Study Report

COVID-19 vaccine hesitancy: vaccination intentions and attitudes of community health volunteers in Kenya

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List of Abbreviations

CHVs- Community Health Volunteers

COVID-19- Coronavirus disease 2019

PHEIC- A public health emergency of international concern

SARS-CoV-2- Severe acute respiratory syndrome

WHO- The World Health Organization

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Executive summary

Background: Community health volunteers in Kenya link the formal healthcare system to urban and rural communities and advocate and deliver healthcare interventions to community members. Therefore, understanding their views towards COVID-19 vaccination is critical to the successful rollout of mass vaccination in the country.

Objectives: The study aimed to determine vaccination intention and attitudes of community health volunteers and their potential effects on the national COVID-19 vaccine rollout in Kenya**.**

Methods: The cross-sectional study involved community health volunteers in four counties: Mombasa, Nairobi, Kajiado, and Trans-Nzoia, representing two urban and two rural counties, respectively.

Results: COVID-19 vaccination intention among community health volunteers was 81% (95% CI: 0.76-0.85). On individual binary logistic regression level, Contextual influence; Trust in vaccine manufacturers (adjOR=2.25, 95% CI: 1.52- 2.98; $p < 0.001$), Individual and group influences; Trust in MoH (adjOR=2.12, 95% CI: 1.30-2.94; $p < 0.001$), and belief in COVID-19 vaccine safety (adjOR=3.20, 95% CI: 2.49-3.91; $p < 0.001$), and Vaccine safety and issues; management of risks by government (adjOR=2.46, 95% CI: 1.84-3.08; $p < 0.001$), Trust in health systems (adjOR=1.85, 95% CI: 1.06-2.65; $p < 0.001$); Vaccine concerns (adjOR=0.81, 95% CI: 0.58-1.03; $p < 0.001$); and overall safety of COVID-19 vaccine (adjOR=0.79, 95% CI: 0.52-1.06; $p < 0.001$) were significantly associated with vaccination intention.

Conclusion: Vaccine hesitancy among community health volunteers in Kenya is 19% (95% CI: 0.15-0.24) and is likely to impact vaccine rollout and future COVID-19 vaccination campaigns negatively. The determinants of hesitancy arise from contextual, individual/group and vaccine/vaccination specific concerns and vary from county to county.

Keywords: *COVID-19, Contextual Influences, Individual & Group Influences, Kenya, Vaccine Attitudes, Vaccine Hesitancy, Vaccination Intention, Vaccine Safety*

1. Introduction

Coronavirus disease 2019 (COVID-19) caused by the novel coronavirus severe acute respiratory syndrome (SARS-CoV-2) was first detected on 17 November, 2019, in Wuhan City, Hubei Province, China, and rapidly spread across the globe. On 30 January, 2020, the World Health Organization (WHO) declared the novel coronavirus outbreak a public health emergency of international concern (PHEIC), WHO's highest level of alarm. COVID-19 has resulted in numerous deaths worldwide, and one of the strategies to control the pandemic is mass vaccination.

Although vaccine development and trials are still ongoing, at least eight vaccines have been rolled out in different countries including Pfizer-BioNTech with 95% efficacy (Polack *et al.*, 2020); Moderna with 94.5% efficacy (Mahase, 2020); AstraZeneca with 70.4% efficacy (Voysey *et al.*, 2021); Sputnik V with 91.6% efficacy (Jones & Roy, 2021; Logunov *et al.*, 2021); Novavax with 86% efficacy against the UK variant and 60% against the South African variant (Mahase, 2021); Sinopharm with 72.5% efficacy (Dyer, 2021); Janssen with 66.3% efficacy (Oliver *et al.*, 2021); and Covaxin with 81% efficacy (Bharat, 2021). The efficacy of Sinovac (unpublished results) was also reported as 50.7% in Brazil (Palacios *et al.*, 2020), and Chile 79.4% (Dyer, 2021).

The several technologies used in the development of the SARS-CoV-2 vaccines include viral vector vaccines (Johnson & Johnson (Janssen COVID-19), AstraZeneca (Oxford), and Sputnik V (Gamaleya); protein-based vaccines (Novavax); mRNA vaccines (Pfizer-BioNTech and Moderna); and inactivated virus vaccines (Sinopharm, CoronaVac (Sinovac)) and Covaxin (Bharat Biotech).

The WHO Strategic Advisory Group of Experts on Immunisation (SAGE) working group defines vaccine hesitancy as the delay in acceptance or refusal of vaccines despite the availability of vaccine services (MacDonald, 2015). Based on systematic literature reviews and interviews with immunisation managers, attitudes as determinants of vaccine hesitancy were grouped into contextual influences, individual and group influences, and vaccine or vaccination specific issues. Contextual influences address issues arising from historical, socio-cultural, environmental, health system and institutional, economic and political factors. Individual and group influences address

personal perceptions of the vaccine or influences of the social and peer environment. Vaccine safety directly addresses issues related to specific vaccines or the vaccination process. Addressing the scope of COVID-19 vaccine hesitancy is an initial step for building trust in COVID-19 vaccination efforts (Sallam, 2021). This study addressed vaccine hesitancy based on the three levels of behavioural attitudes and vaccine intention as the potential determinants of vaccine hesitancy on the uptake of the COVID-19 vaccine by Community Health Volunteers in Kenya.

Community health workers are community members with some basic training to promote health or carry out some healthcare services but are not healthcare professionals (Nkonki, Cliff, & Sanders, 2011). They also go by the names community health workers, lay health workers, village health workers, community health aides, community health promoters, volunteer health workers, community health distributors, community health surveyors, community health assistants, village health helpers, and health advisors. However, some community health workers are trained nurse aides, medical assistants, physician assistants, paramedic workers in emergency and fire services, and others who are auxillaries, mid-level workers, and self-defined health professionals or health paraprofessionals (Lehmann & Sanders, 2007). Table *1* show the literature summary based on the continent.

