

## Article

# Analysis of Perception, Reasons, and Motivations for COVID-19 Vaccination in People with Diabetes across Sub-Saharan Africa: a Mixed-Method Approach

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**Abstract:** Diabetes mellitus (DM) is associated with severe COVID-19 infection and complications. This study assessed COVID-19 vaccine acceptance and hesitancy in diabetes and explored reasons for nonvaccinating. This was a web-based cross-sectional survey using a mixed-method approach conducted between March-May 2021 corresponding to most SSA countries' early vaccine rollout period. Participants were those aged  $\geq 18$  years with self-reported DM in 11 Sub-Saharan African (SSA) countries. Responses to comments on reasons for vaccine hesitancy and facilitators for vaccine uptake were analyzed. Of the 73 participants with DM, 65.8% were males older than 35 years (86.3%), had post-secondary education (90%), and a significant proportion was from South Africa (39.7%), Nigeria (28.8%) and Ghana (13.7%). 64.4% had COVID-19 symptoms, 46.6% were tested for COVID-19, of which 19.2% tested positive. Few participants (6.8%) had taken the COVID-19 vaccination, 65.8% were willing to take the vaccine, while 26.0% either refused or hesitated to take the vaccine. The main reasons identified for not taking the vaccine were: advice from religious leaders, concerns about the vaccine safety, its effects, and efficacy, mistrust of the pharmaceutical companies, the conspiracy theories around the vaccines, the process of production, and the personal belief of the participants. However, participants stated they would take the vaccine if given more education about it, receive positive feedback from those vaccinated, are rewarded for taking the vaccine or if

vaccination becomes a condition for travel and employment. The findings of this study showed that uptake of the COVID-19 vaccine was very low in this high-risk group. It is imperative that efforts to increase the uptake of vaccines, such as the provision of education and relevant information, are made.

**Keywords:** diabetes; survey; sub-Saharan Africa; coronavirus; vaccine; hesitancy; refusal; qualitative; lockdown

## 1. Introduction

Diabetes mellitus (DM) has reached epidemic proportions, affecting approximately 463 million people worldwide[1]. It is a leading cause of avoidable hospitalizations, amputations, cardiovascular events, renal failure, fetal malformations and blindness[2]. Three-quarters of those with DM live in low- to middle-income countries (LMIC), and this is projected to increase[3], mostly due to increasing urbanization, demographic, and nutritional changes in the region[4-6]. Studies have found that sub-Saharan Africa (SSA) is particularly affected by obesity and diabetes[7]. This risk represents a substantial challenge for the overburdened healthcare systems in the region faced by COVID-19 challenges[8]. Understanding the challenges of this high-risk group is crucial to COVID-19 recovery and lessons learnt in informing preparation for future pandemics.

Prior to the development and rollout of COVID-19 vaccines, stringent lockdowns and other public health safety measures were the predominant methods used to curb the spread of the SARS-CoV-2 virus [9]. Some of these measures, such as stay at home policies and mandatory quarantine, promote a sedentary lifestyle, leading to an increase in obesity. This predisposes individuals to a greater risk of poor glycemic control due to physical inactivity. Following the development and rollout of COVID-19 vaccines worldwide, most governments - especially in the developed countries - rapidly vaccinated their populations as a public health preventative measure to contain the spread of the virus [10]. However, access and distribution of COVID-19 vaccines remain an issue in most developing countries, particularly in the low-income African countries[10], despite recent global efforts to make the vaccines affordable and available to these countries.

The development of the COVID-19 vaccines may have come as a welcome relief for people living with DM in terms of the opportunity to resume outdoor exercises and activities and their higher risk of infection and severe complications from being infected with the virus [11,12]. People with DM have poorer health outcomes, such as higher hospitalisation and mortality rates from COVID-19 infection compared with their counterparts without the disease [11,12]. As a result, most governments shifted their focus from previously prioritizing health care workers to receive the vaccine to including those with chronic illnesses, including DM[13]. In some SSA countries like Cameroon, priority for vaccination was given to people with Type 1 and Type 2 DM who were on two or more medications[14].

The breakthrough in COVID-19 vaccine discovery, manufacture and availability was accompanied by issues of myths and misinformation, followed by resistance and hesitancy[15]. There is a paucity of information on COVID-19 vaccine hesitancy among people with DM in SSA countries. Higher prevalence of vaccine hesitancy in Italy (14.2%)[16] and Saudi (29.0%) [17] were reported for individuals with DM. In SSA, people with DM are not left out of these controversies, with reports of mistrust for pharmaceutical companies and concerns about the safety of the COVID-19 vaccines featuring prominently in previous studies conducted elsewhere[16,17]. However, similar concerns with vaccine safety and side effects, lack of trust in pharmaceutical industries and vaccination trials, and misinformation or conflicting information from the media have been expressed among the general population in SSA countries[18,19].

Considering that almost every person needs to receive the COVID-19 vaccine to achieve herd immunity[20], and individuals with DM are more severely affected by COVID-19 disease [21,22], this survey was conducted to assess COVID-19 vaccine acceptance and hesitancy/unwillingness among people with DM in SSA. It also assessed the barriers and beliefs that affect their willingness to receive the COVID-19 vaccine. The findings will help narrow the current knowledge gap and improve health outcomes for people living with DM in SSA countries.

