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Trust in government, social media and willingness to vaccinate

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ABSTRACT

Vaccine hesitancy is considered one of the biggest global health threats. The prevalence of false information about vaccines on social media amplifies this challenge, making it more urgent. This study examines the relationship between social media use, trust in information sources, beliefs about vaccination rates, and willingness to adopt vaccines using data gathered in late 2023 from 975 respondents in South Africa. Our results suggest that people who rely on social media as their primary news source are more hesitant to get vaccinated for themselves and their children. Trust, which includes various sources including confidence in the government, is positively linked to vaccination decisions. Trust is especially important when it comes to less traditional vaccines such as COVID-19 and flu vaccines for both adults and children. We also note gender differences, with South African men showing more reluctance to get vaccinated as adults. Additionally, there is a negative correlation between social media use and the willingness of males to get vaccinated, but this relationship is not evident among females. Our research highlights the need for targeted interventions aimed at improving vaccine uptake, taking into account the links with information sources about vaccination and government trust.

1. Introduction

The World Health Organization has listed vaccine hesitancy as one of the top 10 threats to global health (World Health Organization, 2019). While vaccine hesitancy is not new, the spread of false information about vaccinations on social media and the decline in trust in information from the government and other sources has made it more pressing in recent years (Casiday et al., 2006; Nicholls and Yitbarek, 2022; Trent et al., 2022; Larson et al., 2018). Vaccinations play a crucial role in maintaining global health. However, there is limited knowledge about the prevalence of vaccine hesitancy and resulting reduced vaccine uptake and its determinants in low- and middle-income countries. To shed light on this issue, we follow a recent body of literature (e.g. Goldenberg, 2021) looking at the role of public trust in vaccine hesitancy. Our research investigates the predictors of vaccination decisions in South Africa. Specifically, we ask whether trust in social media or the government can predict the decisions of individuals to vaccinate against a variety of diseases, including MMR (Measles, Mumps and Rubella), Tuberculosis (TB), COVID-19, and HPV (Human Papillomavirus).

Studies have shown that institutional trust (the belief in the reliability of institutions), such as trust in the government or scientific community, is crucial in influencing public compliance with public health measures and vaccine acceptance (Van Oost et al., 2022; Jennings et al., 2021; Fukuyama, 1995; Putnam et al., 1993). Pre-COVID-19 studies, including those by Goldenberg (2021) and Larson et al. (2018), highlighted the long-lasting effects of trust on vaccine acceptance. These studies showed how vaccine hesitancy persisted even after scientific misinformation had been corrected. Trust in healthcare professionals (Solís Arce et al., 2021) and the government also emerged as crucial factors that determined people's willingness to get vaccinated (Blair et al., 2017; Larson et al., 2018).

The COVID-19 pandemic rekindled interest in the relationship between trust and vaccine hesitancy and the adoption of COVID-19 vaccines (Jennings et al., 2023). The link between trust in government and willingness to vaccinate has been explored in a range of studies, mostly in developed countries, for the COVID-19 vaccine. However, there is a noticeable gap in studies related to trust conducted in developing countries, particularly in Africa, both pre-COVID-19 (Larson et al., 2018) and after the COVID-19 pandemic. A review of the post-COVID-19 literature continues to reveal gaps when it comes to empirical research centered on African populations. Moreover, existing studies focus largely on individual vaccines and the intention to vaccinate rather than

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the actual uptake of vaccines, a vital distinction emphasized by Betsch et al. (2018). In a scoping review of studies considering COVID-19 vaccine hesitancy in Sub-Saharan Africa, Deml and Githaiga (2022) also highlight the lack of standardised measures for assessing vaccine hesitancy, further underscoring a critical gap in the literature. To address this knowledge gap, this study investigates the uptake of vaccines for MMR (Measles, Mumps, and Rubella), Tuberculosis (TB), COVID-19, and HPV (Human Papillomavirus) in South Africa for both adults and children.

Predictors of vaccine uptake may vary depending on the type of vaccine. SteelFisher et al. (2023) found that US adults are more willing to get the flu vaccine compared to the COVID-19 vaccine, especially when they are concerned about vaccine effectiveness and safety. In a meta-analysis on COVID-19 vaccine hesitancy, Ackah et al. (2022) found that misinformation from social media and mistrust in vaccine manufacturers worsen vaccine hesitancy in Africa. Ackah et al. (2022) also argue that lower perceived mortality is associated with vaccine hesitancy in many African countries.

This paper explores vaccine uptake in South Africa, to help bridge the considerable research gap regarding vaccination uptake and trust within the African context. We contribute to the current literature in several ways. First, by including multiple vaccines such as flu, COVID-19, and childhood vaccines, the study provides a comprehensive analysis beyond just COVID-19 vaccine uptake. This approach allows for a broader examination of how vaccine behaviors change by the type of vaccine. Given the decline in vaccine uptake since the COVID-19 pandemic in many African and other developing countries (UNICEF, 2023), this approach gives insight into whether factors such as trust in government and social media affect all vaccination uptake or only temporarily disrupt COVID-19 vaccine uptake. Second, the study measures actual vaccine uptake, as our data was collected towards the end of 2023, after South Africans had sufficient time to receive vaccinations and COVID-19 booster vaccines in the country. South Africa initiated COVID-19 vaccination in February 2021, starting with high-risk groups such as health workers and individuals with comorbidities. In September, eligibility was expanded to include all individuals aged 12 and above (World Health Organization, 2022). Although most studies in Africa measured COVID-19 vaccine hesitancy, only a few studies investigated actual uptake of COVID-19 vaccinations after these became available (Deml and Githaiga, 2022). Focusing on behaviors rather than vaccination hesitancy, which relates to attitudes (Betsch et al., 2018), will provide valuable implications for policymakers and public health officials in South Africa as well as across the broader African continent. The success of vaccination programs is critical for disease prevention and public health promotion, making this study significant in advancing our understanding and improving vaccine uptake in emerging African countries like South Africa. Finally, trust is an important starting point to explore vaccine hesitancy and uptake more broadly, given the existing empirical evidence suggesting a negative association between trust and COVID-19 vaccine adoption in other countries. Thus, we seek to contribute to the existing literature by examining the role of trust in government, social media, and other institutions in shaping vaccination decisions in South Africa. Drawing on a diverse set of predictors, including general trust, media usage patterns, and beliefs, our research addresses questions about these predictors of vaccination decisions.

