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Prevalence of COVID-19 Vaccine Hesitancy in a Rural Setting: A Case Study of DIMAMO Health and Demographic Surveillance Site, Limpopo Province of South Africa

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Abstract: Background: The primary purpose of introducing the COVID-19 vaccine was to fight the pandemic. However, the vaccine was not well received worldwide. This challenge has threatened the effective implementation and roll-out of COVID-19 immunization campaigns. The challenge of vaccine hesitancy was reported to be more prevalent in rural areas due to various factors such as cultural beliefs, misinformation, poverty, lack of education, and distrust of vaccines. Yet there seems to be a scarcity of studies determining the prevalence of vaccine hesitancy in deep rural areas of Limpopo. Purpose: The study aimed to explore the prevalence of COVID-19 hesitancy among the rural black population in South Africa. Study Methods: A longitudinal quantitative study was conducted with data from the DIMAMO Health and Demographic Surveillance Site (HDSS) database for 2020 to 2022. A non-probability total sampling technique was used to select the respondents. Trained fieldworkers collected data using an electronic data capture questionnaire. A comparison of categorical variables was performed using Chi-Square in SPSS version 26 and the statistical significance was set at $p < 0.05$, with a 95% confidence interval to analyze the data. Results: The limited availability of vaccination sites in Limpopo Province, South Africa, was associated with a reduced certainty that the vaccine would be accepted, as reported in the current study. The prevalence of visiting traditional healers was significantly higher in non-vaccinated than vaccinated participants among the rural black population, indicating a different cultural belief among the rural black population that existed before and during the COVID-19 pandemic. Conclusion: The present study findings show diverse factors of concern associated with vaccination hesitancy for COVID-19 among rural black people. Lack of education, gender, not being diagnosed with COVID-19, not being a Christian, visiting traditional healers, vaccine mistrust, unknown side effects, and a lack of confidence in the vaccine itself. Conspiracy theories were factors that impacted vaccine acceptance among black people living in rural areas. The prevalence of visiting traditional healers was significantly higher in non-vaccinated than vaccinated participants. Therefore, the present study findings emphasize the need to collectively integrate and utilize the traditional healers in the South African healthcare system.

Keywords: prevalence; COVID-19; vaccine hesitancy; rural areas; DIMAMO

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1. Introduction

Globally, the COVID-19 pandemic disrupted socio-economic status and education and affected society's physical and mental health [1]. COVID-19 detrimental effects included severe respiratory syndrome, shortened life span, and an increased mortality and morbidity rate [2]. The rapid spread of the virus and its impending consequences to individuals led to the suspension of various services, such as educational programs and non-essential services, following compliance with the imposed lockdown regulations intended to reduce the spread of the infection. The lockdown guidelines for controlling social gatherings, movements, and restrictions were executed as preventive measures to prevent the pandemic [3–5]. Nevertheless, these actions were not compelling worldwide due to the heightened spread of the infections.

The increased spread of the infections stimulated a debate about using the vaccine to minimize the disease across the globe. Vaccines are one of the effective public health interventions to control the spread of infections [6]. In addition, approved vaccines have the potential to restore and safeguard the economy and individuals who are not inoculated, reduce severe cases that trouble medical services, and decrease hospitalization. Although the COVID-19 vaccine was considered effective to curb the virus, challenges related to the acceptance and refusal of vaccination (vaccine hesitancy) emerged as a significant problem worldwide, with more than 90% of countries experiencing vaccine hesitancy [7]. Studies across the globe have shown that one in three people may reject the COVID-19 vaccine, with the acceptance of vaccines ranging from 52% to 82% [7]. Furthermore, vaccine hesitancy threatened the effective implementation and roll-out of COVID-19 immunization campaigns in many countries [8].

