 doi:10.20944/preprints202205.0099.v1

Article

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

Uchechukwu Levi Osuagwu[1,4,*], Raymond Langsi[2], Godwin Ovenseri-Ogbomo[3], Khathutshelo Percy Mashige[4], Emmanuel Kwasi Abu [5], Esther Awazzi Envuladu[6], Piwuna Christopher Goson[7], Bernadine Nsa Ekpenyong[8], Richard Oloruntoba[9], Chundung Asabe Miner[6], Deborah Donald Charwe[10], Chikasirimobi Goodhope Timothy[11], Tanko Ishaya[12], Onyekachukwu Mary-Anne Amiebenomo[13], David Lim[1,14] and Kingsley E Agho (PhD)[1,4,14]

1 Translational Health Research Institute (THRI), School of Medicine, Western Sydney University, Campbelltown, NSW 2560, Australia; l.osuagwu@westernsydney.edu.au; David.Lim@westernsydney.edu.au; k.agho@westernsydney.edu.au
2 Health Division, University of Bamenda Bambili, Cameroon; raylangsi@yahoo.com
3 Department of Optometry, Centre for Health Sciences, University of the Highlands and Islands, Inverness, IV2 3JH, United Kingdom; godwin.ovenseri-ogbomo@uhi.ac.uk
4 African Vision Research Institute, Discipline of Optometry, University of KwaZulu-Natal, Westville Campus, Durban, 3629, South Africa; Mashigek@ukzn.ac.za; l.osuagwu@westernsydney.edu.au; k.agho@westernsydney.edu.au
5 Department of Optometry and Vision Science, School of Allied Health Sciences, University of Cape Coast, Ghana; eabu@ucc.edu.gh
6 Department of Community Medicine, College of Health Sciences, University of Jos, Nigeria; esvula@gmail.com; minerc@unijos.edu.ng
7 Department of Psychiatry, College of Health Sciences, University of Jos, Nigeria; piwunag@unijos.edu.ng
8 Department of Public Health, Faculty of Allied Medical Sciences, College of Medical Sciences, University of Calabar; bekpenyong@unical.edu.ng
9 School of Management and Marketing, Curtin Business School Bentley, Western Australia; richard.oloruntoba@curtin.edu.au
10 Tanzania Food and Nutrition Center, P. O. Box 977 Dar-es-Salaam; mischarwe@yahoo.co.uk
11 Department of Optometry and Vision Sciences, Mzuzu University, Mzuzu, Malawi: chikasirimobi.t@mzuni.ac.mw
12 Department of Computer Science, University of Jos, Nigeria; ishayat@unijos.edu.ng
13 School of Optometry and Vision Sciences, College of Biomedical Sciences, Cardiff CF24 4HQ, UK; maryanne.amiebenomo@uniben.edu
14 School of Health Sciences, Western Sydney University, Campbelltown, NSW 2560, Australia; David.Lim@westernsydney.edu.au; k.agho@westernsydney.edu.au
* Correspondence: l.osuagwu@westernsydney.edu.au; Tel.: +61(2) 4620 3569

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 ≥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: 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-

 doi:10.20944/preprints202205.0099.v1

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

 doi:10.20944/preprints202205.0099.v1

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 forty-six 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

 doi:10.20944/preprints202205.0099.v1

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 utilising a Likert scale and the other a 'yes/no/not sure' response). Participants were asked to comment on what would encourage them to receive COVID-19 vaccines.

Statistical analysis

All statistical analysis was conducted using IBM SPSS Statistics for Windows, version 27 (IBM Corp., Armonk, N.Y., USA). The normality of all continuous variables was assessed. Variables that were not normally distributed were re-coded as categorical variables. Collinearity was assessed, and no variable required exclusion due to weak association. 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, which was then used in a subsequent analysis of reasons for non-vaccination and facilitators to vaccination.

The reasons for COVID-19 vaccine hesitancy among participants were analysed using the open-ended comments provided by the participants. The responses were grouped into major topics, and significant recurrent and silent points were reported using quotations.

3. Results

This section may be divided into subheadings. It should provide a concise and precise description of the experimental results, their interpretation, as well as the experimental conclusions that can be drawn.