In the Afrobarometer 2021 survey, when respondents in South Africa were asked how much they would trust the government to ensure the safety of COVID- 19 vaccines, 39% of respondents said not at all, 25% said a little, and only 12% said a lot. At that time, 50% of respondents said they were somewhat or very unlikely to get the COVID-19 vaccine. Furthermore, the recent measles and mumps outbreaks and the increase in zero-dose and under-vaccinated children (UNICEF, 2023) in South Africa highlight the importance of better understanding issues around vaccine hesitancy in the country. These factors make South Africa an interesting case study in the under-studied African context.

2. Literature

The importance of institutional trust, defined as the belief that institutions including the government, science and the medical establishment will act in the interest of citizens, has been well-established (e.g. Fukuyama, 1995; Putnam et al., 1993). Issues around (lack of) trust in institutions have been raised by various authors to help explain vaccine hesitancy and to highlight the importance of trust in getting members of the public to comply with public health measures (see e.g. Jennings et al., 2021; Van Oost et al., 2022, and references therein). This includes research prior to COVID-19, as well as studies related specifically to COVID-19 vaccination. In the former category, Goldenberg (2021) highlights continued hesitancy around the MMR vaccine even after the scientific record was corrected following falsified data linking the vaccine with autism. The author argues that if the issue had been one of availability of accurate information, vaccination levels would have adjusted to align with the corrected scientific record. Instead, she attributes the issue to trust. Supporting this focus on trust, a meta-analysis by Larson et al. (2018) looked at different types of trust and their links to vaccine hesitancy, and found mostly positive associations between government trust, trust in health care professionals and willingness to vaccinate. Blair et al. (2017) also notes that lower trust in government was associated with less willingness to take government-recommended precautions to slow the spread of Ebola during the outbreak in Liberia in 2014.

With the introduction of vaccinations against COVID-19, a number of papers have investigated the issue of trust in relation to adoption of the COVID-19 vaccine specifically. These studies include a mix of hypothetical questions about willingness to vaccinate, asked before the vaccine was available (e.g. Jennings et al., 2021; Schernhammer et al., 2022; Soares et al., 2021) and self-reported questions on vaccination uptake (e.g. Nicholls and Yitbarek, 2022). Lower trust in scientists and belief in misinformation have been associated with COVID-19 vaccine hesitancy in the USA (Stoler et al., 2022), where specific mistrust in public health institutions has also been found to predict vaccine hesitancy (Choi and Fox, 2022). Lack of trust in institutions (including the church, government, the justice system and the EU) is also related to vaccine hesitancy in Italy (Cordella et al., 2023). Low confidence in government measures and the health service response around COVID-19 were associated with greater vaccine hesitancy in Portugal (Soares et al., 2021), with distrust in authorities also being associated with greater hesitancy in Austria (Schernhammer et al., 2022) and Belgium (Van Oost et al., 2022). Mistrust in government, as well as lack of trust in vaccines in general, were associated with higher vaccine hesitancy in the UK (Jennings et al., 2021).

In a study across 3 countries, Trent et al. (2022) noted that the link between government trust and COVID-19 vaccine hesitancy varies with the stance of government towards vaccination. For example, while Australian respondents' trust in government was positively correlated with willingness to vaccinate, the opposite was seen in the USA, where the president at the time did not support vaccination. With the political polarisation around the adoption of COVID-19 preventative measures in the USA and other countries, studies have investigated possible links between political views and COVID-19 vaccination. A meta-analysis found that political ideology was strongly associated with refusal of the COVID-19 and flu vaccines (Troiano and Nardi, 2021); and Schernhammer et al. (2022) notes that those who voted for the governing party in Austria were significantly less hesitant about vaccinating. However, Cordella et al. (2023) found no significant link between political values and vaccine acceptance in Italy.

Other studies consider trust in a range of institutions. Cordella et al. (2023) finds evidence suggesting that trust in institutions in Italy seems to be a fairly generalised attitude, regardless of the specific institution (e.g. church, president). Jennings et al. (2021) notes the importance of distinguishing between different types of trust, for example government versus media versus experts. Considering COVID-19 vaccine hesitancy in

a range of countries, including 10 LMICs, Solís Arce et al. (2021) notes that government trust is markedly lower than trust in healthcare workers in almost all countries in their study.

While social media is not usually considered an "institution", a few studies considering trust in institutions also address social media's role in vaccine hesitancy. Nurmi and Jaakola (2023) finds, in a study using ethnographic interviews of vaccine hesitant parents in Finland, that parents who do not understand the medical research might turn to social media groups for information. These authors note that this can cause anxiety as these parents might lack trust in the government or experts but might also be aware that social media information might also not be trustworthy. Jennings et al. (2021) reports that respondents in the UK who got a lot their information from social media sources were less willing to be vaccinated, while Nicholls and Yitbarek (2022) finds similar links with trust in social media for the COVID-19 vaccine in South Africa. Van Oost et al. (2022) highlights the important role that trusted authorities (such as governments) can play in reducing belief in conspiracy theories, frequently spread through social media channels. Carrieri et al. (2019) reports on a quasi-experiment exploiting differences in internet coverage in Italy after the Court of Rimini claimed a causal link between MMR and autism in 2012. They found that the spread of misinformation through non-traditional media following this court ruling was associated with reduced immunisation rates for children across all types of vaccine.