## 2. Materials and Methods

### *Study design*

This study used a web-based embedded cross-sectional survey using a mixed-method approach to evaluate the study objectives and responses. The self-administered questionnaire was validated previously [23] and was adapted with minor modifications to suit this study's objective. The questionnaire was pre-tested with 10 participants who were not included in the final study and were not part of the research group. The pilot study was to ensure clarity and understanding as well as to determine the duration for completing the questionnaire prior to dissemination. The survey tool was tested for the internal validity of the items, and Cronbach's alpha coefficient scores ranged from 0.70 and 0.74, indicating satisfactory consistency[23]. The final survey in English was translated to a French version to allow for wider participation from SSA countries. Researchers from the Department of Linguistics at the University of Bamenda, Cameroon, translated the survey tool. There was also a backward translation from French to English to ensure that the meaning of the items was retained.

### *Ethical approval*

Ethical approval for this study was obtained from the Humanities and Social Sciences Research Ethics Committee of the University of KwaZulu-Natal, Durban, South Africa (HSSREC 00002504/2021). The study adhered to the principles of the 1967 Helsinki Declaration (as modified in Fortaleza, 2013) for research involving human subjects. Participation in this survey was voluntary, and informed consent was sought prior to the survey. Confidentiality of the participants was maintained, and all the data were kept anonymous. As part of the preamble, participants were instructed not to take part in the survey more than once, and the IP address of the participants also restricted analysis of the data to prevent multiple and repeat participation in the survey.

### *Participants*

Consenting English and French-speaking participants aged 18 years and above who were born in any of the 26 SSA countries and self-reported DM at the time of this survey were eligible to participate in this study. In contrast, data for participants with no record of age, or those younger than 18 years, who did not state their DM status or had no DM, were excluded.

### *Data collection*

The survey was distributed online across the forty-six SSA countries between March and May 2021. A convenient sampling technique was used to include all the participants in the survey, and those who self-reported DM during the study were extracted. An invitation link to the survey created in Survey Monkey was disseminated in English and French languages (which are spoken languages in 21 of 26 SSA countries[24]) using social media platforms (Facebook and WhatsApp) and by email through the authors' networks.

The survey items included: eleven sociodemographic variables, items on smoking status; past vaccinations for other conditions [hepatitis, influenza, chickenpox, whooping cough, tuberculosis, yellow fever, measles/mumps/rubella (MMR), diphtheria, pertussis, and tetanus (DPT), the presence of pre-existing condition including heart disease, kidney disease, hypertension, diabetes, obesity, asthma, and sickle cell anaemia; knowledge of

COVID-19 vaccination; COVID-19 test and result; if they have received any COVID-19 vaccination and for those who were not vaccinated at the time, a follow-up question was asked to gauge their willingness to get COVID-19 vaccine when it becomes available in their country. This allowed participants to provide comments on their opinions. There were also questions to understand the participants' sources of information on COVID-19 and their perception of risk for COVID-19 (four items: three utilizing a Likert scale and the other a 'yes/no/not sure' response).

#### *Qualitative responses*

Two questions were asked to the participants who were hesitant/refused to get the COVID-19 vaccines and their responses analyzed qualitatively. Both questions required the participants to select from ten options with an additional section for added comments, if they choose to. For the first question, 'which of the following factors contribute to your decision to not accept a COVID-19 vaccine?', the options were: advice from religious leaders, advice from politicians, mistrust for the pharmaceutical company, mistrust of the health system in my country, mistrust in the medical process for developing the vaccine, mistrust for the country where the vaccine was produced, personal beliefs/past historical experiences with vaccines, concerned about safety of the COVID-19 vaccine, not enough information from healthcare providers, and Information from the media.

For the second question, 'what can be done to encourage you to get the vaccine?', the options included: I am more likely to accept the COVID-19 vaccine, If financial incentives are giving to everybody, If Monetary rewards are given to health care providers involved in the vaccination, If it is given for free, If there is adequate information regarding the specific vaccine, If I can get more education on the vaccine, their side effects and how effective they are, If it is a travel condition, If it is an employment condition, If many people start receiving the vaccine and If I get positive feedback from those who have been vaccinated.

#### *Statistical analysis*

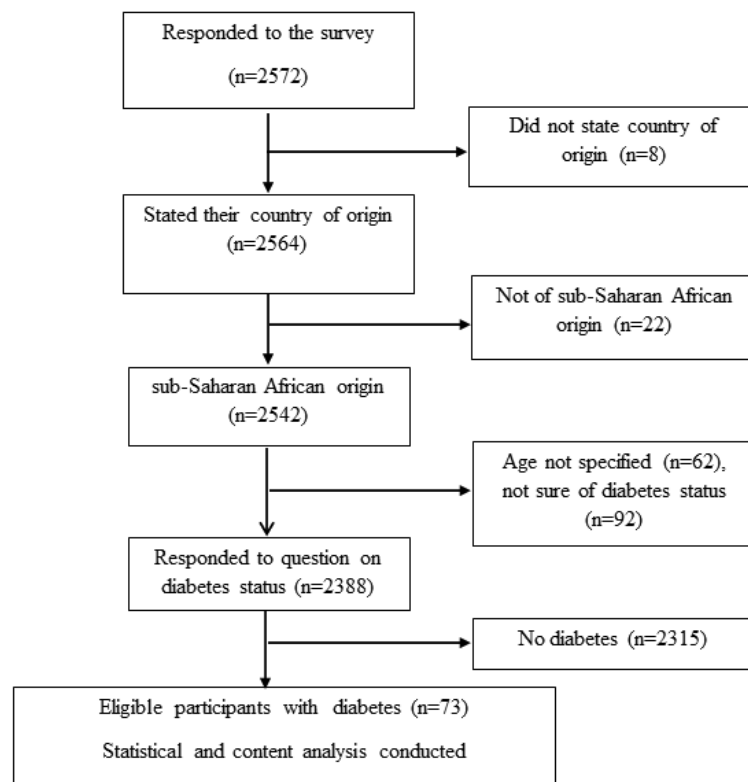
All statistical analysis was conducted using IBM SPSS Statistics for Windows, version 27 (IBM Corp., Armonk, N.Y., USA). The frequency and percentage of categorical variables were reported. Estimation of the proportion of participants with DM who were vaccinated against COVID-19 and those who expressed uncertainty towards being vaccinated were determined. The vaccinated group were those who responded in affirmation (Yes) to the question 'have you been vaccinated against COVID-19?' Similar to a previous study [25], those who responded 'not sure' or 'no' regarding being vaccinated against the COVID-19 vaccine were asked if they were willing to be vaccinated when the vaccine becomes available in their home countries. The responses of 'not sure' or 'no' to the follow-up question were used to derive the 'hesitant/refused to accept COVID-19 vaccine' estimation and the association with demographic variables were determined by Fisher's exact test due to the small number of persons in the cells.