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.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 9 May 2022 doi:10.20944/preprints202205.0099.v1

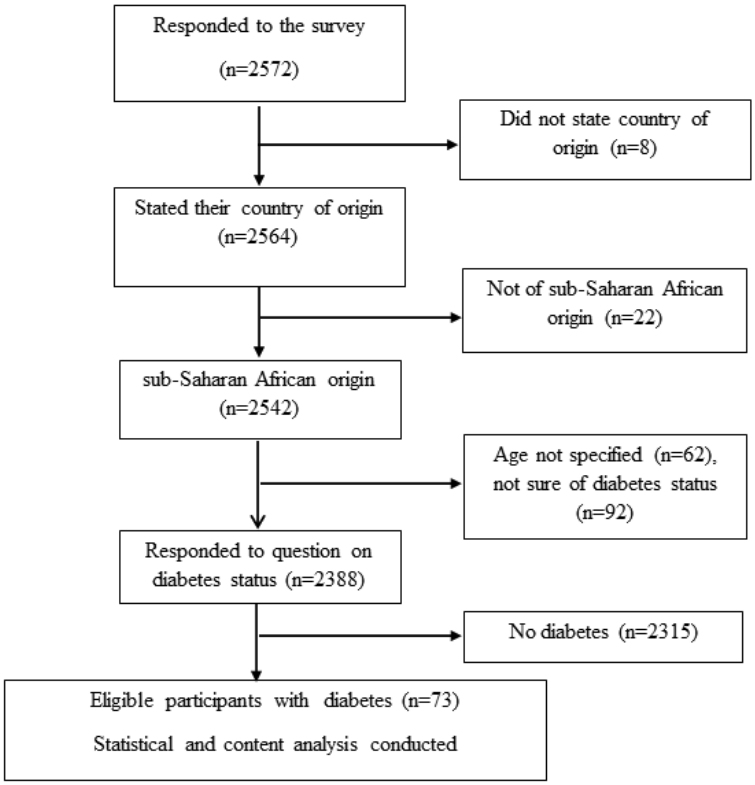

Figure 1: Flowchart of study participants

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

 doi:10.20944/preprints202205.0099.v1

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

‡ 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.

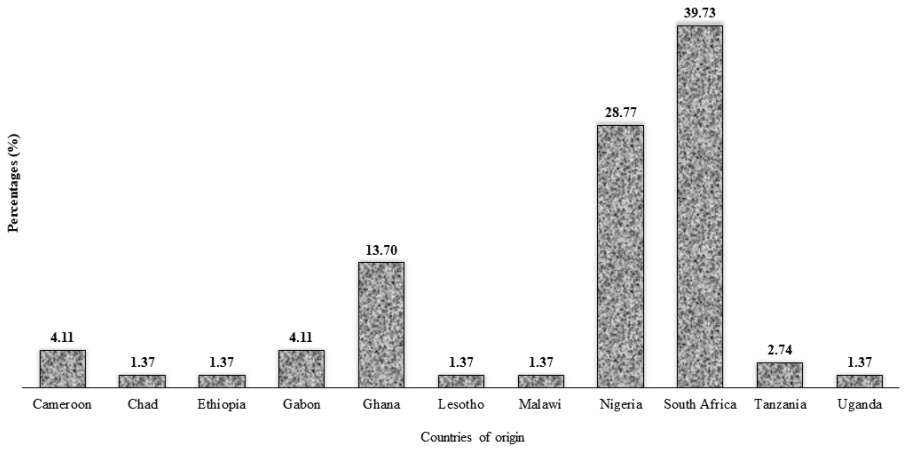

Figure 2: Distribution of study participants (n=73) by country of origin.

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.