Other studies consider associations between demographic variables and vaccine hesitancy. Deml and Githaiga (2022) and Ackah et al. (2022) review the literature on the determinants of COVID-19 vaccine hesitancy and uptake in sub-Saharan Africa. The main reasons for vaccine hesitancy in the region were concerns with vaccine safety and side effects, lack of trust for pharmaceutical industries and misinformation. Income shows mixed findings. Sakai (2018) finds that childhood vaccination rates initially rise with income, but then fall, suggesting that both very low and high income parents are less likely to vaccinate their children. The authors postulate that high income parents might count on being able to afford treatment or on herd immunity protecting their children. However, having low income was associated with extreme COVID-19 vaccination hesitancy in the USA (Stoler et al., 2022). Results on gender are also mixed. Troiano and Nardi (2021) notes that women had a lower acceptance rate for the COVID-19 and flu vaccines, and vaccine hesitancy was found to be higher among women in a cross-country study of 53 low and middle income countries (Eberwein et al., 2022). Schernhammer et al. (2022) finds that women and younger people reported lower willingness to vaccinate in Austria too. Conversely, in China, Wu et al. (2023) notes lower vaccine hesitancy among females. Prior to COVID-19, a multi-country survey (Larson et al., 2016) shows an inverse relationship between higher levels of schooling and good access to health (at country level) and positive sentiment towards vaccination. On the other hand, considering 53 low- and middle-income countries, Eberwein et al. (2022) reports that less education was associated with greater COVID-19 vaccine hesitancy. In Africa higher education attainment, being male and fear of contracting COVID-19 are related to positive attitudes towards COVID -19 vaccine (Ackah et al. ,2022).

Although many studies have considered the issue of trust in vaccinations, particularly since COVID-19, Larson et al. (2018) notes that few of these studies were conducted in developing countries. Further, very few of the COVID-19 trust studies focused on African countries, with the exceptions including qualitative research noting distrust in local government and Western countries as factors in COVID-19 vaccine hesitancy in Ghana, Cameroon and Malawi by Ojong and Agbe (2023) and work on the role of social media trust in predicting adoption of COVID-19 preventive measures and vaccines (Nicholls and Yitbarek, 2022). The question of trust in government is also touched on by Eberwein et al. (2022). Their model does not show a significant correlation between government trust and vaccine hesitancy. However, since trust was not the primary focus of that research, the authors do not consider other dimensions of institutional trust. Similarly, although the cross-country analysis of Solís Arce et al. (2021) explored trust in different institutions, trust was not correlated with vaccine hesitancy in their paper.

We, therefore, build on this existing body of work by considering the role of trust in government, social media and other institutions in explaining self-reported adoption of a range of vaccines in South Africa.

3. Methodology

3.1. Sample and data collection procedure

We used an online survey panel provider, TGM Research, to obtain a sample of individuals from different demographic groups. The online data collection occurred from 21 September to October 5, 2023. Participants were informed that the survey was about people's opinions on vaccinations and provided informed consent to participate. Ethics approval for this study was granted by the Economic and Management Sciences ethics committee at our institution (EMS167/23). To participate in the survey, respondents had to be living in South Africa and be aged 18 years or older.

To ensure data quality, we only included participants who passed two screener questions assessing attentiveness. A total of 1006 participants passed both screener questions.

Table 1 summarises the demographic characteristics of our sample. Among the participants, 500 were females, 502 were males, and four identified as non-binary. Due to the small size of the non-binary group, we did not separately analyse their responses and removed these four observations from the sample. 27 respondents chose not to disclose their household income. After removing these entries from the data, we have 975 observations.

Our sample is similar to the race representation of South Africa where 79% of the population are Black people (our sample contains 74%

Table 1
Descriptive statistics for demographic variables.

	Obs	% sample
Gender		
Female	500	49.70
Male	502	59.90
Non-binary	4	0.40
Race		
Black	740	73.56
Coloured	72	7.16
Indian/Asian	35	3.48
White	159	15.81
Income		
Low income	171	16.98
Medium income	588	58.39
High income	220	21.85
Don't know/prefer not to say	27	2.68
Education		
No degree	354	35.19
Degree	652	64.81
General health level		
Unhealthy	127	13.03
Healthy	848	86.97
Province		
Eastern Cape	67	6.66
Free State	39	3.88
Gauteng	444	44.14
KwaZulu-Natal	160	15.90
Limpopo	56	5.57
Mpumalanga	33	3.28
North West	25	2.49
Northern Cape	13	1.29
Western Cape	169	16.80

Total number of observations is 1006.
Obs indicates the number of observations for each characteristic.
% sample displays the share of the sample that aligns with a characteristic.

of Black individuals) (Statistics South Africa, 2012). Only 12% of all South Africans have a form of higher education, while our sample is far more likely to hold a degree (65%) (Statistics South Africa, 2012). When comparing our income distribution to that of the nationally representative data on key outcomes such as unemployment, household income, child poverty, and access to government grants, we find that our sample under-represents the low-income earners (National Income Dynamics Study - Coronavirus Rapid Mobile Survey Wave 5, 2021). These differences are typical of online samples.