The selected options and the open-ended comments obtained from the qualitative section of the questionnaire on their reasons for not receiving the vaccination and what would encourage them to get vaccinated were grouped into major topics and analyzed qualitatively. The significant recurrent and silent points were also reported using quotations and their frequencies were reported descriptively.

### **3. Results**

#### *Characteristics of the study population.*

Of the total 2572 participants in the general survey, only the responses from 73 (2.94%) participants with self-reported DM (of any type) were used in this study. Figure 1 shows the flowchart of the participant selection from the larger study population.



**Figure 1:** Flowchart of study participants

The characteristics of the study sample presented in Table 1 show that the majority (65.8%) were males, more than two-thirds were aged 35 years and older, and most had at least a tertiary education (90% had either a diploma, university, or higher education), the majority were married (72.6%) and employed (79.5%), and few were working in a healthcare sector (31.5%) (Table 1).

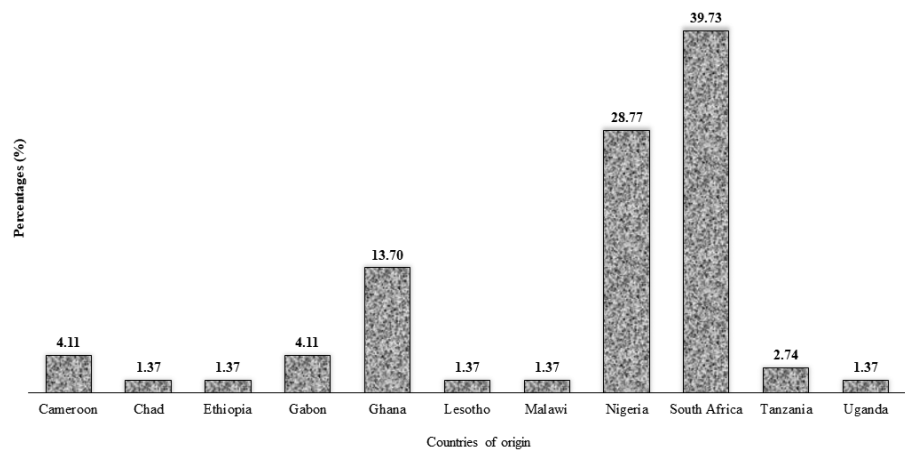
**Table 1:** Sociodemographic characteristics of study participants (n=73).

Variables	Frequency n (%)
<b>Demography</b>	
<b>Age category in years</b>	
<35	10 (13.7)
≥35	63 (86.3)
<b>Sex</b>	
Males	48 (65.8)
Females	25 (34.2)
<b>Place of residence<sup>†</sup></b>	
Local	62 (84.9)
Diaspora	9 (12.3)
<b>SSA region of origin</b>	
Central Africa	7 (9.6)
East Africa	5 (6.8)
Southern Africa	30 (41.1)
West Africa	31 (42.5)
<b>Marital status</b>	
Not married	20 (27.4)

Married/de-facto	53 (72.6)
<b>Highest level of education</b>	
Secondary or less	6 (8.2)
University/diploma	35 (48.0)
Postgraduate (Masters/PhD)	32 (43.8)
<b>Employment status<sup>†</sup></b>	
Unemployed	14 (19.2)
Employed	58 (79.5)
<b>Religion</b>	
Non-Christians	16 (21.9)
Christians	57 (78.1)
<b>Occupation<sup>†</sup></b>	
Non-healthcare sector	48 (65.8)
Healthcare sector	23 (31.5)
<b>Smoking status</b>	
Current smoker	9 (12.3)
Ex-smoker	11 (15.1)
Non-smoker	53 (72.6)
<b>Previous vaccination</b>	
Yes	64 (87.7)
No/not sure	9 (12.3)

<sup>†</sup> frequencies do not add up to 100% due to some missing responses.