In South Africa, although the COVID-19 vaccine was approved and declared safe and effective, the majority of the population was reported as not being willing to be vaccinated. Most community members said they would never receive the vaccine for various reasons [9]. Low vaccination rates were seen amongst people who live in developing countries, such as South Africa. This has become a threat to South Africa's achievement of community immunity; consequently it has become a risk for both vaccinated and unvaccinated people [9]. The literature reveals that vaccine hesitancy is common amongst black people in rural areas and the unemployed, also among young people and women [10]. Moreover, the distribution of wrong information and misconceptions about the development and safety of vaccines by media and social platforms is considered the contributory factor in the hesitancy. Mose, et al. [11]) identified political affiliations, education, ethnicity, work status, and cultural factors influencing vaccine hesitancy. The current study was conducted to explore the prevalence of COVID-19 hesitancy among the rural black population in South Africa. Department of Health Limpopo Province vaccination statistics indicate different response rates according to different age groups, with those who are aged 60+ being the highest (85%), followed by those aged 50–59 years (47%), with a low vaccination rate amongst those aged 35–49 years (23%) [12]. In Limpopo Province, the Member of the Executive Council of Health, Dr. Phophi Ramathuba, reported challenges of low turnover amongst youth between 18 and 34 years in the vaccination sites linked to vaccine hesitancy [13], which followed the high number of positive cases of COVID-19. Cooper (2021) shared similar sentiments with the statement by a Member of the Executive Council, Dr. Ramathuba, by indicating age and education as factors influencing COVID-19 vaccine hesitancy in the Capricorn District of Limpopo Province, which reported 44,612 positive cases of COVID-19. Factors such as educational status, geographical location, and politics were also identified [14] as challenges for COVID-19 vaccination. It is against this background that the researchers were prompted to explore the prevalence of vaccine hesitancy in the Dikgale, Mamabolo, and Mothiba (DIMAMO) Health and Demographic Surveillance Site(HDSS). DIMAMO is a chosen surveillance area that continuously collects data for monitoring the high rate of non-communicable diseases from lifestyle changes and their risk factors [15]. Moreover, there seems to be a scarcity of studies determining the prevalence of vaccine hesitancy in deep rural areas with positive COVID-19 cases in Limpopo Province.

2. Material and Methods

A longitudinal quantitative study design was conducted with data from the DIMAMO Health and Demographic Surveillance Site (HDSS) database for 2020 to 2022. This study design provided access to geographically well-defined research populations and facilities suitable to execute the surveillance protocol.

2.1. Study Setting

The study was conducted in the Dikgale, Mamabolo, and Mothiba (DIMAMO) surveillance area in the Capricorn District of the Limpopo Province, South Africa. The DIMAMO [15] areas consist of rural and semi-rural areas within the HDSS consisting of 51 villages with approximately 100,000 individuals who are mostly Northern Sotho-speaking. The greater part of the black population is of low economic status and educational levels. A quantitative cross-sectional population study was conducted within a bigger ongoing project of the DIMAMO Health and Demographic Surveillance Site (HDSS). A structured questionnaire was designed and incorporated into the survey solutions. This was distributed per household within the HDSS by trained field workers; other participants were contacted by the DIMAMO surveillance area HDSS call center.

2.2. Population and Sampling

The study consisted of males and females above 15 years from DIMAMO HDSS under the Tribal Authority of Dikgale, Mamabolo, and Mothiba tribal councils forming three functional areas in Limpopo Province. A population size of 102,734 was estimated from the three Functional Community Areas (FCA 1, FCA 2, and FCA 3), with approximately 20,000 households being contacted once every 15 weeks, yielding about 1400 households contacted per week. The household proxy informant was asked to respond to the screening tool for each resident member of the household. Assuming confidence of 95%, a margin of error of 5%, and a conservative prevalence estimate of 50%, the initial sample size was set at 380 using the Raosoft sample calculator per F.C.A. [16]. The current study followed simple random sampling to select respondents [17,18]. This sampling method made it possible to get deep insights into the phenomenon we were interested in. With broad coverage of the population of interest, there was also a reduced risk of missing potential insights from members not included. A total of 90,267 participated in the study with 52,574 partially responding to COVID-19 vaccination questions. To determine the prevalence of COVID-19 hesitancy amongst the rural black population in South Africa, we excluded the partial respondents from the final analysis. In total, 37,693 participants (20,875 females and 16,818 males) aged between 18 and 110 years fully completed the questionnaire and were part of the final analysis.