Table 1: Literature Review summary

Study	**Continent**	**Country**	**Predictor (s) of vaccination Intention**	**Predictor(s) of vaccine hesitancy**
Khubchandani *et al.* (2021)	North America	USA		Sex, education, employment, income, having children at home, political affiliation, perceived COVID-19 threat
Palm, Bolsen, and Kingsland (2021)	North America	USA		Negative information on reluctance to get COVID-19 vaccination; negative information on COVID-19 vaccines; information on political influences on COVID-19 vaccines

Fridman, Gershon, and Gneezy (2021)	North America		Political affiliation	
Bogart *et al.* (2021)	North America	USA		Mistrust beliefs about the government withholding COVID-19 information; Lack of honesty
Dzieciolowska *et al.* (2021)	North America	Canada	Gender; Age; Occupational exposure	
Oliveira *et al.* (2021)	South America	Brazil		Females, older adults, evangelicals, and lack of COVID-19 symptoms
Bivar, de Aguiar, Santos, and Cardoso (2021)	South America	Brazil		Scepticism about the genuine interest of the industry and politicians; Lack of trust in research; Inaccurate COVID-19 information on social media
Campo-Arias and Pedrozo-Pupo (2021)	South America	Colombia	Vaccine distrust related to non-health science carriers; Rural residents; Low-income; Low perceived stress; Health literacy	
Alvarado-Socarras *et al.* (2021)	South America	Colombia	Vaccine efficacy	
Argote *et al.* (2021)	South America	Argentina, Brazil, Chile, Colombia, Mexico and Peru		Side effects: Vaccines being developed too fast; Government mistrust; Vaccine effectiveness
Wang *et al.* (2020)	Asia	China		Suspicion of the efficacy of COVID-19 vaccines; Vaccine effectiveness and safety; the beliefs that

				the vaccine are unnecessary; lack of time to take vaccines
Dror *et al.* (2020)	Middle East	Israel	Self-perception of high risk for severe COVID-19 infection; Gender	Vaccine hesitancy associated with not caring for COVID-19 positive patients;
Kwok *et al.* (2021)	Asia	Hong Kong	Age; more confidence; less complacency; more collective responsibility.	Vaccine effectiveness; side effects; the effective duration of the vaccine.
Qattan *et al.* (2021)	Middle East	Saudi Arabia	Gender; perceived high risk of COVID-19 infection; perception of mandatory vaccine to all	
Sallam *et al.* (2021)	Middle East	Saudi Arabia, Jordan, Kuwait		COVID-19 misinformation; conspiracy beliefs; the reliance on social media on COVID-19 vaccine information; gender; education levels
Qunaibi, Helmy, Basheti, and Sultan (2021)	Middle East			Vaccine safety; distrust in healthcare policies; vaccine expedited production; published studies increases
Ali and Hossain (2021)	Asia	Bangladesh		Gender; age; unemployment; income; tobacco users
Edwards, Biddle, Gray, and Sollis (2021)	Australia	Australia	Religiosity; populist views; gender; age; income	
Dodd *et al.* (2021)	Australia	Australia		Inadequate health literacy; lower education level

Rhodes, Hoq, Measey, and Danchin (2021)	Australia	Australia	Vaccine efficacy; vaccine safety; belief that the vaccine was unnecessary	
Di Gennaro *et al.* (2021)	Europe	Italy		Facebook as the primary source of COVID-19 information; being a non-physician; vaccine safety; receiving little/conflicting information about COVID-19 vaccines
Razai, Osama, McKechnie, and Majeed (2021)	Europe	UK		Ethnicity; Education level
Robertson *et al.* (2021)	Europe	UK		Ethnicity; Education level; vaccine side effects; unknown future vaccine effects; lack of trust in the vaccine
Paul, Steptoe, and Fancourt (2021)	Europe	UK		Mistrust of vaccine benefits; concerns about future unforeseen side effects
Murphy *et al.* (2021)	Europe	Ireland, UK		Gender, age; income level
Freeman *et al.* (2020)	Europe	UK		Age; gender; income level; ethnicity; lower adherence to social distancing guidelines; vaccine efficacy; side effects; speed of development
Gagneux-Brunon *et al.*, (2021	Europe	France		Nurses and assistant nurses more hesitant than physicians
Grech, Gauci, and Agius (2020)	Europe	Maltase		Insufficient knowledge about the unknown long term

				side effects of the novel vaccine
Nzaji *et al.* (2020)	Africa	Democratic Republic of Congo	Positive attitude	
Fares, Elmnyer, Mohamed, Elsayed, and (2021)	Africa	Egypt		Absence of enough clinical trial; fear of side effects; vaccine safety; healthcare cadres

2. Materials and methods

A cross-sectional study design was employed to determine the contextual, individual and group influences, and vaccine-specific issues on vaccine acceptance. The study was conducted in four counties in Kenya: Nairobi and Mombasa representing urban communities; Kajiado comprising a mainly nomadic population; and Trans Nzoia, a mainly agrarian population. Registered CHVs from the four selected counties were selected from lists of CHVs within the health departments of each county. CHVs were included if they were attached to a community unit and a link health facility and had practised for at least one year. Other cadres of community health workers were excluded from this study. The data was collected from the 22–27 March 2021. A total sample size of 408 CHVs was determined based on the Krejcie & Morgan, 1970, formula. R script programming was then used to randomly choose the CHVs proportionately to the population size of each county.

A vector of indices having an 80% random sample was created using R script where the dataset was split into a train (n=330) and a test (n=83) dataset based on a ratio of 80:20, respectively. The hierarchical binary logistic model was conducted using vaccine intention as the dependent variable and contextual influences, individual and group influences, and vaccine safety as the independent variables. The final model adequacy was estimated by generating linktest hat (the predicted value) and hatsq (the predicted value squared) to determine if the model was properly specified. The hat (p=0.036) and hatsq (p=0.405) values suggested model adequacy. The non-significant Hosmer and Lemeshow goodness of fit test χ^2 (7) = 0.107, p = 1, was evidence of overall goodness of fit. The average marginal effects of the independent variables were contextual

influences (0.081; CI:95%, -0.038-0.199); individual and group influences (0.088; CI:95%, -0.011-0.187); and vaccine safety (0.151; CI:95%,0.065-0.238). This indicate that for a 1-unit increase in contextual influences, individual and group influences, and vaccine safety, the probability of CHV's vaccine intention will increase by 8.1%, 8.8% and 15.1%, respectively.