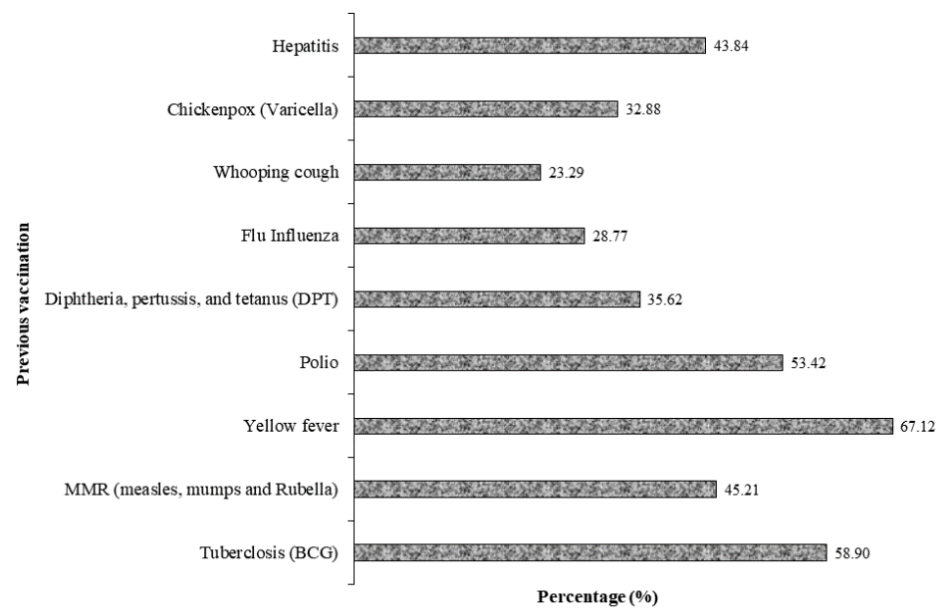
Figure 2 presents the participants' countries of origin, indicating that the participants were mostly from South Africa (39.7%), Nigeria (28.8%) and Ghana (13.7%) while other SSA countries had minimal participation.



**Figure 2:** Distribution of study participants (n=73) by country of origin.

There were few smokers (12.3%), and nearly all the participants reported they had been previously vaccinated for other conditions, mostly yellow fever, tuberculosis, polio, and hepatitis which are shown in Figure 3.





**Figure 3:** Percentage of previous vaccinations for other conditions among the study participants.

Table 2 presents the self-reported health conditions of the participants. More than half (63.0%) had other chronic diseases, mostly hypertension (46.6%), and obesity (20.5%), as well as other related cardiovascular diseases coexisting with diabetes.

**Table 2:** Other self-reported health conditions of study participants (n=73).

Variables	Frequency n(%)
Any chronic disease!	
Yes	46 (63.0)
No	27 (37.0)
Asthma <sup>†</sup>	
Yes	6 (8.2)
No	59 (80.8)
Hypertension <sup>†</sup>	
Yes	34 (46.6)
No	36 (49.3)
Sickle cell anaemia <sup>†</sup>	
Yes	1 (1.4)
No	67 (91.7)
Obesity <sup>†</sup>	
Yes	15 (20.5)
No	55 (75.3)
Any heart condition <sup>†</sup>	
Yes	8 (11.0)
No	62 (85.0)
Kidney disease <sup>†</sup>	
Yes	2 (2.7)
No	66 (91.8)

!=asthma, hypertension, obesity, kidney disease, sickle cell anemia, any heart condition. †=few missing responses.

Approximately two-thirds (64.4%) of the participants have had a symptom of COVID-19 during the pandemic, about half had been tested for COVID-19 at least once (46.6%), and 41.2% (n=34) tested positive for COVID-19. Nearly every one of the participants was aware that COVID-19 vaccines had been developed. However, only five of the 73 people with DM (6.8%) had already received a COVID-19 vaccine (34.7%), while the rest were either hesitant to vaccinate (65.8%) or refused to get vaccinated (26.0%). Most participants (93%) believed that COVID-19 was real, and more than half either agreed or strongly agreed that the vaccine could protect or prevent them from contracting COVID-19 infection. Regarding their perception of risk, about two-thirds (64.3%) felt they were at risk of contracting the virus, and a slightly lower proportion thought they could die from the infection if they contract the virus (Table 3)

**Table 3:** Awareness and risk perception of COVID-19 vaccine among study participants.

Variables	Frequency (%)
<b>Awareness of COVID-19 vaccination</b>	
Symptom of COVID-19	
Yes	47 (64.4)
No/not sure	26 (35.6)
Tested for COVID-19	
Yes	34 (46.6)
No	38 (52.1)
Tested positive for COVID-19†	
Yes	14 (41.2)
No	20 (58.8)
Aware that COVID-19 vaccines have been developed	
Yes	71 (97.3)
No	1 (1.4)
<b>Have you been vaccinated against COVID-19</b>	
Yes	5 (6.8)
No	67 (91.8)
<b>Will you be willing to take COVID-19 vaccine when it becomes available in your country?</b>	
Yes (willing)	48 (65.8)
No/not sure (refusal/hesitancy)	19 (26.0)
<b>Risk perception of COVID-19 vaccination</b>	
Do you think COVID-19 virus is real	
Yes	68 (93.2)
No/not sure	5 (6.8)
COVID-19 vaccine can prevent COVID-19 infection and its complications	
Strongly agree	17 (23.3)
Agree	25 (34.2)
Don't know	15 (20.5)
Disagree	8 (11.0)
Strongly disagree	1 (1.4)
Perception of risk of dying from COVID-19 infection	
Very High	13 (17.8)
High	25 (34.2)
Unlikely	7 (9.6)
Low	18 (24.7)
Very Low	8 (11.0)



Perception of risk of becoming infected	
Very High	12 (16.4)
High	35 (47.9)
Unlikely	8 (11.0)
Low	16 (21.9)
Very Low	2 (2.7)

≠denominator are those that were tested for COVID-19

The sources through which the participants obtained information related to COVID-19 are presented in Figure 4. The figure shows that about 88% of the participants obtained information from internet sources during the pandemic including, via personal search on google, scientific journals, health websites (WHO, CDC, the ministry of health websites. A breakdown of the various internet sources listed by the respondents have been presented as a supplementary figure. Social media was the second highest source of information used by the participants during the pandemic, followed by the TV while the least source of information was newspapers, which was used by slightly more than half of the participants (52.1%) for COVID-19 related information, during the pandemic