2.3. Data Collection

The data collection tool included questions on demographics, COVID-19 diagnosis, vaccine hesitancy reasons, risk perception, information and trust, stereotyped stigma, anticipated stigma, symptom screening, epidemiological risk, and travel history. Trained fieldworkers used electronic data capture software to record data on tablets, which included automated skip patterns and validation checks. Fieldworkers were trained on COVID-19 data collection using standard operating procedures developed following the World Health Organization (WHO) guidelines. Preventive measures such as wearing masks, hand sanitization, and social distancing were adhered to during data collection. Between March 2020 and May 2021, field-based data collection was suspended and only the telephonic data collection method was used as the country was on lockdown due to the COVID-19 pandemic. Field-based data collection resumed from late May 2021 to March 2022 when the lockdown regulations eased in the country.

2.4. Data Analysis

All statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 26.0 software (I.B.M., Armonk, New York, NY, USA). Data were reported as frequency and percentages. A comparison of categorical variables was performed using Chi-Square and the statistical significance was set at $p < 0.05$, and a 95% confidence interval. The spatial distribution analysis was done to analyze the distribution of the percentage of people who were vaccinated and estimates of COVID-19 vaccine hesitancy rates in all villages within the DIMAMO HDSS. We used the ArcGIS software version 10.8 to create the spatial distribution maps of the percentage of people who were vaccinated and estimates of COVID-19 vaccine hesitancy rates in the study area. The spatial distribution maps were created by visualizing the percentage of people who were vaccinated and estimates of COVID-19 vaccine hesitancy rates data using choropleth maps.

2.5. Validity and Reliability

The questionnaire responses from participants were cross-checked by the field supervisor and quality controllers for consistency in the results. The questionnaires were piloted and approved for the study site (DIMAMO). Therefore, there was no amendment to the questionnaires, and the study complied with the main study protocol throughout the data collection period.

2.6. Ethical Considerations

Ethical approval to conduct the study was sought from the University of Limpopo Turfloop Research Ethics Committee (TREC). Permission to conduct the study was also granted by the tribal authority and the Department of Health in Limpopo Province.

3. Results

The map in Figure 1 below shows the percentage of vaccinated people and estimates of COVID-19 vaccine hesitancy rates using data from the DIMAMO PHRC. We estimated the percentage of vaccinated and hesitancy rates at the village level using the HDSS data for the collection period from March 2021—to March 2022. Estimates were apportioned across those villages based on the overall visited populations. FCA 1 shows a low vaccination rate compared to FCAs 2 and 3, with moderate and high vaccination rates. Vaccine hesitancy for FCAs 1 and 2 shows low to moderate rates, whereas FCA 3 is dominated by high vaccine hesitancy rates.

Vaccination Hesitancy

Table 1 compares the characteristics of COVID-19 vaccination status. Participants who were vaccinated were significantly more likely to be females than males (p-value < 0.001). When compared to non-vaccinated participants, vaccinated participants were significantly more likely to be Christian, have a high educational status (degree and post-graduate), have been diagnosed with COVID-19 before, distrust the government, and have reported no information withheld from the public (p-value < 0.05). Furthermore, participants who reported visiting traditional healers were also associated with vaccination status with a prevalence of 1.8%. The prevalence of visiting traditional healers was significantly higher in non-vaccinated than vaccinated participants. Depression, anxiety, deaths, and pharmacy visits were also investigated for an association with vaccination status; however, the results were not significant.