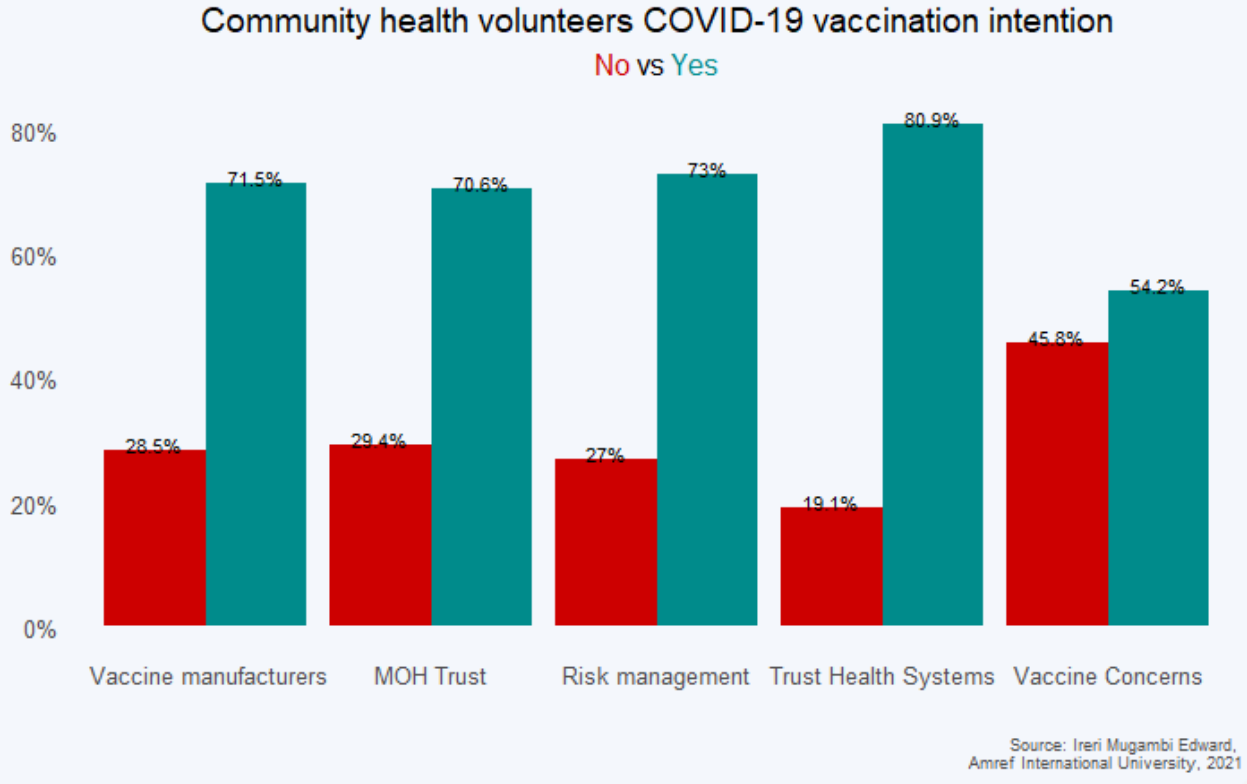
After fitting the hierarchical binary logistic regression, the test data were reviewed to check how well the fitted model performed on the unseen 20% data. A Binary classification with a cut-off value of 0.5 was set. Any value below 0.5 on vaccine intention was considered negative (0), while above that was considered positive (1). A confusion matrix between the actual (neg:0, pos:1) and the predicted (neg:0, pos:1) values were created, and a classification accuracy determined. The confusion matrix showed that the test dataset had 15 sample cases of negative (0) and 68 cases of positive (1). The trained model classified two negatives and 67 positives class accurately. The accuracy of 0.831 shows that the classifier was about 83.1% accurate in classifying the unseen 20% test data. The preliminary analysis focused on the Chi-square statistics while hierarchical binary logistic regression was conducted, and the crude odds and adjusted odds ratio interpreted. The tables were plotted using the Stargazer package in R (Hlavac, 2018), the statistical analyses were performed using (R Core Team, 2020) and the graphs were plotted using the ggplot2 package (Wickham, 2011).

3. Results

3.1 Sociodemographic

The total number of CHV's interviewed was 413, representing Nairobi 209 (50.6%), Mombasa 84 (20.3%); Kajiado 54 (13.1%); and Trans Nzoia 66 (16%). See Table 2 for segregated demographics and Figure 1 on significant independent variables.

Figure 1: The frequencies of significant independent variables (attitude) and COVID-19 vaccination intention.



3.2 Inferential statistics

There was a wide variation in COVID-19 vaccination intention among the counties. The distribution on those who intended to get vaccinated was: Nairobi 184 (44.6%), Mombasa 49 (11.9%), Kajiado 42 (10.2%) and Trans Nzoia 60 (14.5%). The distribution of those who did not intend to get vaccinated was Nairobi 25 (6.1%), Mombasa 35 (8.5%), Kajiado 12 (2.9%) and Trans Nzoia 6 (1.5%); χ^2 (3) = 39.52, $p < 0.001$. Overall, 267 CVH's intended to get the COVID-19 vaccine once made available in the country, while 63 were hesitant. Thus, the prevalence of COVID-19 vaccine intention among CHV's was 81% (95% CI: 0.76-0.85), while 19% (95% CI: 0.15-0.24) represented the hesitant group. The vaccination intention of the COVID-19 vaccine had significant differences based on the level of education and county. Nairobi County had a significant association between level of education and region; χ^2 (2) = 6.70, p = 0.035, with the acceptors tending to be among the educated. The association with Kajiado County was not

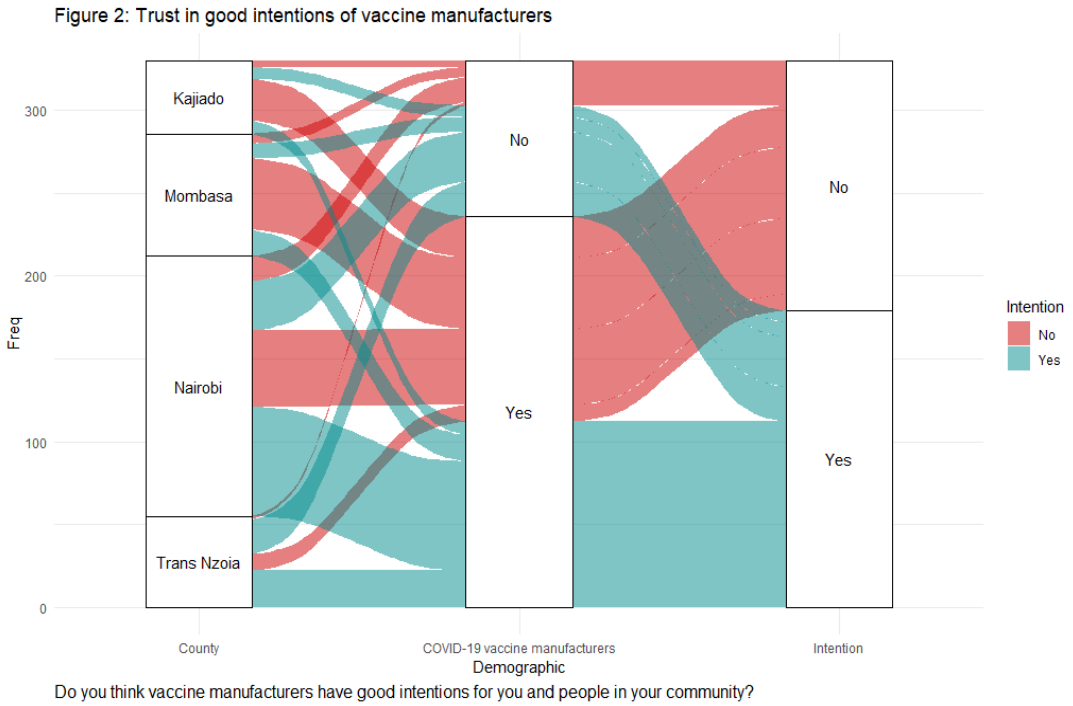
conclusive due to the violation of interpreting the Chi statistics results. There were no significant associations reported in Mombasa and Trans Nzoia Counties.