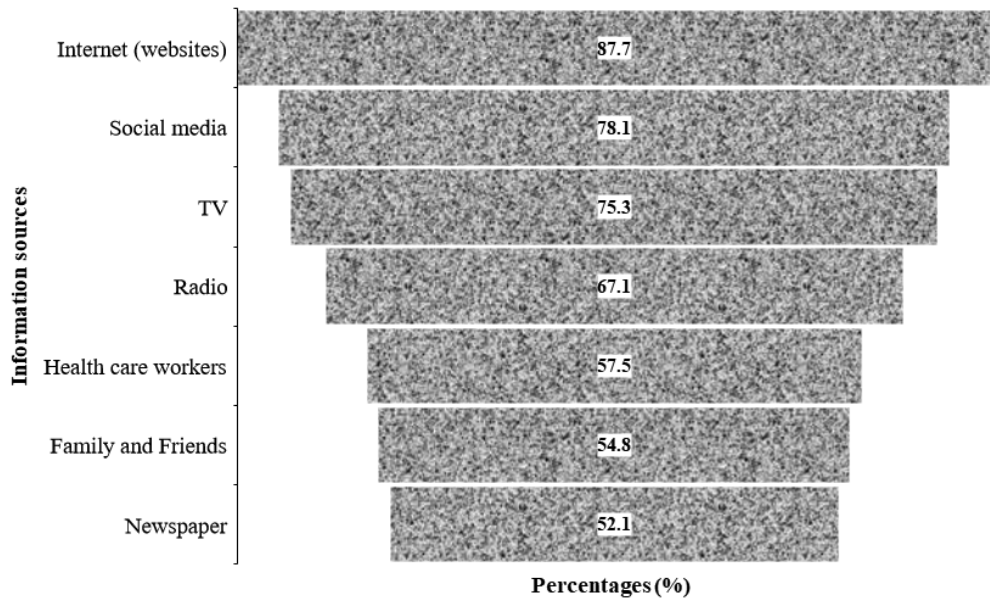


Figure 4: Main sources of COVID-19 related information used by the participants.

Association between hesitancy/refusal towards COVID-19 vaccine and the study variables

Results of Fisher’s exact test revealed significant associations between hesitancy/refusal of vaccine and sex, region of origin and place of residence (local and diaspora, see Table 4). In addition, a significant proportion of those who expressed concern about the safety of the vaccine were less likely to receive the COVID-19 vaccine when it becomes available in their country ( $p<0.0001$ ) compared with those who had no such concern. Compared with participants who had not been tested for COVID-19 at the time of this study, there were significantly more people who had done a COVID-19 test were willing to accept the vaccine. Other variables, not shown in Table 4 including previous vaccination history and the presence of other health conditions like hypertension, did not show significant association with COVID-19 vaccine hesitancy/refusal.

Table 4: Association between COVID-19 vaccine hesitancy/refusal and the demographic variables of the participant. Only significant variables have been shown.

Variables	No/not sure	Yes	P-value
Gender			
Male	7 (14.6)	36 (75.0)	0.008
Female	12 (48.0)	12 (48.0)	
SSA region of origin			
Central Africa	2 (28.6)	5 (71.4)	0.045
East Africa	2 (40.0)	3 (60.0)	
Southern Africa	5 (16.7)	25 (83.3)	
West Africa	10 (32.3)	15 (48.4)	
Place of residence			
Diaspora	3 (33.3)	3 (33.3)	0.009
Local	15 (24.2)	44 (71.0)	
Have you been tested for COVID-19?	7 (20.6)	26 (76.5)	0.006
Are you concerned about the vaccine safety?	11 (64.7)	5 (29.4)	<0.001

Responses of those who answered 'No or not sure' corresponding to 'hesitancy and refusal' to the question, 'will you be willing to receive COVID-19 vaccine when it becomes available in your country?' were merged. P-value are results of chi-square analysis.

#### *Reasons for COVID-19 vaccine hesitancy/refusal among participants*

The responses of nineteen participants who said they were either not sure or unwilling to receive the COVID-19 vaccine when it becomes available in their respective countries were categorized into seven major headings. These are represented in Figure 5, and the participant's statements have been presented in supplementary Table 1. From the figure, two in five people who were unwilling to take the vaccine cited advice from their religious leaders as their main reason, followed by 22% of participants including three pregnant, and one with a compromised immune system, who cited concern about the safety of the vaccines as the main reason for not taking the vaccines (Supplementary Table 1). A participant from an Eastern African country said, '*vaccines have been used against black people for far too long - Kenya infertility, Tuskegee, etc.*' while another participant from West Africa said, '*this vaccine is as questionable and its benefits for politicians far outweigh its care to manage this self-limiting bug*'. Few participants did not trust the pharmaceutical manufacturing companies, the countries where the vaccines were produced or the manufacturing process of the vaccine, which was reflected in the following participant statements: '*the vaccines have been developed so quickly*'; '*I don't trust the research done about it*'; '*there is not enough scientific data on clinical trials for the vaccines*' and '*I rather prefer self-protection for prevention purposes than trust the vaccine*'. Few others refused the vaccine due to personal beliefs or past historical events, including one person who stated, '*I have not seen a need for it*'. For other participants, different conspiracy theories circulating regarding the COVID-19 vaccine discouraged them from taking the vaccine, with statements such as '*the vaccine is meant to reduce world population, especially Africans*', '*It could be a birth control procedure to reduce world population*' (see supplementary Table 1). The lack of trust in their country's health system was reported by a few participants as the main reason for not accepting the vaccine '*my country is making money with COVID-19, and there is no trace of the disease here*, and someone mentioned that refusal to take the vaccine was because of the advice received from some politicians.