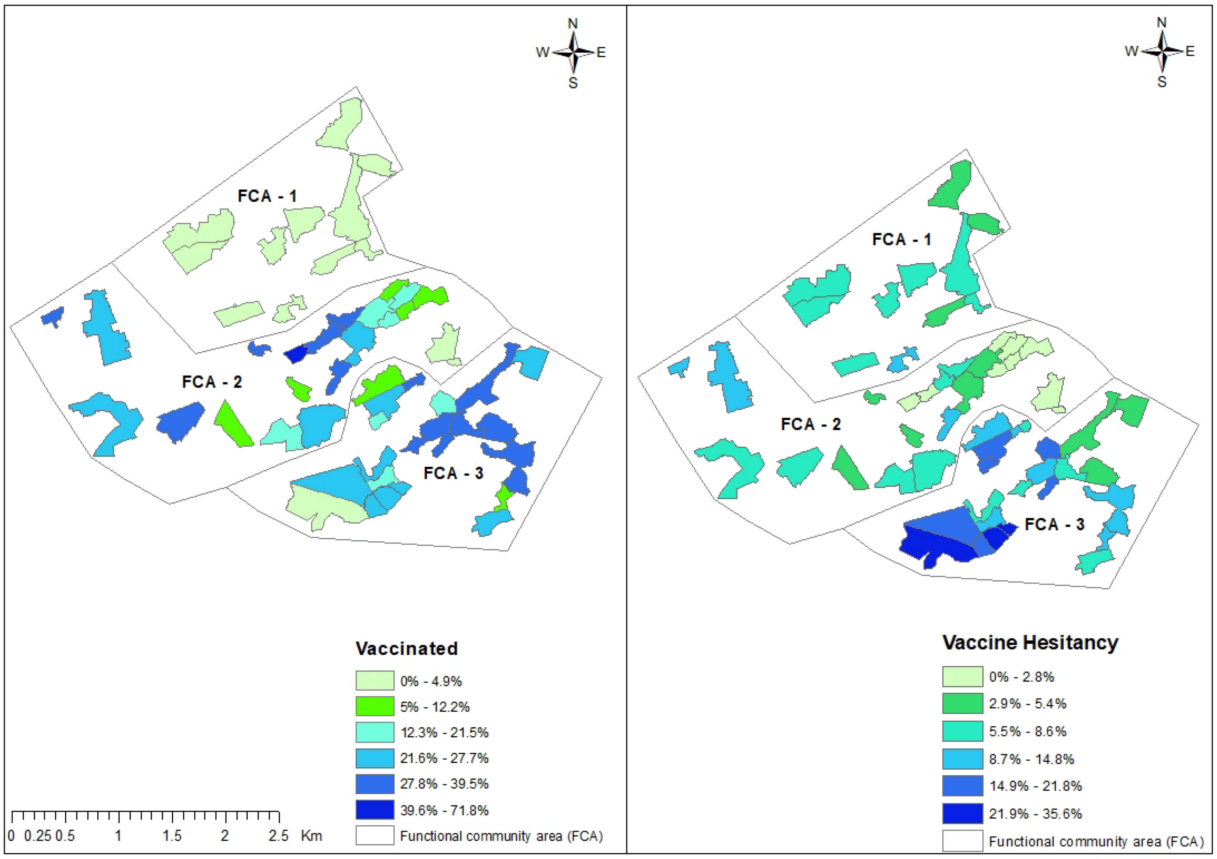

Figure 1. Percentage of people who were vaccinated and estimates of COVID-19 vaccine hesitancy rates.

Table 1. Results about vaccination and hesitancy.

	Not Vaccinated n (%) 32,714 (87%)	**Vaccinated n (%) 4979 (13%)**	***p*-Value**
Gender			<0.001
Male	15,300 (91.0%)	1518 (9.0%)	
Female	17,414 (83.4%)	3461 (16.6%)	
Education			<0.001
Low education status	29,396 (86.0%)	4283 (14.0%)	
Higher Certificate	1521 (84.5%)	279 (15.5%)	
National Diploma	707 (91.9%)	62 (8.1%)	
Degree	345 (74.5%)	118 (25.5%)	
Postgraduate	59 (66.3%)	30 (33.7%)	
Religion			0.007
Christian	2188 (48.8%)	2297 (51.2%)	
Others (etc. Muslim)	72 (62.1%)	44 (37.9%)	
None	827 (51.1%)	790 (48.9%)	
COVID-19 diagnosed			<0.001
Positive	17 (37.8%)	28 (62.2%)	
Negative	9508 (68.2%)	4431 (31.8%)	
Public clinic visit (No)	4915 (78.8%)	3287 (70.6%)	<0.001
Pharmacy visit (Yes)	368 (5.9%)	304 (6.5%)	0.398
Traditional healer visit (Yes)	179 (2.9%)	85 (1.8%)	0.002
Died (Yes)	14 (0.0%)	3 (0.1%)	0.589
Depression (Yes)	1584 (16.6%)	707 (15.8%)	0.256
Anxiety (Yes)	1611 (16.9%)	724 (16.2%)	0.326
Government not trusted (Yes)	1908 (20.0%)	1041 (23.3%)	<0.001
Information withheld from Public (No)	5913 (11.8%)	2725 (61.1%)	<0.001