 doi:10.20944/preprints202205.0099.v1

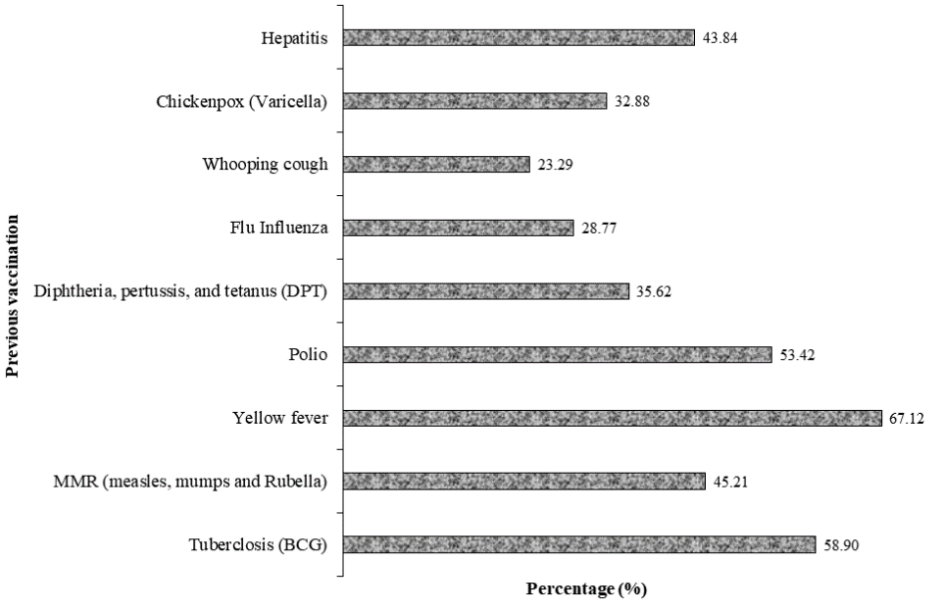

Figure 3: Percentage of previous vaccinations for other conditions among the study participants.

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‡	
Yes	6 (8.2)
No	59 (80.8)
Hypertension‡	
Yes	34 (46.6)
No	36 (49.3)
Sickle cell anaemia‡	
Yes	1 (1.4)
No	67 (91.7)
Obesity‡	
Yes	15 (20.5)
No	55 (75.3)
Any heart condition‡	
Yes	8 (11.0)
No	62 (85.0)
Kidney disease‡	
Yes	2 (2.7)
No	66 (91.8)

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

Information related to COVID 19 and vaccination uptake

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 9 May 2022 doi:10.20944/preprints202205.0099.v1

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 (%)
Awareness of COVID-19 vaccination	
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-19ǂ	
Yes	14 (41.2)
No	20 (58.8)
Aware that COVID-19 vaccines have been developed	
Yes	71 (97.3)
No	1 (1.4)
Have you been vaccinated against COVID-19	
Yes	5 (6.8)
No	67 (91.8)
Will you be willing to take COVID-19 vaccine when it becomes available in your country?	
Yes (willing)	48 (65.8)
No/not sure (refusal/hesitancy)	19 (26.0)
Risk perception of COVID-19 vaccination	
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)

 doi:10.20944/preprints202205.0099.v1

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)

ǂ=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 participants relied heavily on internet sources like the ministry of health websites, followed by social media and the TV while the least source of information was newspapers, through which a reasonable proportion also obtained COVID-19 related information during the pandemic (52.1%).

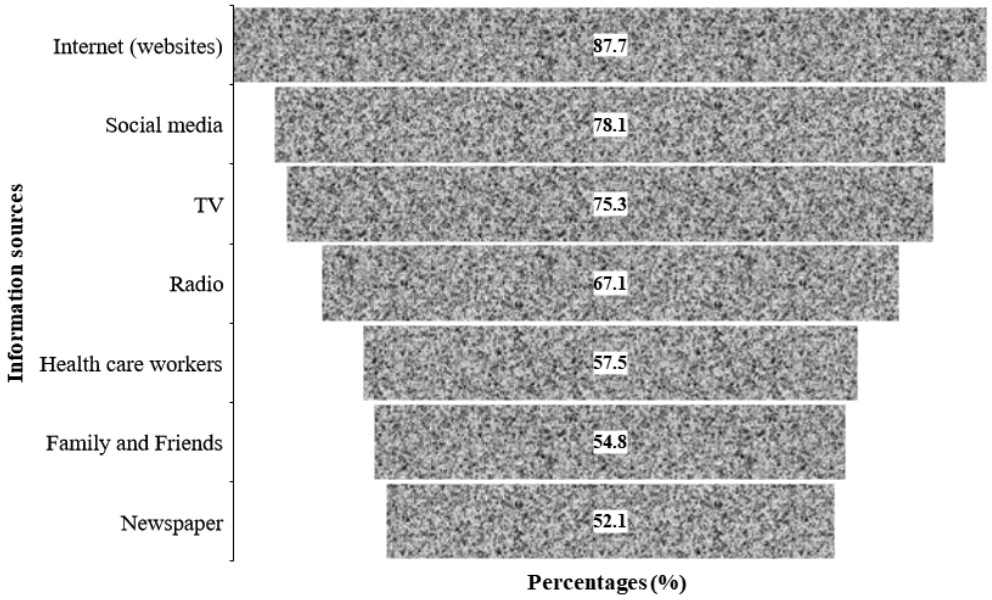

Figure 4: Main sources of COVID-19 related information used by the participants.