3.2. Data

3.2.1. Dependent variables

The questionnaire started by asking whether respondents received vaccinations for MMR, TB, influenza (flu) or HPV. We selected these vaccines to represent a variety of vaccination scenarios: MMR and TB are among the standard (single or double dose) early childhood vaccines adopted by most South Africans, while HPV is a more recently introduced single dose vaccine given to older children or young adults. The flu vaccine can be administered annually, so is not a once-off decision. For each of these vaccines, participants could either state that they received the vaccination as an adult or as a child or that they have not received this vaccine. Participants were also asked whether they had received the COVID-19 vaccine and the COVID-19 booster vaccine. It is important to note that having doubts or concerns about a particular vaccine does not necessarily mean that a person is hesitant towards all vaccines. People may have reservations about newly developed vaccines while still having confidence in vaccines with a proven track record of efficacy and historical usage. We used vaccines received as an adult as our dependent variables as respondents would not have had agency in decisions about vaccinations that they had received as infants or as children.

If respondents reported having children in the survey, we asked whether respondents had vaccinated their children for MMR, TB, influenza, HPV and COVID-19. The *total vaccines (child)* variable indicates the total number of these vaccinations administered to the respondents' children.

3.2.2. Independent variables

Social media indicates whether individuals obtain most of their news from a news outlet or a form of social media. We ask participants 'Which of the following news sources do you use most to get your news?' and provided options 'Twitter', 'Facebook', 'YouTube', 'WhatsApp', 'Local (South African) TV', 'Radio news', 'Local (South African) print', 'Online newspapers (e.g. News 24, Mail & Guardian, IOL, Business Day, etc.)', 'International TV', 'Online news' and individuals could specify their own preferred source of news. The *social media* variable indicates one when individuals choose 'Twitter', 'Facebook', 'YouTube', 'WhatsApp' or the individual specifies a social media platform. The variable returns zero otherwise.

Trust in entity is an index variable to offer a measure of generalised trust. This is derived from respondents' evaluations of their trust in four entities: immunologists, South African government, social media and healthcare professionals using a four-point Likert scale. The survey question asked: "How much do you think you can trust each of the following?" Respondents rated each entity (immunologists, South African government, social media and healthcare professionals) in turn. Respondents could choose between 'Not at all', 'A small amount/occasionally', 'Mostly' and 'Completely' to rate their trust levels. The *trust in entity* variable is created by summing the respondent's trust level for each agent. This variable ranges from 0 (do not trust any entities listed) to 12 (completely trust all entities listed).

Participants were also asked to evaluate their trust levels in obtaining vaccine-related information from a range of sources. We asked participants to assess their level of trust in the following sources: the South African government, healthcare professionals, social media, friends and family, religious leaders, news reports, alternative health networks and celebrities. Respondents could report trust levels with the following options: 'Very high', 'High', 'Average', 'Low', and 'Very low'. We create two variables: the *reputable info source* measures a respondent's trust level in the South African government, healthcare professionals and news reports, and the *questionable info source* evaluates the trust level participants have in social media, friends and family, religious leaders, alternative health networks and celebrities. Both variables are indices summing the trust levels reported by each participant for these various information sources. These variables range from 0 (very low trust in all information sources) to 12 (for the *reputable info source* variable) or 20 (for the *questionable info source* variable) where the higher value indicates the maximum trust in each type of information source.

Trust in state is an index to determine the level of trust that respondents have in government concerning vaccinations. Respondents assess the following statements: 'The South African government has the best interests of ALL its citizens at heart when they make vaccination recommendations', 'The SA government makes vaccination recommendations because they gain financially from vaccination sales' (This statement was reverse coded so that a high value on the trust in state index indicates strong agreement that the state can be trusted with vaccine-related matters) and 'The South African government has the necessary competence to make recommendations on vaccinations'. We ask whether respondents agree with these statements using a 5-point Likert scale from 'Disagree strongly' to 'Agree strongly'. The *trust in state* variable ranges from 0 (lowest trust) to 12 (highest trust).

Belief vaccine rate is the believed vaccination rate. Respondents were asked about the percent of parents who vaccinate their children, where the question reads: 'What percent of parents do you think are vaccinating their children with the standard childhood vaccines in South Africa?' Similarly, the *belief covid rate* variable refers to the percentage of South Africans that the respondent believed were vaccinated for COVID-19: 'What percent of South Africans do you think got the COVID-19 vaccine?'

For child vaccines is coded 1 when respondents state that they support universal childhood vaccinations and zero otherwise. We asked respondents how they would vote on a policy requiring universal childhood vaccinations before school, with exemptions only for medical reasons. They could choose: 1) 'I would vote for this policy,' 2) 'I would vote against this policy,' or 3) 'I'm not sure how I would vote.' These variables are summarised in Table 2.

3.3. Estimation strategy

3.3.1. The relationship between social media, trust and own vaccination behaviour by vaccine type

We use logistic regression to analyse the relationship between social media, trust, and adult vaccination uptake for the flu, COVID-19, and COVID booster vaccines. Due to low rates of vaccination during adulthood for MMR, TB, and HPV, these vaccines are excluded from the analysis.

Table 2
Descriptive statistics for dependent and independent variables.