As depicted in Figure 2 below, most of those who did not vaccinate were concerned about COVID-19 vaccine side effects (n = 1528, 5%), followed by those who did not like needles (n = 1291, 4%). In contrast, others reported the vaccine as ineffective with a fear of being allergic to the vaccine; and while others did not want to receive the vaccine in public spaces, and some being also not concerned about COVID illness (less than 450 participants, =1%). The vaccination rate was observed as 15% in the study setting.

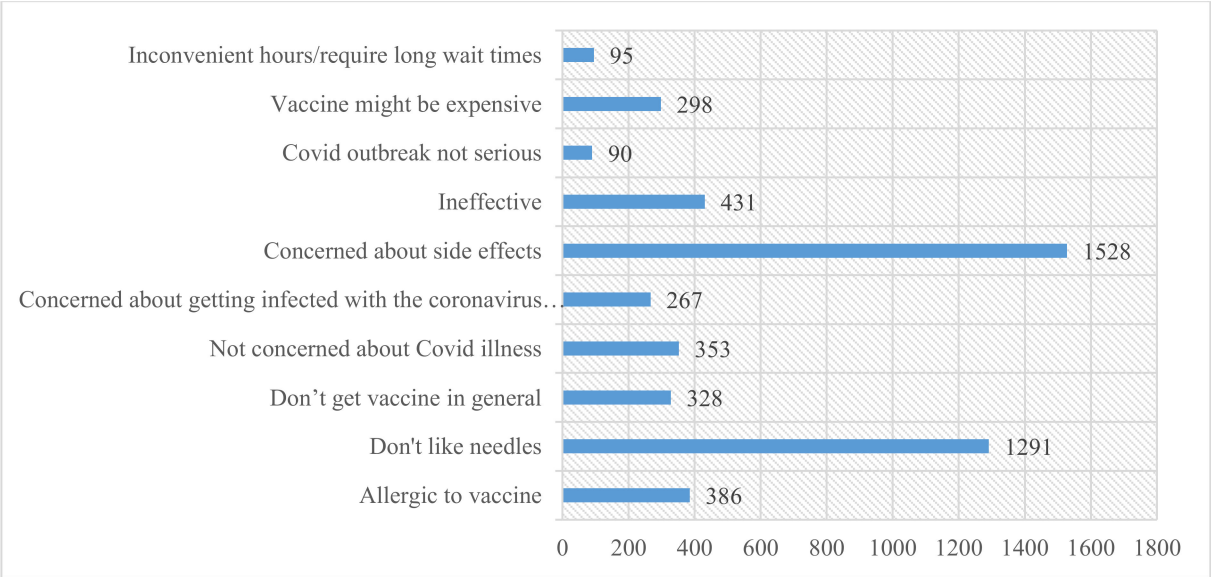

Figure 2. Factors associated with vaccine hesitancy.