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

Chi-square analysis revealed significant associations between hesitancy/refusal of vaccine and some variables, as shown in Table 4. The uncertainty towards taking any COVID-19 vaccine was associated with demographic variables of sex, region of origin and place of residence (local and diaspora). In addition, a significant proportion of those who expressed concern about the safety of the vaccine was less likely to receive the COVID-19 vaccine when it became available in their country ($p<0.0001$) compared with those who had no such concern. A higher proportion of those who tested for COVID-19 stated they were willing to accept the vaccine compared with those who had not been tested. Other variables, including previous vaccination history and the presence of other health conditions like hypertension, did not show significant association with uncertainty towards the vaccine.

Table 4: Chi-square analysis of the association between uncertainty towards COVID-19 vaccine and participant variables. Only significant variables have been shown.

Variables	No/not sure	Yes	P-value
Gender			
Male	7 (14.6)	36 (75.0)	0.008

 doi:10.20944/preprints202205.0099.v1

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)	
Been tested for COVID-19	7 (20.6)	26 (76.5)	0.006
Concerned about the vaccine safety	11 (64.7)	5 (29.4)	<0.001

No/not sure = participants who were hesitant/refused to take the COVID-19 vaccine.

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 categorised into seven major headings. These are represented in Figure 5, and the participant's statements have been presented in supplementary Table 1. The figure showed that the majority of the participants said they were concerned about the safety of the vaccines, three were pregnant, and another had a compromised immune system (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*'. Some did not trust the pharmaceutical manufacturing companies, and about a quarter of the participants either did not trust 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 religious grounds, 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.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 9 May 2022 doi:10.20944/preprints202205.0099.v1

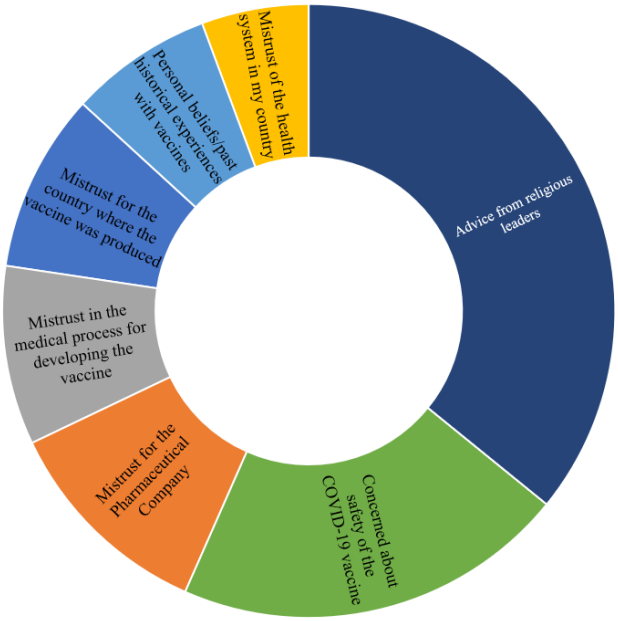

Figure 5: Main reasons for vaccine hesitancy/refusal among people with diabetes.

Factors that would encourage uptake of vaccination in people with DM

Figure 6 is a pyramid of the factors that participants stated may influence their decision to receive the COVID-19 vaccine when it becomes available in their countries. From the figure, all the participants reported that they were more likely to get vaccinated if they received more education about it, its side effects, and its effectiveness, as shown by this statement: *'If I can get more education on the vaccine, their side effects and how effective they are, I will take it*.