	N	Mean	Std. Dev.	Min	Max
Dependent variables					
Total vaccines	975	1.730	1.248	0	6
Total vaccines (child)	975	1.882	1.698	0	6
Independent variables					
Social media	971	33.7%	0.473	0	1
Trust in entity	975	5.415	2.136	0	12
Reputable info source	975	6.765	2.563	0	12
Questionable info source	975	8.811	3.745	0	20
Trust in state	975	5.576	2.756	0	12
Belief vaccine rate	975	63.6%	23.053	1	100
Belief covid rate	975	58.8%	18.025	2	100
For child vaccines	975	50.0%	0.500	0	1

$$\mathbf{V_i} = \alpha_0 + \beta_1 \textit{social media}_i + \beta_2 \textit{trust in entity}_i + \beta_3 \textit{reputable info source}_i + \beta_4 \textit{questionable info source}_i + \beta_5 \textit{trust in state}_i + \beta_6 \textit{belief vaccine rate}_i + \gamma \mathbf{X_i} + \epsilon_i \quad (1)$$

The matrix $\mathbf{V_i}$ represents whether an individual is vaccinated for flu, COVID-19 and the COVID booster returning a value of 1 when vaccinated and zero otherwise. Equation (1) is estimated for every vaccine separately.

The *social media* variable takes a value of one if a respondent mainly receives their news from a social media platform and zero otherwise. Three variables observe the trust that respondents have in entities, information sources related to vaccines and trust in the state concerning vaccines. *Trust in entity* is a continuous variable measuring the respondents' reported trust level in a broad range of entities ranging from 0 (do not trust any entities listed) to 12 (completely trust all entities). Similarly, *reputable info source* reports the respondents' trust level in vaccine-related information from news sources, health care professionals and the government. This variable ranges from 0 (very low trust in all information sources) to 12 (very high trust in all information sources). *Questionable info source* show participants' trust level in vaccine-related information from family, friends, religious leaders and celebrities. This variable ranges from 0 (very low trust in all information sources) to 20 (very high trust in all information sources). Also, *trust in state* ranges from 0 (disagree strongly) to 12 (agree strongly) assessing the level of trust that respondents have in the South African government concerning vaccinations. The *belief vaccine rate* is the perceived rate at which parents are vaccinating their children. Lastly, the vector of control variables $\boldsymbol{X_i}$ includes the respondent's income, whether the respondent has a degree, their general health which is self-reported as being 'good' or 'excellent', race, gender and age. All continuous variables are standardised.

3.3.2. The relationship between social media, trust and the total number of vaccines for respondent's child

We estimate the following OLS model to estimate the relationship between social media, general trust levels in agents and vaccination behaviour for children.

$$\textit{total vaccines child}_i = \alpha_0 + \beta_1 \textit{social media}_i + \beta_2 \textit{trust in entity}_i + \beta_3 \textit{reputable info source}_i + \beta_4 \textit{questionable info source}_i + \beta_5 \textit{trust in state}_i + \beta_6 \textit{belief vaccine rate}_i + \beta_6 \textit{for child vaccines}_i + \gamma \boldsymbol{X_i} + \epsilon_i \quad (2)$$

Our dependent variable, *total vaccines child* is the total number of vaccines that respondent i has vaccinated their child for. Most of the independent variables are as described for our first model.

The *belief vaccine rate* is the rate at which respondents believe parents are vaccinating their children. *For child vaccines* returns one when respondents support policies imposing child vaccination in schools and zero otherwise. As before, the vector of control variables $\boldsymbol{X_i}$ includes the respondent's income, whether the respondent has a degree, their general health, race, gender and age. Again, all continuous variables are standardised.

3.4. Initial relationships

3.4.1. The correlation between trust measures

Table 3 shows the correlation between trust measures. We note that all trust variables are positively related to the general trust in entities (*trust in entity*). We note that individuals who generally trust various societal agents are also more likely to trust vaccine-related information from sources that may lack factual accuracy (*questionable info source*) and respondents are also more likely to trust the state's decisions regarding vaccines if they have general trust in the government (*trust in state*).

Table 3
Correlation of trust measures.

	Reputable info source	Questionable info source	Trust in state
Trust in entity	0.587***	0.448***	0.497***

*p < 0.10, **p < 0.05, ***p < 0.01.
Trust in entity refers to the general trust that individuals have in entities. *Reputable info source* refers to the trust in vaccine information from reputable sources. *Questionable info source* refers to the trust in vaccine information from questionable sources. *Trust in state* refers to the general trust in the state concerning vaccinations. When excluding the social media element from the *trust in entity* index, correlational signs and significance remain: *reputable info source* (0.622***), *questionable info source* (0.345***) and *trust in state* (0.539***).

3.4.2. Vaccination rate by news source

Table 4 presents the vaccination rate of both adults and children, categorised by the primary source of news. Overall, individuals who receive their news from traditional news platforms tend to have a higher number of vaccines (1.817) compared to those who rely on social media for their information (1.581). This difference is significant at a 1% level. Since many of the vaccines are typically administered to children, the number of people having these as an adult is small. Since respondents did not have the agency to determine which vaccines they received as children, we only consider vaccines taken during adulthood. The significant difference in vaccination rates by news source is therefore driven by the flu and COVID-19 vaccines. When individuals obtain their news from social media, they are less likely to receive the flu (34.3%) and COVID-19 vaccine (67.3%) in comparison to those who rely on traditional news platforms (49.3% for the flu vaccine and 73.3% for the COVID-19 vaccine).

A similar trend is observed for the total number of vaccines administered to the respondent's children: individuals who obtain news from traditional news platforms have higher rates of vaccination for the MMR (87.4%), TB (50.3%) and COVID-19 (38.8%) vaccines relative to the individuals who obtain their news from social media platforms (82.5% for MMR, 41.7% for TB and 31.6% for COVID-19). Overall the reported vaccination rate for MMR in our data is in line with the national MMR vaccine coverage rate in South Africa (86% in 2022), while the reported vaccination rate for TB is well below the national TB vaccine coverage rate of 84% during the same period (World Health Organization, 2023). Since the BCG vaccine for TB is given to infants at birth, we hypothesise

Table 4
Descriptive statistics of total vaccines by main news source.