4. Discussion

FCA 1 showed a lower vaccination rate than FCAs 2 and 3, which showed moderate and high vaccination rates. Vaccine hesitancy for FCAs 1 and 2 showed low to moderate rates, whereas FCA 3 was dominated by high vaccine hesitancy rates. This might be because data collection in DIMAMO HDSS was largely characterized by face-to-face interviews collected by trained field workers. Some of the general measures to contain the spread of COVID-19 were restrictions on face-to-face meetings, which blocked this avenue for gathering face-to-face data in the villages. The researchers mitigated this by undertaking COVID-19 telephone surveys through the DIMAMO call center from March 2020 to March 2021 for FCA 3. It showed that most participants in FCA 1 in the first wave (16 March 2020 to 31 October 2020) and second wave (01 November 2020 to 31 March 2021) were willing to vaccinate; however, during these times vaccination was limited in South Africa. On 17 February 2021, South Africa started its national vaccination program against COVID-19. Again, the country first prioritized certain groups of people to receive their shots before others. The program was administered in phases, prioritizing healthcare and frontline workers and those aged over 60 years.

The study by Coustasse et al. [19] reported that rural people have a high rate of COVID-19 positive status, and as such, a low acceptance rate of COVID-19 vaccine should be a concern to the local Department of Health. This supplements the study findings as we found more participants in FCA 3 with high vaccine hesitancy rates. This might be due to limited vaccination sites and prioritization for vaccination negatively impacting vaccine acceptance in rural areas of Limpopo Province during data collection. For example, by September 2021, Limpopo Province, Capricorn District as a study focus had expanded its COVID-19 vaccine sites to three vaccination sites: Pietersburg and Mankweng hospitals' primary healthcare (PHC) facilities; and one higher educational institution. Challenges, such as limited access to healthcare, extended travel time to an acute care facility, and lack of liable transport, could have caused the rural population to postpone vaccination of

COVID-19 [19]. Community members across the functional areas needed more information about how the vaccine can protect the family and friends [20].

In this study, 13% said they had received a COVID-19 vaccine; 87% said they had not. The study by Kelp, et al. [21] reported that uncertainty influences COVID-19 vaccine acceptance. This is consistent with the study findings as we found that most rural people indicated uncertainty about COVID-19 vaccination due to their concern about the side effects and their fear of needles. The lower certainty of accepting the COVID-19 vaccine could be attributed to the level of mistrust and misinformation about the use of the vaccine in protecting the population's health. Mistrust about the COVID-19 vaccine has been identified by different scholars, including the World Health Organization, as a critical concern for health and science innovations worldwide [22–24]. The origin of COVID-19 mistrust could be associated with political or government-related factors; for example, community members perceiving the government as hiding the truth about the COVID-19 pandemic, or prioritizing economic issues. Our study findings echo the findings of Bogart et al. [24], who reported that uncertainty about COVID-19 vaccination occurs from a fear of harm and the side effects of the vaccine among global citizens [25]. The uncertainty of COVID-19 echo similar findings on other vaccines introduced to communities across the globe. For instance, uncertainty about influenza or influenza vaccine was observed among urban risk group populations in Brazil, Chile, Paraguay, Peru, Uruguay, and other countries in South America [26]. Suryadevara et al. [27] reported misperceptions about influenza vaccine efficacy and safety as a contributory factor of vaccine hesitancy among low-income communities in central New York. Additionally, similar findings of the current study may also be associated with vaccine safety, misinformation, myths, and fear of becoming ill from the vaccine among the young black population [28,29]. The present study findings demonstrated concern about "side effects" and "do not like needles" as other factors contributing to hesitancy in rural areas. Therefore, the study's findings also support the conclusion that COVID-19 vaccination was not well received by most people due to their fear of getting sick from the vaccine [28,29], thus the COVID-19 vaccine, like the influenza vaccine, is not well received among low income risk populations across the globe.