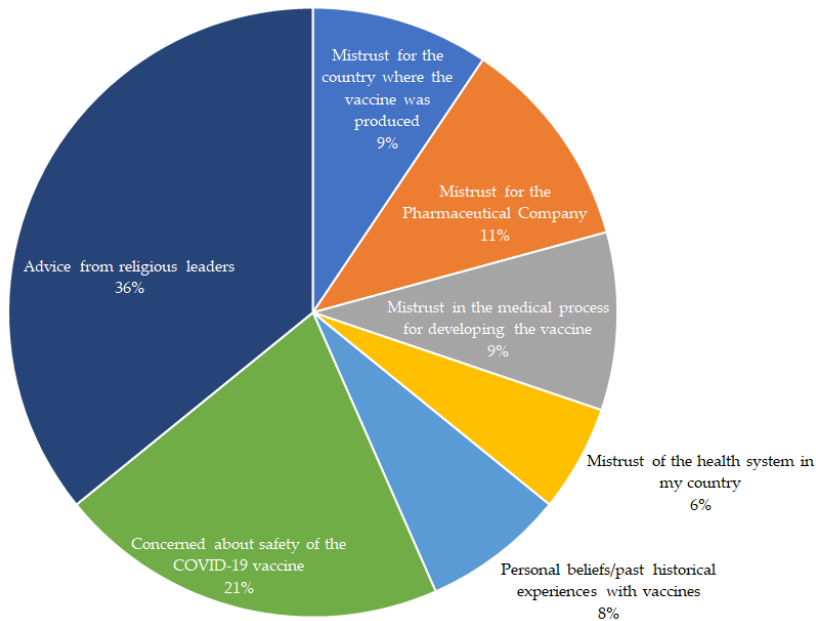


Figure 5: Main reasons for vaccine hesitancy/refusal among people with diabetes (n=19).

Factors that would encourage uptake of vaccination in people with DM

Figure 6 is a pyramid of the factors reported to influence the participants’ decision towards receiving COVID-19 vaccination when it becomes available in their countries. Education about the vaccines, was top in the list of factors that would encourage uptake of COVID-19 vaccines, and this was reflected by this statement: ‘If I can get more education on the vaccine, their side effects and how effective they are, I will take it. More than half of the participants said they would consider receiving the vaccine if they get positive feedback from those who already got it ‘I will decide after I hear positive feedback from those who have been vaccinated’. For some participants, high uptake in the population (i.e., after many people had already gotten theirs) would encourage them to receive the vaccine ‘I will accept the vaccination only after many people start receiving the vaccine’ or if the vaccination was free ‘I will accept the vaccination if I don’t have to pay or bribe someone to get vaccinated’. For others, they were more likely to accept the COVID-19 vaccine if there was a monetary reward for getting the vaccine, ‘I will accept the vaccine if monetary rewards are given to health care providers involved in the vaccination’.

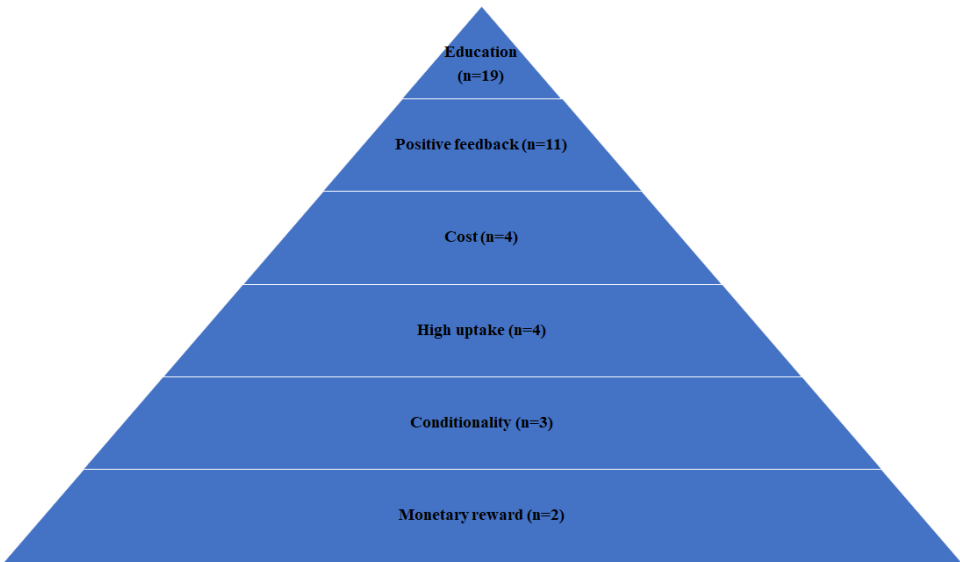


Figure 6: Factors that would encourage uptake of the vaccine among people with DM.

#### 4. Discussion

The COVID-19 pandemic caused massive disruption worldwide in diagnosing and treating chronic illnesses such as DM, leading to an increased risk of morbidity and mortality[26]. This can partially be explained by the increased tendency to manifest a cytokine storm characterized by severe COVID-19 due to disruptions in the cytokine/chemokine pathway[27]. This cross-sectional survey assessed the vaccine hesitancy among adults with DM in SSA. We found that vaccination was very low in the region even though most of them had previous vaccinations for other conditions and were at greater risk due to other comorbidities mostly hypertension. Male participants, those from Central and Southern African countries, people who lived locally and those that had been tested for COVID-19 were significantly more willing to get vaccinated when it became available in their country compared with their counterparts in this study. While advice from religious leaders, concern about the safety of the vaccine and mistrust of the pharmaceutical companies were the main reasons behind vaccine hesitancy, participants reported that education about the vaccine, its side effects, efficacy and getting positive feedback from those vaccinated would encourage them to get vaccinated. Participants reported that the Ministry of Health's website was their main source of information, followed by social media.