There was significantly higher vaccination intention among CHV's exposed to MoH approved training on COVID-19 (62.5%) even if not trained on vaccination (18.6%); χ^2 (1) = 5.56, p = 0.018. Thus, the factors that were significantly associated with vaccination intention among the CHV's were based on county of origin (region), level of education, previous exposure to MoH approved training on COVID-19.

3.3 Attitude: Contextual Influences

There was significant association on intention to accept the vaccine and cultural opposition to COVID-19 vaccine; χ^2 (1) = 4.68, p = 0.030, Trust in MoH decisions on COVID-19 vaccination; χ^2 (1) = 13.36, p < 0.001; and Trust in good intentions of vaccine manufactures; χ^2 (1) = 9.82, p = 0.002. Based on regions, Nairobi stood out significantly different from other counties on Trust in good intentions of vaccine manufacturers; χ^2 (1) = 8.47, p = 0.004, and Trust in MoH decisions on COVID-19 vaccination; χ^2 (1) = 7.01, p = 0.008. Kajiado county had significant results on Trust in MoH decisions on COVID-19 vaccination; χ^2 (1) = 4.19, p = 0.041. Binary logistic regression on contextual influences indicated; Trust in good intentions of vaccine manufactures was the only independent variable that had a significant effect in vaccination intention (adjOR=2.25, 95% CI: 1.52- 2.98; p < 0.001). See Table 3 & Table 4 & Alluvial Figure 2.

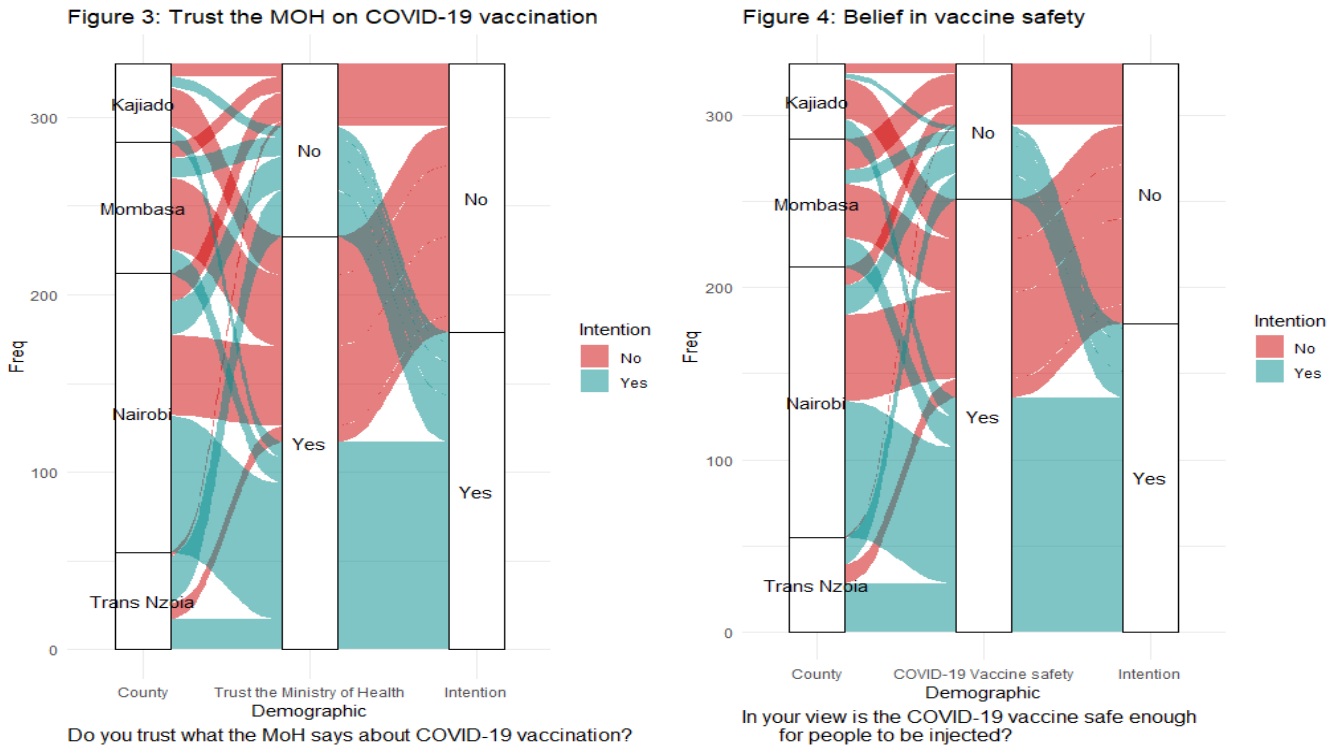
Figure 2: Trust in good intentions of COVID-19 vaccine manufacturers



3.4 Attitude: Individual and Group Influences

There was significant association on intention to accept the vaccine and the feeling that information on COVID-19 vaccines is being openly shared; χ^2 (1) = 5.13, p = 0.023, Trust in what the MoH says about COVID-19 vaccination; χ^2 (1) = 18.96, p < 0.001; belief in COVID-19 vaccine safety; χ^2 (1) = 20.51, p < 0.001, and support for mass COVID-19 vaccination; χ^2 (1) = 16.20, p < 0.001. Mombasa county was significantly different on trusting what the MOH says about COVID-19 vaccination; χ^2 (1) = 4.70, p = 0.030. Binary logistic regression indicated only two independent variables had positive significant effects on vaccine intention: Trust in what the MoH says about COVID-19 vaccination on vaccine intention (adjOR=2.12, 95% CI: 1.30-2.94; p < 0.001), and belief in COVID-19 vaccine safety (adjOR=3.20, 95% CI: 2.49-3.91; p < 0.001). See Table 3 & Table 4, & Alluvial Figures 3 & 4.