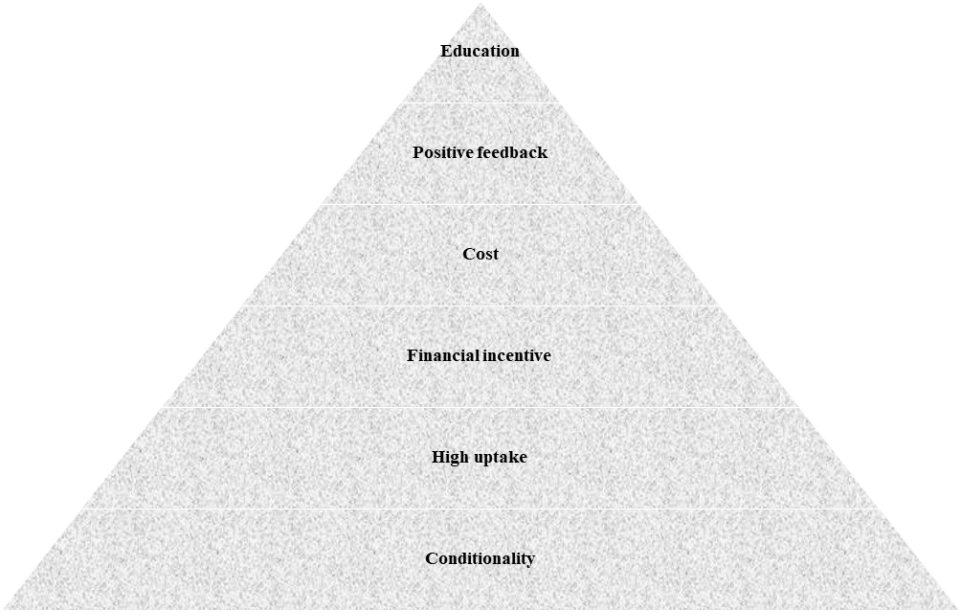

Figure 6: Factors that would encourage uptake of the vaccine among people with DM.

With regards to facilitators for COVID-19 vaccination, more than half of the participants each 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*' or get adequate information regarding the vaccine. Some said they would receive the vaccine after many people had already gotten theirs '*I will accept the vaccination*

 doi:10.20944/preprints202205.0099.v1

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 financial incentives were given and someone said, '*I will accept the vaccine if monetary rewards are given to health care providers involved in the vaccination'*.

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 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

 doi:10.20944/preprints202205.0099.v1

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.

While concern about the vaccine's safety and mistrust of the pharmaceutical companies were the 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. 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, Table S1: Participants comments on reasons for their unwillingness to accept the COVID-19 vaccines (n=19).

Author Contributions: Conceptualization, all authors; Methodology, U.L.O. and R.L.; Software, K.E.A, U.O.; Validation, T.I., R.O., B.N.E., E.E., K.P.M., E.A., O.M.O.; M.C. and T.C.; Formal Analysis, K.E.A. and U.L.O; Investigation, all authors; Resources, all authors; Data Curation, K.E.A., T.C., D.L., D.C. and C.P.; Writing – Original Draft Preparation, U.L.O.; R.L., E.E.; D.L. and E.A.; Writing – Review & Editing, T.I., E.E.; O.M.O.; B.N.E., G.O., U.L.O., K.E.A., K.P.M., E.A., M.C., D.L., R.O. and T.C.; Visualization, X.X.; Supervision, K.E.A, U.L.O, T.I., B.E., and K.P.M.; Project Administration, K.E.A., U.L.O. and T.I.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Humanities and Social Sciences Research Ethics Committee of the University of KwaZulu-Natal, Durban, South Africa (HSSREC 00002504/2021) for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study through an online preamble accompanying the survey.

Data Availability Statement: The datasets analyzed during this study are available from the authors on reasonable request.