	Social media	News platforms	z
Vaccine received as an adult			
Total vaccines	1.581	1.817	2.876***
MMR vaccine	4.8%	3.5%	0.991
TB vaccine	6.4%	6.2%	0.128
Flu vaccine	34.3%	49.3%	4.483***
HPV vaccine	6.7%	5.7%	0.605
COVID-19 vaccine	67.3%	73.3%	1.956*
Booster vaccine	38.5%	43.5%	1.476
Vaccines for respondent's children			
Total vaccines	1.584	2.045	4.211***
MMR vaccine	82.5%	87.4%	1.689*
TB vaccine	41.7%	50.3%	2.056**
Flu vaccine	64.1%	62.7%	0.346
HPV vaccine	11.7%	15.5%	1.321
COVID-19 vaccine	31.6%	38.8%	1.799*
Booster vaccine	19.9%	21.4%	0.436

The 'Total vaccines' row shows the total number of vaccines an individual has received. z refers to z values from the Wilcoxon rank-sum test.
*p < 0.10, **p < 0.05, ***p < 0.01.

that parents might not realise that they have vaccinated their children against this illness and might therefore under-report this vaccination.

3.5. Regression results

3.5.1. The relationship between social media, trust and vaccination behaviour by vaccine type

We consider the relationship between vaccine uptake, social media and trust for the flu, COVID-19 and COVID-19 booster vaccines. We present logit estimates in Table 5 to examine this relationship.

In column 1, we note that receiving news primarily from a social media platform has a negative relationship with uptake of the flu vaccine. This finding is in line with related literature (e.g. Jennings et al., 2021; Nicholls and Yitbarek, 2022) showcasing that social media is positively related to vaccine hesitancy. Although we do not have details of the mechanism for this, we hypothesise that individuals might take to social media to complain when contracting (a variety of) the flu despite being vaccinated against the flu. This might influence others against being vaccinated.

Table 5
Logit estimates: the impact of social media and state trust on vaccination behaviour by vaccine type.

Dependent variable: Received vaccine			
	Flu (1)	Covid (2)	Booster (3)
Social media	−0.391**	−0.049	−0.027
	(0.15)	(0.18)	(0.16)
Trust in entity	0.015	0.380***	0.296***
	(0.09)	(0.11)	(0.09)
Trust in state	0.120	0.413***	0.201**
	(0.10)	(0.11)	(0.10)
Reputable info source	0.293***	0.384***	0.370***
	(0.10)	(0.13)	(0.11)
Questionable info source	−0.053	−0.350***	−0.088
	(0.09)	(0.10)	(0.09)
Belief vaccine rate	0.063	−0.333***	−0.228***
	(0.07)	(0.08)	(0.08)
Belief covid rate		0.507***	0.325***
		(0.09)	(0.08)
Medium income	0.384*	0.303	0.466**
	(0.21)	(0.23)	(0.22)
High income	0.508**	0.517*	0.655**
	(0.26)	(0.29)	(0.26)
Degree	0.405**	0.209	0.386**
	(0.16)	(0.18)	(0.17)
Healthy	0.097	−0.005	0.305
	(0.22)	(0.24)	(0.22)
Black	0.109	0.045	−0.192
	(0.18)	(0.22)	(0.19)
Male	−0.525***	−0.412**	−0.172
	(0.14)	(0.16)	(0.15)
Age	0.416***	0.131	0.058
	(0.08)	(0.10)	(0.08)
Constant	−0.673**	0.901**	−1.079***
	(0.33)	(0.36)	(0.34)
Observations	971	971	971
Pseudo R^2	0.089	0.165	0.124

*p < 0.10, **p < 0.05, ***p < 0.01 Standard errors are in parenthesis.
All continuous variables are standardised.
All columns contain a control variable relating to the province in which individuals live. This categorical variable is omitted from this table for conciseness.
Social media is coded 1 when individuals mainly receive their news from social media and zero otherwise. *Trust in entity* is an index reporting respondents' trust level in entities. *Reputable info source* refers to the trust in vaccine information from reputable sources. *Questionable info source* refers to the trust in vaccine information from questionable sources. *Trust in state* reports the respondents' trust in the state regarding vaccine-related matters. *Belief vaccine rate* is the perceived vaccine rate.
As a robustness check, we have excluded the social media element from trust in entity and all relationships hold (Table A1 in the supplementary appendix).

Greater general trust levels in entities (*trust in entity*) within the community (immunologists, government and health care professionals) is associated with a greater likelihood of receiving the COVID-19 and COVID booster vaccines. This may be related to the newness of these vaccines. Cordella et al. (2023) highlight the importance of general trust levels in societal entities to improve vaccine rates. Also, *trust in state* shows that individuals trusting the state to make vaccine recommendations based on the best interests of all citizens positively relates to the number of vaccinations that an individual receives. Interestingly, general trust in entities is more important than trust in the state in predicting COVID-19 booster vaccine uptake. Trent et al. (2022) notes that Australians treat general trust in the state and trust in the government's handling of vaccine-related decisions similarly. Similarly, there is a positive relationship between individuals rating vaccine information as trustworthy from reputable sources (healthcare professionals, news reports and the state) and vaccine uptake for the flu, COVID-19 and COVID-19 booster vaccines.

Vaccine-related information that is obtained from questionable sources (social media, friends and family, religious leaders, alternative health networks and celebrities) is negatively related to the likelihood of individuals receiving the COVID-19 vaccine, where religious leaders are driving this negative effect. This finding also holds when removing the *social media* variable from the regression specification.