Figure 3: Trust the MOH on the vaccination process and belief in COVID-19 vaccine safety

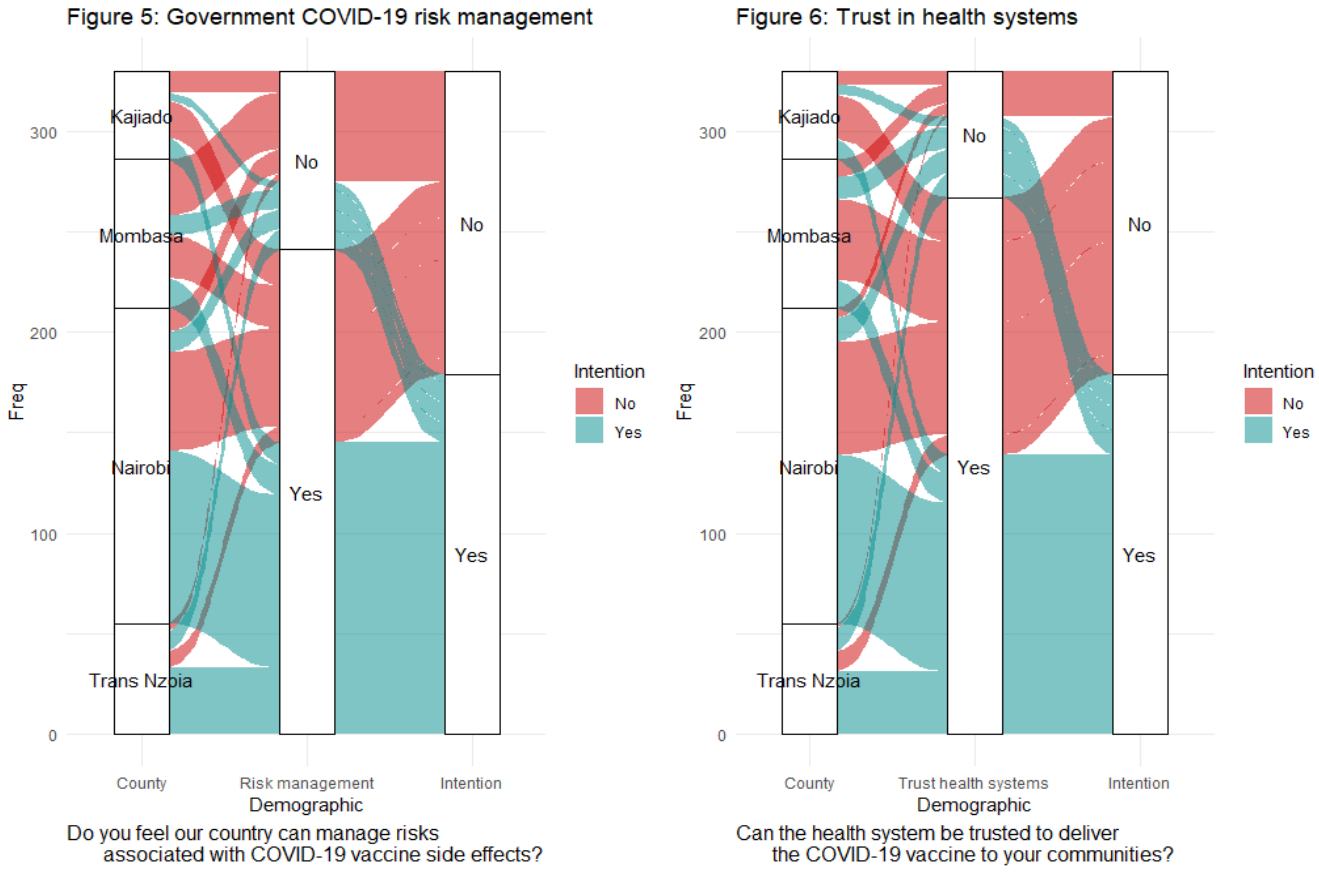


3.5 Attitude: Vaccine safety and vaccination specific issues

There was significant association on intention to accept the vaccine and the ability of the government to manage risks associated with COVID-19 vaccine side effects being openly shared; χ^2 (1) = 24.60, $p < 0.001$, Trust in the health system to deliver COVID-19 vaccine to communities; χ^2 (1) = 20.06, $p < 0.001$; confidence in the safety of COVID-19 vaccine; χ^2 (1) = 23.43, $p < 0.001$, concerns that the COVID-19 vaccine might not be safe for the public; χ^2 (1) = 19.55, $p = 0.001$, and the overall feeling about the safety of COVID-19 vaccine for the general population; χ^2 (1) = 13.76, $p = 0.008$. Nairobi stood out significantly different from other counties on the belief that the government can manage risks associated with the vaccine; χ^2 (1) = 9.54, $p = 0.002$. A significant majority in Nairobi had trust that the health system can deliver the vaccine to the community; χ^2 (1) = 10.68, $p = 0.001$. However, the significance level was not reliable due to the violation of Chi statistics interpretation measures. The finding only tells us that trust in the health system is stronger in Nairobi than in other counties. Binary logistic regression that had significant positive effects on vaccine intention: the ability of the government to manage risks associated

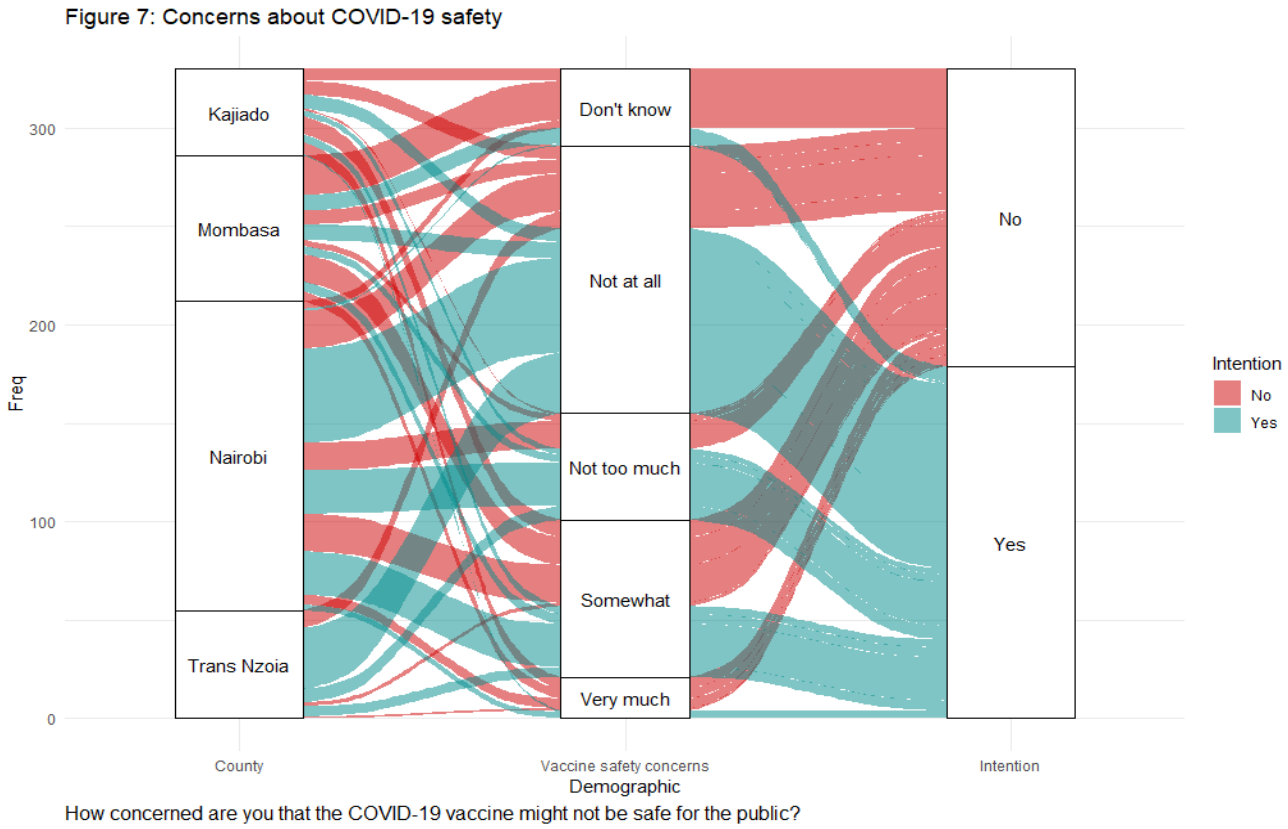
with COVID-19 vaccine side effects being openly shared (adjOR=2.46, 95% CI: 1.84-3.08; $p < 0.001$), and trust in the health system to deliver COVID-19 vaccine to communities (adjOR=1.85, 95% CI: 1.06-2.65; $p < 0.001$). See Table 3 & Table 4 & Alluvial Figure 5 & 6.