Acknowledgments: None to acknowledge

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Saeedi, P.; Petersohn, I.; Salpea, P.; Malanda, B.; Karuranga, S.; Unwin, N.; Colagiuri, S.; Guariguata, L.; Motala, A.A.; Ogurtsova, K. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes research and clinical practice* **2019**, *157*, 107843.
2. Atlas, D. International diabetes federation. *IDF Diabetes Atlas, 7th ed. Brussels, Belgium: International Diabetes Federation* **2015**.
3. Atlas, I.D. Global estimates for the prevalence of diabetes for 2015 and 2040. *Diabetes Res Clin Pract* **2017**, *128*, 40-50.
4. Kengne, A.P.; June-Rose McHiza, Z.; Amoah, A.G.; Mbanya, J.C. Cardiovascular diseases and diabetes as economic and developmental challenges in Africa. *Progress in cardiovascular diseases* **2013**, *56*, 302-313, doi:10.1016/j.pcad.2013.10.011.
5. Kengne, A.P.; Amoah, A.G.; Mbanya, J.C. Cardiovascular complications of diabetes mellitus in sub-Saharan Africa. *Circulation* **2005**, *112*, 3592-3601, doi:10.1161/circulationaha.105.544312.
6. Jakovljevic, M.B.; Milovanovic, O. Growing Burden of Non-Communicable Diseases in the Emerging Health Markets: The Case of BRICS. *Frontiers in public health* **2015**, *3*, 65, doi:10.3389/fpubh.2015.00065.
7. Health, A.I.o.; Welfare; Holdenson, Z. *A picture of diabetes in overseas-born Australians*; Australian Institute of Health and Welfare: 2003.
8. Dzinamarira, T.; Dzobo, M.; Chitungo, I. COVID-19: A perspective on Africa's capacity and response. *Journal of medical virology* **2020**, *92*, 2465-2472.
9. Nwaeze, O.; Langsi, R.; Osuagwu, U.L.; Oloruntoba, R.; Ovenseri-Ogbomo, G.O.; Abu, E.K.; Charwe, D.D.; Ekpenyong, B.; Mashige, K.P.; Goson, P.C. Factors affecting willingness to comply with public health measures during the pandemic among sub-Sahara Africans. *African Health Sciences* **2021**, *21*, 1629-1639.
10. Basak, P.; Abir, T.; Al Mamun, A.; Zainol, N.R.; Khanam, M.; Haque, M.R.; Milton, A.H.; Agho, K.E. A Global Study on the Correlates of Gross Domestic Product (GDP) and COVID-19 Vaccine Distribution. *Vaccines* **2022**, *10*, 266.
11. Bonora, E.; Fedeli, U.; Schievano, E.; Trombetta, M.; Saia, M.; Scroccaro, G.; Tacconelli, E.; Zoppini, G. SARS-CoV-2 and COVID-19 in diabetes mellitus. Population-based study on ascertained infections, hospital admissions and mortality in an Italian region with~ 5 million inhabitants and~ 250,000 diabetic people. *Nutrition, Metabolism and Cardiovascular Diseases* **2021**, *31*, 2612-2618.
12. Silverii, G.A.; Monami, M.; Cernigliaro, A.; Vigneri, E.; Guarnotta, V.; Scondotto, S.; Allotta, V.A.; Conti, M.; Giordano, C.; Mannucci, E. Are diabetes and its medications risk factors for the development of COVID-19? Data from a population-based study in Sicily. *Nutrition, Metabolism and Cardiovascular Diseases* **2021**, *31*, 396-398.
13. Gao, Y.d.; Ding, M.; Dong, X.; Zhang, J.j.; Kursat Azkur, A.; Azkur, D.; Gan, H.; Sun, Y.l.; Fu, W.; Li, W. Risk factors for severe and critically ill COVID-19 patients: a review. *Allergy* **2021**, *76*, 428-455.
14. dei Ministri, P.d.C. Conferenza Permanente per i Rapporti tra lo Stato, le Regioni e le Province Autonome di Trento e Bolzano. *Disponibile all'indirizzo http://www. statoregioni. it/Documenti/DOC_044351_82% 20CSR% 20PUNTO* **2016**, *20*.
15. MacDonald, N. SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: Definition, scope and determinants. Vaccine.[Internet] 2015 [Citado 2019 Nov 06] 2015; 33 (34): 4161-4.
16. Guaraldi, F.; Montalti, M.; Di Valerio, Z.; Mannucci, E.; Nreu, B.; Monami, M.; Gori, D. Rate and predictors of hesitancy toward SARS-CoV-2 vaccine among type 2 diabetic patients: results from an Italian survey. *Vaccines* **2021**, *9*, 460.
17. Aldossari, K.K.; Alharbi, M.B.; Alkahtani, S.M.; Alrowaily, T.Z.; Alshaikhi, A.M.; Twair, A.A. COVID-19 vaccine hesitancy among patients with diabetes in Saudi Arabia. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews* **2021**, *15*, 102271.
18. Cooper, S.; van Rooyen, H.; Wiysonge, C.S. COVID-19 vaccine hesitancy in South Africa: how can we maximise uptake of COVID-19 vaccines? *Expert Rev Vaccines* **2021**, *20*, 921-933, doi:10.1080/14760584.2021.1949291.
19. Ackah, B.B.; Woo, M.; Ukah, U.V.; Fazal, Z.A.; Stallwood, L.; Okpani, A.; Adu, P.A. COVID-19 vaccine hesitancy in Africa: A scoping review. **2021**.

