	-	Reference	-
Intervention	1.66 (1.25–2.22)	0.001	1.53 (1.13–2.07)	0.006

Table 3. Effect of the intervention on perceived safety of COVID-19 vaccines. *Adjusted for: gender, age, language, education, COVID-19 vaccination status, baseline belief in misinformation.

that corrective information may help to reduce the belief in misinformation but may not be sufficient to increase other downstream effects, such as trust and vaccination behaviors⁵⁶. Future studies should explore how such audio dramas can be used to more effectively shift vaccination intention among unvaccinated individuals. Multi-pronged approaches that go beyond the correction of misinformation to address practical vaccination issues as well as ensuring high quality service delivery in health centers may help to increase vaccine trust^{57–59}.

Our intervention successfully reduced the beliefs in misinformation, but this effect was not seen for all participants in the intervention group. This could be a demonstration of the continued influence effect, whereby misinformation, despite efforts to counter it, still affects people's thinking^{32,33}. The misinformation that we targeted could be seen as especially challenging, given how widespread it was and the severity of the (imagined) effects if it were true. The emotional component of this piece of misinformation may have made it sticky and thus difficult to counter among all participants in the intervention group^{32,37}. Implementation strategies which aim to change complex beliefs and behaviors such as conspiratorial thinking or vaccine uptake should be multifaceted, including actions which reinforce the effects of previous interventions^{59,60}.

The questions that were raised by the 49 participants who called the study hotline also indicate a need for further information on practical issues of vaccination, such as where and how many times to get vaccinated. As to the potential effect of the calls on the findings of this study: the calls were anonymous, so we could not determine whether the calls affected participants' belief in misinformation or vaccination status and intentions.

A major strength of this study is that we were able to evaluate the effectiveness of the intervention through a randomized controlled trial - a strong study design that enables causal inferences. With the IVR method we could include people of low literacy, as the entire study was done via audio. By producing the audio in both Twi and English, we were able to reach people in a language they were comfortable with. However, this still excluded people who spoke languages other than Twi and English (i.e., in Ghana, there are 11 government-sponsored languages). The study population was young (which increased the relevance of the topic of the audio drama) and had high COVID-19 vaccination coverage (per self-report), which is different compared to the COVID-19 vaccination coverage among Ghanaian adults⁶¹. As the study population was sampled through the Agoo platform, they may have a stronger interest in health information compared to their peers. The high drop-out rates were to be expected based on previous IVR studies, but also reflect that the study population may be different compared to our target population. It can be speculated that a more diverse sample would likely have included more unvaccinated participants, to whom the intervention would be appealing. At the same time, more diversity in terms of age could reduce the relevance of the audio dramas (given that they are about fertility concerns), making it difficult to assess what the effect on the overall results would be. While IVR is an accepted method of data collection in low-income settings^{62–65}, it requires mobile phone access which excludes people who are not in possession of one. However, the share of mobile phone possession in Ghanaian adults aged 20–50 years is on average more than 83%⁶⁶.

A context-driven, behavioral science-based audio drama that tackled prevalent misinformation about COVID-19 vaccine misinformation and fertility was effective in reducing the belief in the misinformation among a young, adult, Ghanaian population. Future work should aim to investigate the effects of these types of interventions alone and in combination as they are rolled-out on a large scale and assess the link with vaccine uptake. The results of this study also provide a strong resource for similar interventions in low-resource settings.

Data availability

De-identified data is available on Open Science Framework (OSF) at the following link: <https://osf.io/9zbqh/>.

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Author contributions

MW, SC, HM, II, HAH, EE, AA and SBO conceptualized the study. Development and co-creation of the intervention was led by II, HAH, EE, RA, AA, with input from MW, SC, HM, LM, CL, AT and SBO. Data collection was carried out by NS and DN. Data analysis was led by MW, with input from SC, HM, II, AA, SBO. The manuscript was drafted by MW, SC, HM, and received input from II, HAH, EE, LM, RA, NS, DN, CL, AT, AA and SBO. All authors approved the final version of the manuscript.

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Declarations

Competing interests

NS and DN work for Viamo, a digital intervention company; NS and DN assisted in the collection of data, but not the analysis of data. All other authors have no conflicts of interest to declare.

Additional information

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