The present study findings indicate gender imbalances regarding COVID-19 vaccine hesitancy, resulting in an uncontrolled rate of infections, especially considering the competition for love between the two genders [30]. Female participants and those with less than a bachelor's degree were more likely to report vaccine unwillingness, whereas those with at least a bachelor's degree were more likely to report willingness [31]. The study findings demonstrate that females compared to males within the three FCAs understood the role of the vaccine and accepted it as the only way to ensure that they are healthy, and that it protects the lives of vulnerable citizens. The current study findings add knowledge regarding the socioeconomic inequalities for vaccine hesitancy among the rural black population. For instance, 86% of community members with low educational status reported vaccine hesitancy; this is higher than the 66.3% of community members with post-graduate qualifications reporting vaccine hesitancy. Vaccine acceptance of community members with post-graduate qualifications was 33.7% compared to the 14% of community members with low educational status. This provides evidence of educational inequalities for vaccine hesitancy and acceptance among the rural black population. The findings echo Cesaroni, Calandrini, Balducci, et al. [32] who reported socio-economic educational inequalities for vaccine hesitance and acceptance among the adult population in the Lazio Region, Italy. Furthermore, the fact that vaccination hesitancy is more prevalent among males with less education means that COVID-19 vaccine hesitancy and acceptance in rural areas present gender differences as reported by Pitjoos; and Letzing, [33–35].

The present study findings also indicate religiosity as another significant factor in vaccination. For example, of those diagnosed with COVID-19, those vaccinated were significantly more likely to be Christians. Therefore, the current study findings indicate a high vaccination rate for COVID-19 among Christians from rural areas without undermining the low numbers of other religions in comparison to Christianity. This suggests

a high vaccine hesitancy among non-Christians such as Muslims and others. This could be associated with religious leaders' influence regarding vaccination. For instance, the message "together we can conquer COVID-19" by two Zion Christian Church leaders in Limpopo Province was followed by an increased vaccination rate among Christians [36]. Therefore, the present study findings indicate the significant role played by church leaders in enforcing the COVID-19 vaccination program, which the World Church Council (2021) also reported [37].

However, the present study findings also indicate the role of traditional healers in enforcing the vaccination program in rural areas which previously received less scholarly attention. For example, the prevalence of visiting traditional healers is significantly higher in non-vaccinated than vaccinated participants among the rural black population—indicating a different cultural belief among the rural black population that existed before and during the COVID-19 pandemic. Mmamosheledi et al. [38] reported similar findings on the major role of traditional healers in the healthcare system among black people in South Africa and Cameroon. The present study findings emphasize the need to collectively integrate and utilize the traditional healers into the South African healthcare system as advocated by Mutola, et al. [39].

Although the study had a large sample that presented good results, we acknowledge some limitations. For example, the paper reports vaccine hesitancy of one surveillance area in Capricorn District of Limpopo. The findings cannot be generalized across the whole district's surveillance areas of Limpopo Province and other provinces in South Africa.

5. Conclusions

This is the first study to assess the prevalence of COVID-19 vaccine hesitancy within the DIMAMO HDSS of South Africa. The study found diverse factors of concern associated with vaccination acceptance for COVID-19 among black people living in rural areas of Limpopo Province in South Africa. Overall, 13% of the sample had received a COVID-19 vaccine, and 87% said they had not. COVID-19 vaccine hesitancy is correlated with a low level of education, gender, not being positively diagnosed with COVID-19, religion, visiting traditional healers, vaccine mistrust, unknown side effects, confidence in the vaccine itself, and conspiracy theories among black people living in rural areas. Vaccine hesitancy is more prevalent among less educated and non-Christian black populations. We recommend that health promotion programs strengthen the understanding of community members about the vaccine and its scope. Setting up the health promotion and vaccine awareness campaigns via social media, integrating traditional healers and churches may produce positive results for vaccination campaigns. The study further emphasizes the need to integrate the traditional healers into the western healthcare system.

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Institutional Review Board Statement: Ethical clearance was issued by TREC as described in item 2.6 above.

Informed Consent Statement: Written informed consent for participation was obtained from the participants, and they were provided with an information leaflet about the study. The researcher explained to the participants that their participation was voluntary and that they could withdraw from the study at any time if they wished to do so. The information collected was kept in a secure database to which only selected researchers had access. Participants' identities were not exposed

throughout the preparation or presentation of the research report, and pseudonyms were used for those participants who consented.

Data Availability Statement: Due to confidentiality issues and complying with the funding body requirements, data is not available for sharing to the public.

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

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