Figure 4: Trust in the government COVID-19 risk management and health systems



Nevertheless, negative significant effects were recorded on: concerns that the COVID-19 vaccine might not be safe for the public (adjOR=0.81, 95% CI: 0.58-1.03; $p < 0.001$), and the overall feeling about the safety of COVID-19 vaccine for the general population (adjOR=0.79, 95% CI: 0.52-1.06; $p < 0.001$). See Table 3 & Table 4 & Alluvial Figure 7.

Figure 5: Concerns about the safety of COVID-19 vaccine



The Hierarchical binary logistics regression (model4) showed that contextual influences and Individual & group Influences had no significant effect on vaccine intention at the multivariate level. Nevertheless, COVID-19 risk management and vaccine safety significantly affected vaccination intention at the multivariate level: 'Do you feel our country can manage risks associated with COVID-19 vaccine side effects?' (adjOR=1.86, 95% CI: 1.19-2.54; $p < 0.001$); 'In your view is the COVID-19 vaccine safe enough for people to be injected?' (adjOR=2.04, 95% CI: 1.26-2.83; $p < 0.001$).

4. Discussion

Most published studies on the prevalence of COVID-19 hesitancy have focused on healthcare workers with formal employment or the general population. This study is the first to focus on COVID-19 vaccine hesitancy among community health volunteers in the African context.

Community health volunteers link the formal healthcare system to communities in many low and middle-income countries (LMICs), including in Africa.

The insignificant socio-demographic factors in vaccination intention were gender (contrary to (Khubchandani *et al.*, 2021) study in the USA; (Dzieciolowska *et al.*, 2021) study in Canada; (Qattan *et al.*, 2021) study in Saudi Arabia; (Sallam *et al.*, 2021) study in Saudi Arabia; (Edwards *et al.*, 2021) study in Australia; (Murphy *et al.*, 2021) study in the UK), age (contrary to (Ali & Hossain, 2021) in Bangladesh; (Edwards *et al.*, 2021) study in Australia; (Murphy *et al.*, 2021) study in the UK), religion (contrary to (Edwards *et al.*, 2021) study in Australia), years of service as a CHV, the number of households each CHV was attached to, and source of income (contrary to (Khubchandani *et al.*, 2021) study in the USA; (Campo-Arias & Pedrozo-Pupo, 2021) study in Colombia; (Ali & Hossain, 2021) study in Bangladesh; (Edwards *et al.*, 2021) study in Australia; (Murphy *et al.*, 2021) study in the UK).

Overall COVID-19 vaccination intention among CHVs in the four counties studied in Kenya was 81%. Thus, the government ability to manage risks, trust in the health system, concerns for vaccine safety, and being well informed on the vaccine would explain 81% of the variance in COVID-19 vaccination intention. This figure was not far from the 18% reported in the UK (Robertson *et al.*, 2021), 22% in the USA (Khubchandani *et al.*, 2021), and 17.5% in Brazil (Oliveira *et al.*, 2021). This low hesitancy in Kenya is attributed to the increased level of education, such that the vaccine acceptors tended to be among educated members of the communities, especially in Nairobi. This finding is in line with (Khubchandani *et al.*, 2021) in the USA; (Sallam *et al.*, 2021) study in Jordan, Kuwait and Saudi Arabia; (Dodd *et al.*, 2021) study in Australia; (Robertson *et al.*, 2021) in the UK, all of which had associated education as a significant predictor of vaccine acceptance. However, there was wide variation in vaccination intention among the study counties based on level of education. Education had a statistically significant effect on CHV who intend to get vaccinated in Nairobi χ^2 (2) = 6.7, p = 0.035 (n=209; 88%). Although the effect was not significant in Mombasa (58%), Kajiado (78%) and Trans Nzoia (91%) Counties, there were huge variations in terms of those who intend to get the COVID-19 vaccine. Equally, vaccination intention was higher among CHVs exposed to ministry of health training on COVID-19 (n=258;

62.5%) even if not specifically trained on vaccination (*n*=77;18.6%). Studies by (Palm *et al.*, 2021) in the USA; (Bogart *et al.*, 2021) in the USA; (Di Gennaro *et al.*, 2021) in Italy; (Sallam *et al.*, 2021) in Jordan, Kuwait and Saudi Arabia; (Dodd *et al.*, 2021) in Australia, reported that COVID-19 information delivered via social media (Bivar *et al.*, 2021) in Brazil; (Islam, Laato, Talukder, & Sutinen, 2020) study Bangladesh, and (Di Gennaro *et al.*, 2021) use of Facebook in Italy as predictors of vaccine hesitancy. Overall, in our study, television and radio remained the most important sources of information among the CHVs; those not intending to get vaccinated were significantly (p = 0.002) associated with obtaining information from social media and community meetings such as chief barazas which presents the best way of communicating vaccine safety in the community.

In comparison, those intending to get vaccinated had a higher tendency of getting information from radio and TV. No significant differences were reported between counties. The level of education, exposure to MoH approved training, and being well-informed on COVID-19 information, increases vaccination intention among CHV's. Health workers have a huge role to play in ensuring that the uptake of COVID-19 is high in Africa. Community health volunteers are the gatekeepers to society. Their hesitancy to any vaccination program is likely to impact the roll-out of the vaccine program negatively. Frontline workers are the major conduit of correct health information (Dzinamarira, Nachipo, Phiri, & Musuka, 2021) and so are the community health volunteers and thus any misinformation among them would result in COVID-19 vaccine hesitancy in their communities.