The World Health Organization and Centers for Disease Control and Prevention strongly advocate for individuals with DM to be vaccinated against SARS-CoV-2[28,29]. However, in this study, we found a very low uptake of COVID-19 vaccines among the participants, which may be attributed to the very slow rollout of the vaccines due to their unavailability in SSA at the time of this study [10]. It also reflected the overall low rate of COVID-19 vaccination (defined by total vaccine per 100 population) in SSA[30]. The rate of COVID-19 vaccination in the African continent rose by about 15% between January and February 2022, due to vaccination campaigns by SSA countries[31], but this remains considerably poor compared with resource-rich developed countries[10]. Several studies have shown that people with DM have increased vulnerability to severe COVID-19 illness [32,33] and are three times more likely to be hospitalized compared with those without the disease [32,34]. The risk of severe infections could be further increased in our participants as most of them reported other comorbidities particularly hypertension which is shown to adversely affect the viral clearance thereby worsening the prognosis during a COVID-19 infection[35]. Ensuring that vaccination is promoted among this high-risk group because when admitted due to COVID-19, people with diabetes showed no improvement in outcomes despite having good glycemic control before hospitalization [36].

The present study found that more males than females were willing to take the COVID-19 vaccine. In a review study[37], the authors suggested that the relationship between sex and vaccine acceptance is ambiguous. For instance, whereas some studies reported more COVID-19 hesitant females than males [37-39], and vaccine hesitancy generally[40,41], others[17,18] showed that males were more hesitant than women regarding vaccine uptake[17]. Among people with diabetes in Saudi Arabia, a study found that female gender, longer duration of diabetes and no past influenza vaccination were significantly associated with COVID vaccine uptake after adjusting for confounders. The inconclusive findings suggest the need for further investigation and whether females may respond differently to the different health promotion approaches.

Past vaccination history has been linked with the willingness to get vaccinated[42,43]. In the UK, a study showed that individuals who had received previous flu vaccination showed increased willingness to be vaccinated against COVID-19 [42], and elsewhere, individuals who previously refused any vaccination were less likely to accept the COVID-19 vaccine[43]. Although the present study found that nearly all the participants had a

history of previous vaccination for other conditions, this had no significant effect on the participants' hesitancy or refusal to get the COVID-19 vaccine.

Various perceptions are widespread among people with DM, and this affects their health outcomes. This current survey focused on the COVID-19 vaccine hesitancy among individuals with DM in the SSA continents to better understand barriers and enablers to vaccine acceptance among a population with increased risk of mortality and morbidity. Our study found that whilst almost all the participants were aware of the COVID-19 vaccine, more than half believed that the COVID-19 vaccine could prevent COVID-19 infection and its complications, and nearly all the participants recognized that the disease was not a hoax. The participants reported a high-risk perception of contracting the infection, and about two-thirds felt they were at risk of severe infection with the COVID-19 virus, while some thought they could die from the infection if they contracted the virus. This finding agreed with a Dutch study among young adult students, which suggested that stronger perceptions of perceived severity of COVID-19 infection heighten the worries of being infected. This positively influences the individual's intention to vaccinate against the virus, leading to a higher likelihood of COVID-19 vaccine uptake and vice versa[44]. These perceptions can be traced back to the various sources of information during the early phase of vaccine rollout in SSA, which were mainly on the internet and especially through various social media platforms.

Being female and concerned about vaccine safety are key considerations for hesitancy toward COVID-19 vaccination. Facilitators of vaccination uptake include education[45-47], and this was reported by all participants to improve uptake of the COVID-19 vaccine. Participants reported the need for more education about the vaccine, its side effects and its effectiveness, a finding that can be attributed to the fact that the majority of participants in this study were educated and may tend to be more curious about the vaccine prior to uptake[48]. Similar finding was reported among healthcare workers with high vaccine uptake due to increased knowledge about the vaccine mechanism of action and sources [49]. This finding was in agreement with a landmark population survey of South Africans in June-July 2021 which reported that the independent predictors of COVID-19 vaccine hesitancy include concerns about side effects, distrust of government, belief in conspiracy theories, low or no income, and dependence on alternate decision marker[50]. Therefore, campaigns and sensitization programs geared toward increasing vaccination rates should consider these factors as very essential.

About two in five participants who were hesitant or refused to that the vaccine cited advice from their religious leaders as one of their main reasons for nonvaccinating. This finding is consistent with previous reports[51,52] which demonstrated the key role of religious leaders in the uptake of vaccination programs. The attitude of religious leaders towards vaccination vary from full acceptance to clear refusal and their views are reflected in those of their local congregation members[51]. For some religious leaders like the orthodox Protestants who object to vaccination, their beliefs are rooted in religious doctrine and through their authority, they decide how to interpret and apply this doctrine [51]. A study from Viskupič and Wiltse [52] found that when messages were endorsed by a religious leader, they had a positive and statistically significant effect on people's interest in getting vaccinated, whereas those that were endorsed by a political or medical leader had no significant effect. There needs to be dialogue with the religious leaders on how they can help in controlling epidemics by other means than vaccination [52]. While concern about the vaccine's safety and mistrust of the pharmaceutical companies were the other main reasons behind vaccine hesitancy/refusal, participants reported that education about the vaccine, its side effects, efficacy and getting positive feedback from those vaccinated would encourage them to get vaccinated. Participants reported that the ministry website was their main source of information, followed by social media.