Belief vaccine rate indicates the perceived vaccination rate for children, reflecting how common vaccines are in the South African population. Interestingly, the *belief vaccine rate* measure of beliefs about standard childhood vaccinations has a significant negative association with the likelihood of being vaccinated against COVID-19 and the booster. We hypothesise that this might be related to misunderstandings of the widely discussed concept of herd immunity during the peak of COVID-19. Individuals might believe that if more people are adopting vaccines in general, this might offer them the opportunity to avoid the risks of new vaccines while still benefiting from others' decisions to vaccinate. The believed COVID-19 vaccination rate (*belief covid rate*) was positively associated with choosing to have both the COVID-19 vaccine and the booster. Perhaps believing that many others have safely had these vaccines encourages people to also have them.

Interestingly, it is apparent that males, relative to females, tend to receive fewer vaccines for the flu and COVID-19 vaccines. While different from the finding in much existing literature, this is in line with Wu et al. (2023) where men express greater vaccine hesitancy relative to women.

3.5.2. The relationship between social media, trust and the total number of vaccines for respondent's child

In Table 6, we estimate the relationship between social media, trust and the total number of vaccinations administered to a respondent's child. For ease of interpretation, we report the OLS model. The supplementary appendix (Table A9) shows the ordered logit regression for this relationship, with all main relationships holding.

In the initial column, it becomes apparent that parents exhibit a decreased inclination to vaccinate their children when their primary source of news is social media. As a robustness check, we run this regression for each type of vaccination, with these results available in the supplementary appendix (Table A10). While social media shows a negative relationship with the likelihood of obtaining each vaccine, these individual relationships are not significant. This trend mirrors the decision-making process observed in adults considering vaccination for themselves, as depicted in Table 5. This also aligns with existing literature, such as Nurmi and Jaakola (2023), which found that parents engaged in vaccine debates on social media are more likely to express hesitancy about vaccinating their children.

Regarding trust-related variables, we note that general trust in entities and trust in the state to make vaccine recommendations based on the best interests of all citizens play pivotal roles in encouraging parents

Table 6
OLS estimates: the impact of social media and trust on the total number of vaccines for respondents' child.

Dependent variable: Total number of vaccines					
	(1)	(2)	(3)	(4)	(5)
Social media	−0.246**	−0.223**	−0.222**	−0.235**	−0.199*
	(0.12)	(0.11)	(0.11)	(0.11)	(0.11)
Trust in entity		0.259***	0.253***	0.199***	0.194***
		(0.06)	(0.06)	(0.06)	(0.06)
Trust in state		0.150**	0.135**	0.125*	0.140**
		(0.07)	(0.07)	(0.07)	(0.07)
Reputable info source		0.036	0.034	−0.055	−0.076
		(0.08)	(0.08)	(0.08)	(0.08)
Questionable info source		0.065	0.063	0.092	0.108*
		(0.06)	(0.06)	(0.06)	(0.06)
Belief vaccine rate			0.160***	0.130***	0.122***
			(0.05)	(0.05)	(0.05)
For child vaccines				0.621***	0.571***
				(0.11)	(0.11)
Medium income					0.153
					(0.17)
High income					0.156
					(0.20)
Degree					0.212*
					(0.12)
Healthy					−0.002
					(0.14)
Black					0.100
					(0.13)
Male					−0.128
					(0.10)
Age					0.085
					(0.06)
Constant	2.761***	2.738***	2.733***	2.422***	2.127***
	(0.06)	(0.06)	(0.06)	(0.08)	(0.27)
Observations	683	683	683	683	683
Adjusted R^2	0.005	0.093	0.105	0.145	0.145

*p < 0.10, **p < 0.05, ***p < 0.01 Standard errors are in parenthesis.
All continuous variables are standardised.
Columns 5, 6 and 7 contain a control variable relating to the province in which individuals live. This categorical variable is omitted for conciseness. *Social media* is coded 1 when individuals mainly receive their news from social media and zero otherwise. *Trust in entity* is an index reporting respondents' trust level in entities. *Reputable info source* refers to the trust in vaccine information from reputable sources. *Questionable info source* refers to the trust in vaccine information from questionable sources. *Trust in state* reports the respondents' trust in the state regarding vaccine-related matters. *Belief vaccine rate* is the perceived vaccine rate. *For child vaccines* is coded 1 when individuals support a vaccine mandate for children. *As a robustness check, we have excluded the social media element from trust in entity and all relationships hold (Table A2 in the supplementary appendix).*

to vaccinate their children. *Reputable info source* does not have a significant relationship with the dependent variable. This is different when individuals are making decisions for themselves versus making decisions for their children. Notably, *trust in entity* has the strongest relationship with the dependent variable relative to *trust in state* and *reputable info source*, which confirms that general trust matters to increase vaccination rates. When we consider vaccines for children individually, we find that trust in entity is significantly associated with the flu, COVID-19, and booster vaccines for children. This is in line with the finding of Jennings et al. (2021).

Interestingly, respondents' beliefs about the rate at which other parents vaccinate their children are positively linked to the number of vaccines administered to their own children. This resonates with the findings of Nurmi and Jaakola (2023), suggesting that parents, when hesitant about vaccinating their children, are more likely to seek advice from other parents.

Unsurprisingly, in column 4, supporting a universal vaccine policy for children positively correlates with the dependent variable: supporters are likely to vaccinate their children. Column 5 reveals that all previously identified relationships remain robust with the inclusion of control variables.