4.1 Attitude (Contextual Influence)

The perception of CHV's on manufacturers of COVID-19 vaccines having good intentions to its users' was reported to increase vaccine intention and lower down hesitancy significantly. Any form of mistrust of the manufacturers of the COVID-19 vaccine will lead to hesitancy. Several studies support this fact. For example, (Bivar *et al.*, 2021) study on COVID-19 vaccine hesitancy in Brazil reported scepticism about the true interest of the industry; (Argote *et al.*, 2021) sample from Argentina, Brazil, Chile, Colombia, Mexico and Chile expressed their concerns about the vaccines being developed too fast; (Qunaibi *et al.*, 2021) study on Arabs reported vaccine

hesitancy as a result of its expedited production; (Freeman *et al.*, 2020) study in the UK reported concerns on the speed of development of the vaccine, and (Fares *et al.*, 2021) study in Egypt mentions the absence of enough clinical trial. The study in Kenya showed that if the CHV's believe that the manufacturers have good intentions for their community members, then vaccine intention would increase by 71% (adjOR=2.46).

4.2 Attitude (Individual & Group Influences)

The study report that trust in what the MoH says about COVID-19 vaccination would increase vaccine intention by 70% (adjOR=2.28) among the CHV's in Kenya. A study by (Argote *et al.*, 2021) in Latin America reported government mistrust as a determinant of COVID-19 vaccine hesitancy, while (Qunaibi *et al.*, 2021) reported distrust in healthcare policies among Arabs as a determinant of vaccine hesitancy. Equally, (Bogart *et al.*, 2021) study among black American reported mistrust beliefs about the government withholding COVID-19 information as a promotor of vaccine hesitancy. Belief in COVID-19 vaccine safety would increase vaccine intention by 71% (adjOR=2.48) among the CHV's. This finding support (Di Gennaro *et al.*, 2021) study in Italy; (Wang *et al.*, 2020) study in China; (Kwok *et al.*, 2021) study in Hong Kong; (Qunaibi *et al.*, 2021) study among Arabs; (Rhodes *et al.*, 2021) study in Australia; (Robertson *et al.*, 2021) study in the UK; (Paul *et al.*, 2021) study in the UK; (Freeman *et al.*, 2020) study in the UK; (Grech *et al.*, 2020) study in Maltase; (Fares *et al.*, 2021) study in Egypt all which reported issues with vaccine safety and sides would lead to COVID-19 vaccine hesitancy.

4.3 Attitude: Vaccine safety and vaccine-specific issues

The current study has shown that if CHV's feels that the government can manage risks associated with COVID-19 vaccine side effects, then the probability of vaccine intention will increase by 70% (adjOR=2.31). Studies such as (Argote *et al.*, 2021) in Latin America; (Kwok *et al.*, 2021) study in Hong Kong; (Robertson *et al.*, 2021) study in the UK; (Paul *et al.*, 2021) study in the UK; (Freeman *et al.*, 2020) study in the UK; (Grech *et al.*, 2020) study in Maltase; and (Fares *et al.*, 2021) study in Egypt, all reported COVID-19 vaccine side-effects as the predictor of vaccine hesitancy. Therefore, both the government and the vaccine manufacturers should come out clean and place all the required information about the vaccine in the public domain.

The health system plays a crucial role in delivering routine vaccines and will also play a massive role in delivering the COVID-19 vaccine. Trust in the health system will increase the probability of vaccine intention by 75% (adjOR=3.00). The trust in the health system will include trust in healthcare workers and the resources available to run health facilities. The current study shows (*n*=311;75.3%) CHV's had a significantly stronger trust to deliver COVID-19 vaccine in their communities, which was in contrast to a few (n=24;5.8%) who did not trust the health system in their county but still intend to get vaccinated. In Kenya, Nurses are the primary providers of health services in most rural health facilities and some health facilities in urban settings. Thus, trust in nurses as part of the health system can be a good predictor of vaccine intention among the CHV's. Studies that were done by (Gagneux-Brunon *et al.*, 2021) in France; (Dzieciolowska *et al.*, 2021) study in Canada; (Wang *et al.*, 2020) study in China; (Dror *et al.*, 2020) study in Israel have shown nurses were more COVID-19 vaccine-hesitant among other healthcare cadres. In Africa, in the Democratic Republic of Congo, studies by (Nzaji *et al.*, 2020) excluding doctors, the other healthcare workers were hesitant to COVID-19 vaccine, while (Ditekemena *et al.*, 2021) study reported being a healthcare worker was associated with a decreased willingness to get vaccinated against COVID-19. Thus, to lower down further the vaccine hesitancy in Kenya below 19%, targeted COVID-19 information should be directed towards all healthcare workers. Future, studies should also focus on COVID-19 vaccine hesitancy among the healthcare workers in Kenya.

Concerns have emerged regarding the safety of COVID-19 among the public. The finding from this Kenya sample has shown that concerns on COVID-19 vaccine would decrease the probability of vaccination intention among the CHV's by 43% (adjOR=0.763). It was worth noting that (*n*=91:22%) of CHV's who were not concerned about the COVID-19 vaccine being safe to the public, intended to get vaccinated. This figure was second (*n*= 114;27.6%) to the CHV's that were somewhat fifty-fifty concerned that the COVID-19 vaccine might not be safe for the public. Overall, (*n*=78;18.9%) were significantly not concerned and did not intend to get vaccinated against (*n*=335;81.1%) who intended to get vaccinated. Thus, the proportion of those not intending to take the vaccine was found to rise with the increase in the level of concern significantly; χ^2 (4) = 19.55, p = 0.001.

5. Recommendations

This study recommends training CHV's on COVID-19 and its vaccines to reduce hesitancy, and funds for training must accompany the vaccines. CHWs being gatekeepers to health, the study recommends supporting CHV work on COVID to enhance vaccine roll-out and future COVID-19 vaccine campaign through training, equipping them, deployment and monitoring of their performance. There should be an enhanced provision of information and engagement with CHV's to increase trust in the Ministry of Health messaging around the vaccine. The health system response should be strengthened in counties outside Nairobi to earn the trust of CHV's that the system is capable of handling COVID-19 vaccination.

6. Conclusions

A strong association exists between the CHV's vaccination intention and their readiness to engage with communities. The vaccination intention evidence was most substantial in Nairobi, making it different from other counties. Therefore, it is expected that in counties with high hesitancy among the CHV's, it will be more difficult to mobilise communities for COVID-19 vaccination.

7. Declaration of conflict of interest

The authors declare no conflict of interest.