20. WHO. Coronavirus disease (COVID-19): Herd immunity, lockdowns and COVID-19. **2020**.
21. Klekotka, R.B.; Mizgała, E.; Król, W. The etiology of lower respiratory tract infections in people with diabetes. *Advances in Respiratory Medicine* **2015**, *83*, 401-408.
22. Alguwaihes, A.M.; Al-Sofiani, M.E.; Megdad, M.; Albader, S.S.; Alsari, M.H.; Alelayan, A.; Alzahrani, S.H.; Sabico, S.; Al-Daghri, N.M.; Jammah, A.A. Diabetes and Covid-19 among hospitalised patients in Saudi Arabia: a single-centre retrospective study. *Cardiovascular diabetology* **2020**, *19*, 1-12.
23. Biasio, L.R.; Bonaccorsi, G.; Lorini, C.; Pecorelli, S. Assessing COVID-19 vaccine literacy: a preliminary online survey. *Human Vaccines & Immunotherapeutics* **2021**, *17*, 1304-1312, doi:10.1080/21645515.2020.1829315.
24. Buzasi, K. Linguistic situation in twenty sub-Saharan African countries: A survey-based approach. *African Studies* **2016**, *75*, 358-380.
25. Murphy, J.; Vallières, F.; Bentall, R.P.; Shevlin, M.; McBride, O.; Hartman, T.K.; McKay, R.; Bennett, K.; Mason, L.; Gibson-Miller, J.; et al. Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. *Nature Communications* **2021**, *12*, 29, doi:10.1038/s41467-020-20226-9.
26. Guo, W.; Li, M.; Dong, Y.; Zhou, H.; Zhang, Z.; Tian, C.; Qin, R.; Wang, H.; Shen, Y.; Du, K. Diabetes is a risk factor for the progression and prognosis of COVID-19. *Diabetes/metabolism research and reviews* **2020**, *36*, e3319.
27. Ye, Q.; Wang, B.; Mao, J. The pathogenesis and treatment of theCytokine Storm'in COVID-19. *Journal of infection* **2020**, *80*, 607-613.
28. CDC. People with Certain Medical Conditions. **2022**.
29. WHO. COVID-19 advice for the public: Getting vaccinated. **2022**.
30. WHO. WHO Coronavirus (COVID-19) Dashboard. **2022**.
31. WHO. Africa's COVID-19 vaccine uptake increases by 15%. **2022**.
32. Gregory, J.M.; Slaughter, J.C.; Duffus, S.H.; Smith, T.J.; LeStourgeon, L.M.; Jaser, S.S.; McCoy, A.B.; Luther, J.M.; Giovannetti, E.R.; Boeder, S. COVID-19 severity is tripled in the diabetes community: a prospective analysis of the pandemic's impact in type 1 and type 2 diabetes. *Diabetes Care* **2021**, *44*, 526-532.
33. McGurnaghan, S.J.; Weir, A.; Bishop, J.; Kennedy, S.; Blackbourn, L.A.; McAllister, D.A.; Hutchinson, S.; Caparrotta, T.M.; Mellor, J.; Jeyam, A. Risks of and risk factors for COVID-19 disease in people with diabetes: a cohort study of the total population of Scotland. *The lancet diabetes & endocrinology* **2021**, *9*, 82-93.
34. Barron, E.; Bakhai, C.; Kar, P.; Weaver, A.; Bradley, D.; Ismail, H.; Knighton, P.; Holman, N.; Khunti, K.; Sattar, N. Associations of type 1 and type 2 diabetes with COVID-19-related mortality in England: a whole-population study. *The Lancet Diabetes & endocrinology* **2020**, *8*, 813-822.
35. Chen, X.; Hu, W.; Ling, J.; Mo, P.; Zhang, Y.; Jiang, Q.; Ma, Z.; Cao, Q.; Deng, L.; Song, S.; et al. Hypertension and Diabetes Delay the Viral Clearance in COVID-19 Patients. *medRxiv* **2020**, 2020.2003.2022.20040774, doi:10.1101/2020.03.22.20040774.
36. Cariou, B.; Hadjadj, S.; Wargny, M.; Pichelin, M.; Al-Salameh, A.; Allix, I.; Amadou, C.; Arnault, G.; Baudoux, F.; Bauduceau, B. Phenotypic characteristics and prognosis of inpatients with COVID-19 and diabetes: the CORONADO study. *Diabetologia* **2020**, *63*, 1500-1515.
37. Lin, C.; Tu, P.; Beitsch, L.M. Confidence and Receptivity for COVID-19 Vaccines: A Rapid Systematic Review. *Vaccines (Basel)* **2020**, *9*, doi:10.3390/vaccines9010016.
38. Sallam, M.; Dababseh, D.; Eid, H.; Al-Mahzoum, K.; Al-Haidar, A.; Taim, D.; Yaseen, A.; Ababneh, N.A.; Bakri, F.G.; Mahafzah, A. High rates of COVID-19 vaccine hesitancy and its association with conspiracy beliefs: a study in Jordan and Kuwait among other Arab countries. *Vaccines* **2021**, *9*, 42.