*Limitations and Strengths*



The study has some limitations which should be considered when interpreting the results or comparing them with other studies. First, the small sample size limits the generalizability of findings beyond the study as the survey sample does not include all those with DM in the region and does not represent the opinion of the general SSA population. Second, the key indicators such as diabetes type, duration, and metabolic measures such as glycated hemoglobin A1c (HbA1c) were not asked because the study was not designed specifically for people with diabetes. Third, the self-reported DM, COVID-19 and other health conditions were not objectively verified. Fourth, the social desirability factor, where the opinion of the participants in surveys might not represent their true opinion on the questions asked. Fifth, the inequality in the vaccine supply across the different SSA regions and the unavailability of the vaccines in SSA at the time of this study may have overestimated the proportion of unvaccinated people. Sixth, this was a cross-sectional study, and we were unable to determine causation. Seventh, the use of social media platforms and emails for survey distribution limits the generalizability of the findings because opinions of some participants such as those without internet access, and people living in rural areas, where internet penetration remains relatively low [53] may not have been captured. Despite these limitations, this study provided the first evidence from SSA on reasons for non-vaccination among a high-risk group for COVID-19 adverse outcomes. It captured opinions from Francophone and Anglophone countries through the dissemination of the survey tool in both English and French languages. In addition, the analysis of the comments provided qualitative evidence which can be used to inform public health control measures for this and future pandemics.

## 5. Conclusions

The current study investigated COVID-19 vaccine acceptance by exploring many factors, including the effect of history of vaccination, pre-existing conditions, past diagnosis of COVID-19, as well as the reasons for vaccine hesitancy and facilitators to COVID-19 vaccine uptake. The findings revealed that uptake of the COVID-19 vaccine was very low in this high-risk group. It is imperative that efforts are made to increase uptake of the vaccine, and by providing education and information about the vaccine, as well as some financial incentives, uptake can be increased. This study will help formulate public policies, guidelines, and communication strategies that will enhance the public's confidence in the various COVID-19 vaccines and, therefore, lead to an overall increase in vaccine uptake. That many participants were unwilling to take the vaccine suggests that it is imperative that due efforts are made to increase vaccine acceptance, and the availability of precise information can go a long way toward the success of such efforts. Considering the increased supply of vaccines in the region and the availability of more evidence on the COVID-19 vaccine, similar studies exploring COVID-19 vaccine refusal/hesitancy and the reasons for non-vaccination are needed, particularly in this high-risk group to understand if the reasons have changed over time.

**Supplementary Materials:** The following supporting information can be downloaded at: [www.mdpi.com/xxx/s1](http://www.mdpi.com/xxx/s1), Table S1: Participants comments on reasons for their unwillingness to accept the COVID-19 vaccines (n=19).

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## Supplementary File

Supplementary Table 1: Participants comments on reasons for their unwillingness to accept the COVID-19 vaccines (n=19).

Reasons (Themes)	Statements
Mistrust for the country where the vaccine was produced	<p>why is the European countries that are the most affected refusing to take the vaccine, but are interested in making the vaccine and sending to Africa. Do you think we can trust them?</p> <p>Why is the Western country much interested in Africa meanwhile, we are less affected than the countries producing the vaccines. Europeans should take the vaccine first not forcing it on Africa</p>
Mistrust for the Pharmaceutical Company	<p>Manufacturing companies' refusal to take responsibility for any adverse effects arising from taking the vaccines</p> <p>The indemnity given to manufactures is curious and suspicious</p>
Mistrust in the medical process for developing the vaccine	<p>Not enough scientific research results</p> <p>The vaccines have been developed so quickly. I don't trust the research done about it.</p> <p>Not enough study on the long-term effect of the vaccines</p> <p>Not enough scientific data on clinical trials; Not sufficient time elapsed for observations of side-effects</p>
Mistrust of the health system in my country	<p>My country is making money with covid 19. No trace of it kind here</p>
Personal beliefs/past historical experiences with vaccines	<p>Vaccines have been used against black people for far too long - Kenya infertility, Tuskegee, etc. This vaccine is as questionable and its benefits for politicians far outweigh its care to manage this self-limiting bug.</p> <p>personal intuition, personal decision, personal choice, personal beliefs, personal conviction that the vaccine is not necessary in Africa especially for young people who are not at risk</p>
Concerned about safety of the COVID-19 vaccine	<p>Real benefits of the vaccines not spelt out. Vaccines shrouded with uncertainties; Side effects have a history of thrombosis</p> <p>Risk to my health as I have SLE with a severely compromised immune system; Pregnant; there have also been new developments about how those vaccinated have been re-infected with the virus.</p>
Advice from religious leaders	<p>Personal belief in my Lord Jesus Christ</p>
Conspiracy theories	<p>The conspiracy theories that are circulating regarding COVID-19 vaccine have discouraged me from taking the vaccine</p> <p>It could be a birth control procedure to reduce world population</p> <p>The vaccine is meant to reduce world population especially Africans</p> <p>I am protected from complications of the Covid virus</p> <p>If this vaccine is not curative and not preventive, what does it do?</p> <p>Other conspiracy theories</p>

Supplementary Figure: Percentage breakdown of internet sources used by the participants (n=64) to retrieve COVID-19 vaccine related information during the pandemic. Totals exceed 100% due to multiple responses.