8. Acknowledgement

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Appendixes

Table 2: Demographic characteristics

County	Sex	Age (years)	Religion	Education
Nairobi	Male; 43 (20.6%)	18-24; 15 (7.2%)	Catholic; 65 (31.1%)	Primary; 58 (27.8%)
	Female; 164 (78.5%)	25-35; 56 (26.8%)	Protestant; 103 (49.3%)	Secondary; 108 (51.7%)
	Other; 2 (1%)	Above 35; 138 (66%)	Islam; 7 (3.3%)	Others; 43 (20.6%)
			Others; 34 (16.3%)	
Mombasa	Male; 20 (23.8%)	18-24; 8 (9.5%)	Catholic; 18 (21.4%)	None; 2 (2.4%)
	Female; 63 (75%)	25-35; 28 (33.3%)	Protestant; 28 (33.3%)	Primary; 25 (29.8%)
	Other; 1 (1.2%)	Above 35; 48 (57.1%)	Islam; 28 (33.3%)	Secondary; 29 (34.5%)
			Others; 10 (11.9%)	Others; 28 (33.3%)
Kajiado	Male; 20 (37%)	18-24; 5 (9.3%)	Catholic; 7 (13%)	None; 1 (1.9%)
	Female; 33(61.1%)	25-35; 26 (48.1%)	Protestant; 45 (83.3%)	Primary; 20 (37%)
	Other; 1 (1.9%)	Above 35; 23 (42.6%)	Islam; 2 (3.7%)	Secondary; 21 (38.9%)
				Others; 12 (22.2%)
Trans Nzoia	Male; 25 (37.9%)	18-24; 3 (4.5%)	Catholic; 8 (12.1%)	Primary; 13 (19.7%)
	Female; 41 (62.1%)	25-35; 6 (9.1%)	Protestant; 57 (86.4%)	Secondary; 47 (71.2%)
		Above 35; 57 (86.4%)	Islam; 1 (1.5%)	Others; 6 (9.1%)

Notes: Q1. What is your sex? Q2. What is your age? Q3. What is your religion? Q4. What is your highest education level completed?

Demographics Continued on Table 2

County	CHV Years	Households	MOH Training	Educating	Income
NBI	less than 3; 29 (13.9%)	less than 20; 2 (1%)	No; 20 (9.6%)	No; 9 (4.3%)	CHV; 79 (37.8%)
	3-5; 49 (23.4%)	21-50; 14 (6.7%)	Yes; 186 (89%)	Yes; 200 (95.7%)	OFE; 9 (4.3%)
	Above 5; 131 (62.7%)	Above 50; 193 (92.3%)	Not sure; 3 (1.4%)		ONFE; 121 (57.9%)
MSA	less than 3; 22 (26.2%)	less than 20; 12 (14.3%)	No; 32 (38.1%)	No; 19 (22.6%)	CHV; 51 (60.7%)
	3-5; 16 (19%)	21-50; 25 (29.8%)	Yes; 47 (56%)	Yes; 65 (77.4%)	OFE; 10 (11.9%)
	Above 5; 46 (54.8%)	Above 50; 47 (56%)	Not sure; 5 (6%)		ONFE; 23 (27.4%)
KAJ	less than 3; 15 (27.8%)	less than 20; 14 (25.9%)	No; 13 (24.1%)	No; 4 (7.4%)	CHV; 15 (27.8%)
	3-5; 16 (29.6%)	21-50; 22 (40.7%)	Yes; 41 (75.9%)	Yes; 50 (92.6%)	OFE; 5 (9.3%)
	Above 5; 23 (42.6%)	Above 50; 18 (33.3%)			ONFE; 34 (63%)
TN	less than 3; 5 (7.6%)	less than 20; 3 (4.5%)	No; 16 (24.2%)	No; 25 (37.9%)	CHV; 33 (50%)
	3-5; 4 (6.1%)	21-50; 12 (18.2%)	Yes; 34 (51.5%)	Yes; 41 (62.1%)	ONFE; 33 (50%)
	Above 5; 57 (86.4%)	Above 50; 51 (77.3%)	Not sure; 16 (24.2%)		

Notes: NBI= Nairobi County, MSA= Mombasa County, KAJ= Kajiado County, TN= Trans Nzoia, OFE= Other Formal Employment, ONFE= Other Non-Formal Employment, CHV Years= Years of Service as a Community Health Volunteer, Income= Your main source of Income, Educating= Have you been involved in educating the community on COVID-19?, Training= Have you had MoH approved training on COVID-19?, Households= Number of households you are responsible for

Table 3: Beta coefficients & confidence intervals

Table 3: Hierarchical Binary Logistic Regression-Beta Coefficients & Confidence Intervals

	Dependent variable:			
	Intention			
	(1)	(2)	(3)	(4)
Vaccine_manufacturers	0.809** (0.080, 1.538)			0.376 (-0.460, 1.212)
MOH_Trust		0.752* (-0.068, 1.572)		0.384 (-0.537, 1.304)
Vaccine_safety		1.163*** (0.454, 1.872)		0.714* (-0.073, 1.500)
Risk_management			0.899*** (0.283, 1.516)	0.623* (-0.054, 1.300)
Trust_health_systems			0.618 (-0.181, 1.416)	0.147 (-0.771, 1.065)
Vaccine_concerns			-0.215* (-0.442, 0.012)	-0.170 (-0.403, 0.062)
Constant	0.693** (0.027, 1.359)	-0.124 (-0.791, 0.543)	0.937* (-0.142, 2.017)	0.190 (-1.068, 1.447)
Observations	330	330	330	330
Log Likelihood	-162.935	-152.749	-152.457	-149.067
Akaike Inf. Crit.	329.870	311.498	312.914	312.134
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 4: Odds ratios & confidence intervals

Table 4: Hierarchical Binary Logistic Regression-Odds Ratios & Confidence Intervals

	Dependent variable:			
	Intention			
	(1)	(2)	(3)	(4)
Vaccine_manufacturers	2.245*** (1.516, 2.975)			1.457*** (0.621, 2.292)
MOH_Trust		2.121*** (1.301, 2.941)		1.467*** (0.547, 2.388)
Vaccine_safety		3.201*** (2.492, 3.910)		2.041*** (1.255, 2.828)
Risk_management			2.458*** (1.842, 3.075)	1.864*** (1.188, 2.541)
Trust_health_systems			1.854*** (1.056, 2.653)	1.159** (0.241, 2.077)
Vaccine_concerns			0.807*** (0.580, 1.034)	0.843*** (0.610, 1.076)
Constant	2.000*** (1.334, 2.666)	0.884*** (0.217, 1.550)	2.553*** (1.473, 3.632)	1.209* (-0.048, 2.466)
Observations	330	330	330	330
Log Likelihood	-162.935	-152.749	-152.457	-149.067
Akaike Inf. Crit.	329.870	311.498	312.914	312.134

Note: *p<0.1; **p<0.05; ***p<0.01

OR = 1 No change; OR > 1 Increase; OR < 1 Decrease