39. Murphy, J.; Vallières, F.; Bentall, R.P.; Shevlin, M.; McBride, O.; Hartman, T.K.; McKay, R.; Bennett, K.; Mason, L.; Gibson-Miller, J.; et al. Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. *Nat Commun* **2021**, *12*, 29, doi:10.1038/s41467-020-20226-9.
40. Schmid, P.; Rauber, D.; Betsch, C.; Lidolt, G.; Denker, M.L. Barriers of Influenza Vaccination Intention and Behavior - A Systematic Review of Influenza Vaccine Hesitancy, 2005 - 2016. *PLoS One* **2017**, *12*, e0170550, doi:10.1371/journal.pone.0170550.
41. Dubé, E.; Gagnon, D.; MacDonald, N.; Bocquier, A.; Peretti-Watel, P.; Verger, P. Underlying factors impacting vaccine hesitancy in high income countries: a review of qualitative studies. *Expert Rev Vaccines* **2018**, *17*, 989-1004, doi:10.1080/14760584.2018.1541406.
42. Sherman, S.M.; Smith, L.E.; Sim, J.; Amlôt, R.; Cutts, M.; Dasch, H.; Rubin, G.J.; Sevdalis, N. COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-sectional survey. *Human vaccines & immunotherapeutics* **2021**, *17*, 1612-1621.
43. Alfageeh, E.I.; Alshareef, N.; Angawi, K.; Alhazmi, F.; Chirwa, G.C. Acceptability of a COVID-19 Vaccine among the Saudi Population. *Vaccines* **2021**, *9*, 226.
44. Hilverda, F.; Vollmann, M. The Role of Risk Perception in Students' COVID-19 Vaccine Uptake: A Longitudinal Study. *Vaccines* **2021**, *10*, 22.
45. Allen, E.M.; Lee, H.Y.; Pratt, R.; Vang, H.; Desai, J.R.; Dube, A.; Lightfoot, E. Facilitators and barriers of cervical cancer screening and human papillomavirus vaccination among Somali refugee women in the United States: a qualitative analysis. *Journal of Transcultural Nursing* **2019**, *30*, 55-63.
46. Wiley, K.E.; Massey, P.D.; Cooper, S.C.; Wood, N.J.; Ho, J.; Quinn, H.E.; Leask, J. Uptake of influenza vaccine by pregnant women: a cross-sectional survey. *Medical Journal of Australia* **2013**, *198*, 373-375.
47. Dilley, S.E.; Peral, S.; Straughn Jr, J.M.; Scarinci, I.C. The challenge of HPV vaccination uptake and opportunities for solutions: lessons learned from Alabama. *Preventive medicine* **2018**, *113*, 124-131.
48. Nguyen, K.H.; Lu, P.; Meador, S.; Hung, M.-C.; Kahn, K.; Hoehner, J.; Razzaghi, H.; Black, C.; Singleton, J.A. Comparison of COVID-19 vaccination coverage estimates from the Household Pulse Survey, Omnibus Panel Surveys, and COVID-19 vaccine administration data, United States, March 2021. *CDC AdultVaxView* **2021**.
49. Adane, M.; Ademas, A.; Kloos, H. Knowledge, attitudes, and perceptions of COVID-19 vaccine and refusal to receive COVID-19 vaccine among healthcare workers in northeastern Ethiopia. *BMC public health* **2022**, *22*, 1-14.
50. Katoto, P.D.M.C.; Parker, S.; Coulson, N.; Pillay, N.; Cooper, S.; Jaca, A.; Mavundza, E.; Houston, G.; Groenewald, C.; Essack, Z.; et al. Predictors of COVID-19 Vaccine Hesitancy in South African Local Communities: The VaxScenes Study. *Vaccines* **2022**, *10*, 353.

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	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?
	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

 doi:10.20944/preprints202205.0099.v1

Mistrust for the Pharmaceutical Company	Manufacturing companies' refusal to take responsibility for any adverse effects arising from taking the vaccines The indemnity given to manufactures is curious and suspicious
Mistrust in the medical process for developing the vaccine	Not enough scientific research results The vaccines have been developed so quickly. I don't trust the research done about it. Not enough study on the long-term effect of the vaccines Not enough scientific data on clinical trials; Not sufficient time elapsed for observations of side-effects
Mistrust of the health system in my country	My country is making money with covid 19. No trace of it kind here
Personal beliefs/past historical experiences with vaccines	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. 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
Concerned about safety of the COVID-19 vaccine	Real benefits of the vaccines not spelt out. Vaccines shrouded with uncertainties; Side effects have a history of thrombosis 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.
Advice from religious leaders	Personal belief in my Lord Jesus Christ
Conspiracy theories	The conspiracy theories that are circulating regarding COVID-19 vaccine have discouraged me from taking the vaccine It could be a birth control procedure to reduce world population The vaccine is meant to reduce world population especially Africans I am protected from complications of the Covid virus If this vaccine is not curative and not preventive, what does it do? Other conspiracy theories