4. Discussion

Our study considered the role of social media use, beliefs, and trust in different sources in predicting willingness to vaccinate. The adult vaccination rates in our sample varied as follows: 44.1% for flu, 70.9% for COVID-19, and 41.6% for COVID-19 booster. Regarding children's vaccination, children in our sample, on average, receive 2.69 number of vaccines, with 89.3% getting vaccinated against MMR, 49.6% against TB, and 38.1% against COVID-19. The reported MMR vaccination uptake in our data aligns with the national MMR vaccine coverage rate in South Africa. Interestingly, World Health Organization (2023a,b) data suggests that measles vaccination uptake in South Africa has not declined since the COVID-19 pandemic (vaccination was at 81% in 2017/2018, 87% in 2021 and 86% in 2022 for the first dose). The reported TB vaccination rate is well below the national TB vaccine coverage rate, which we hypothesise might be related to parents not realizing that this is included in the standard childhood vaccination program (it seems likely that parents who obtained the MMR vaccine would largely have followed this program). Overall, vaccination uptake in South Africa (and in our sample) is higher than in other African countries, particularly for the COVID-19 vaccine. According to Seddig et al. (2022), in their literature scoping review, almost 30% of studies included in their review reported less than 50% acceptance for the COVID-19 vaccine in Sub-Saharan Africa. Of policy concern, we have observed a lower uptake rate for COVID-19 boosters in our sample (41.6%) compared to the first vaccine (70.9%). The low uptake of COVID-19 boosters might suggest a declining trust in vaccination, which can lead to more breakthrough infections and compromise herd immunity. Addressing this is crucial for protecting public health and preventing the spread of infectious diseases. Flu vaccination is higher in our sample (44.1%) than in the country (12% in 2022, reported in NICD, 2022). Flu vaccination rates in South Africa lag behind those in many countries (OECD, 2022).

Looking at trust and vaccine uptake, we found that having social media as one's primary source of news was associated with lower vaccine uptake. This finding is similar to results observed in developed country contexts (the UK, Finland and Italy) (Jennings et al., 2021; Nurmi and Jaakola, 2023; Carrieri et al., 2019). The number of individuals using social media in these countries differs. In South Africa, the number of social media users is lower (59.3%) compared with Italy (74.5%), Finland (83.3%) and the UK (86.4%). Globally, platforms like YouTube, WhatsApp, Facebook, and Instagram dominate social media (DataReportal, 2023). The popularity of platforms varies by country, but Facebook and YouTube are the most used overall. In South Africa, Facebook use is similar to other countries, but YouTube use is significantly lower (Kemp, 2023). From our current data, we are unable to disentangle the impacts of individual social media platforms on vaccine uptake.

Trust, including a broad measure of trust in various sources and trust in government, was positively associated with vaccination decisions for adults and their children. This relationship between trust and vaccine hesitancy for adults has also been found in the developed context. Our findings reveal that within the South African population, trust remains a crucial determinant of vaccine uptake, echoing observations from developed nations. This underscores the universal importance of trust in healthcare decision-making, highlighting its role as a consistent predictor of vaccine acceptance across diverse demographic and geographical landscapes. Government trust has been declining in South Africa, with Afrobarometer showing that 27% of respondents trusted the ANC government in 2021. Trust in the health department is somewhat higher, at 56%. OECD data shows that trust levels in South Africa are lower than those in many other countries. Interpersonal trust in South Africa is also low, with only 16% of South Africans surveyed agreeing

that most people can be trusted (IPSOS, 2022). Demonstrating links between trust and vaccine uptake highlights the importance of rebuilding trust in South Africa. This is particularly true because where trust in government institutions is low, people might seek information elsewhere, including on social media.

Considering the vaccines individually, we noted that trust was particularly important for the less traditional vaccines, such as the COVID-19 vaccine. This was true for both adults and their children for COVID-19, and for decisions about the flu vaccine for children. Parents were also more likely to show strong associations between beliefs about vaccination rates and their behaviour toward the MMR and TB childhood vaccines. This could be because many schools in South Africa require early childhood vaccines for admissions. Receiving news from social media was significantly associated with lower flu vaccination rates for adults, while using reputable information sources for vaccine information was associated with higher rates of flu, HPV and COVID-19 vaccination rates for adults.

Interestingly, and in contrast to the findings of many studies, we saw lower adult vaccination uptake among male respondents in South Africa. For men, receiving news from social media is significantly and negatively related to vaccine uptake, but not for women.

For health policy in South Africa, our results highlight the need for targeted interventions to address vaccine hesitancy and to improve uptake. This includes considering the links between social media and government trust with vaccine hesitancy and uptake in formulating policy. Policies might consider, for example, leveraging social media to address misinformation with accurate and easily understandable vaccine information.

Using social norms communications spotlighting the fairly high historical vaccination rates among South Africans, could help to renormalize the practice of universal early childhood vaccination and reduce hesitancy. Additionally, enhancing the perceived trustworthiness of institutions could significantly benefit vaccination uptake, especially for vaccines that are newly developed. Promoting transparency and providing clear, accessible vaccine information from healthcare institutions may improve trust and encourage more individuals to get vaccinated.

Cross-sectional survey studies have limitations: it is not possible to tease out causal associations from this type of data, meaning that all relationships identified are correlational only. Further, the online sample means that lower-income, less educated, and non-urban respondents are not well represented in our dataset. Nonetheless, our results offer a starting point for discussions about improving vaccine uptake in South Africa.

CRediT authorship contribution statement

Nicky Nicholls: Writing – original draft, Project administration, Methodology, Funding acquisition, Conceptualization. **Michelle Pleace:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Eleni Yitbarek:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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