ORIGINAL RESEARCH

COVID-19 Vaccine Uptake and Factors Associated Among Pregnant Women in Mogadishu, Somalia

Najib Isse Dirie[1], Maryan Abdullahi Sh Nur [ID][2], Abdirahman Khalif Mohamud [ID][3], Bashiru Garba [ID][4,5], Hassan Abdullahi Dahie[6], Mohamed Hussein Adam[4], Jamal Hassan Mohamoud [ID][4]

[1]Department of Urology, Dr Sumait Hospital, Faculty of Medicine, and Health Sciences, SIMAD University, Mogadishu, Somalia; [2]Department of Obstetrics and Gynecology, Dr Sumait Hospital, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia; [3]Faculty of Medicine, and Health Science, SIMAD University, Mogadishu, Somalia; [4]Department of Public Health, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, Somalia; [5]Department of Veterinary Public Health and Preventive Medicine, Faculty of Veterinary Medicine, Usmanu Danfodiyo University, Sokoto, SK, Nigeria; [6]Nursing and Midwifery Department, Faculty of Medicine and Health Sciences, SIMAD University, Mogadishu, 2526, Somalia

Correspondence: Maryan Abdullahi Sh Nur, Email dr.maryan.abdullahi@gmail.com

Background: Pregnant women exhibit COVID-19 vaccine hesitancy due to concerns regarding potential risks to their babies, doubts about vaccine efficacy, and limited access to information. Therefore, this study aims to estimate COVID-19 vaccine uptake and factors associated with pregnant women in Mogadishu, Somalia.

Methods: A cross-sectional study was conducted on pregnant women using a questionnaire covering socio-demographic information, pregnancy-related characteristics, perceptions about the COVID-19 vaccine, and vaccination status. Univariable and multivariable logistic regression analyses were utilized to identify factors associated with the outcome variable.

Results: Among the 400 pregnant women who participated in this study, 26.8% had received a COVID-19 vaccine dose, with only 14.9% receiving it during pregnancy. Reasons for not receiving the vaccine included a lack of information about the vaccine (47.4%), concerns about its adverse effects on personal health (33.8%), misconceptions regarding impacts on fertility or menstrual cycles (14.3%), belief in the vaccine's inefficacy (3.4%), and fears about adverse effects on their fetus. In multivariable logistic regression, pregnant women with a history of chronic diseases (AOR=3.27, 95% CI=1.992–6.145), those who perceived themselves at risk of contracting COVID-19 (AOR=3.81, 95% CI=2.11–5.10), those who believed that the vaccine was accessible to them (AOR=4.34, 95% CI=2.915–6.165), and those who discussed the COVID-19 vaccine with their healthcare provider (AOR=3.91, 95% CI=2.123–7.878) were more likely to receive the COVID-19 vaccine compared to their counterparts.

Conclusion: Pregnant women in Mogadishu, Somalia, face challenges with sub-optimal covid-19 vaccine uptake. Implementations should improve awareness of COVID-19 risks and facilitate discussions between healthcare providers and pregnant women. In addition, efforts to provide reliable information about the vaccine, alleviate concerns about its adverse effects, and dispel misconceptions about fertility, menstrual cycles, efficacy, and foetal impact are crucial.

Keywords: COVID-19 vaccine uptake, willingness, hesitancy and acceptance, factors associated, pregnant women, Mogadishu, Somalia

Background

The global impact of COVID-19 has been substantial, contributing significantly to both morbidity and mortality among various populations, particularly vulnerable groups.[1] According to the World Health Organization (WHO), as of November 22, 2023, there have been 772 million confirmed cases of COVID-19, resulting in 6 million reported deaths worldwide.[2] In the battle against this pandemic, the development and authorization of COVID-19 vaccines stand as pivotal milestones. These vaccines, authorized for emergency use across the globe, have played a crucial role in curbing the spread of the virus and reducing severity and hospitalizations.[3,4]

Pregnant women face an equivalent likelihood of contracting the infection compared to the general population or non-pregnant individuals. However, it included a high-risk group for COVID-19, and they might experience more severe symptoms and are at a higher risk of hospitalization or admission to intensive care units (ICUs) due to various physiological,

mechanical, and immunologic alterations during pregnancy.[5] COVID-19 infection during pregnancy has been associated with multiple adverse outcomes, including preeclampsia, preterm birth, and stillbirth.[5,6] Hence, both the World Health Organization (WHO) and the Centers for Disease Control (CDC) have recommended administering the COVID-19 vaccine to pregnant, postpartum, and breastfeeding women to mitigate infection risks and improve pregnancy outcomes.[5,6]

Several studies have reported varying vaccine uptake rates among pregnant women, with uptake percentages ranging from 27.5% to 53.46% in different study settings.[5–8] Numerous factors contribute to low COVID-19 vaccine uptake, including higher income and education, concerns about potential harm to the baby, doubts regarding vaccine efficacy, and insufficient information about the vaccine.[5,8–13] Conversely, other studies have identified certain positive predictive factors associated with vaccine uptake among pregnant women, such as having multiple children, being above 40, accessibility to vaccination, and trust in vaccine effectiveness.[14] However, vaccine COVID-19 vaccine hesitancy remains prevalent, especially among pregnant populations in Sub-Saharan African countries. This hesitancy poses a significant risk since vaccines like Moderna or Pfizer-BioNTech, recommended for pregnancy and breastfeeding, face considerable COVID-19 vaccine hesitancy in these regions.[5,14]

In Somalia, a high portion of the population is young individuals, with 38% being females of reproductive age, exhibiting a notably high fertility rate of 6.2 children per woman.[15] In 2022, the prevalence of COVID-19 among pregnant women residing in Mogadishu was recorded at 34%, a figure closely aligned with the 44.8% seroprevalence found in a prior study among the general population in 2021.[16,17] However, despite the absence of documented data on COVID-19 vaccine uptake among the general populace in Somalia, studies among healthcare workers reported vaccine coverage ranging from 20% to 54.3%. This raises questions about the acceptance of vaccines among healthcare workers, prompting speculation on how this situation might translate to pregnant women.[18–20] Hence, this study hypothesizes a low uptake of vaccines among pregnant women, despite the availability of vaccines, as numerous African studies within the same cultural factors reported.[12,21–23] Moreover, investigations into children's vaccine uptake in Somalia have highlighted low rates attributed to maternal misconceptions about vaccines.[24,25]

This study is vital because it identifies COVID-19 vaccine hesitancy rooted in cultural and social factors, ultimately enabling tailored educational campaigns to combat misinformation. In addition, it guides future pandemic preparedness, ensuring more effective and equitable responses to health crises. Moreover, it informs policymakers, aiding resource allocation and policy adjustments to achieve higher coverage. Furthermore, it facilitates proactive containment measures and the protection of vulnerable populations. Finally, sharing uptake information builds trust in public health systems and contributes to global health security by controlling transmission in Somalia and on a global scale. Therefore, this study aims to estimate COVID-19 vaccine uptake and factors associated with pregnant women in Mogadishu, Somalia.

Method
Study Design and Period
An institutional-based cross-sectional study was conducted among pregnant women from September 1 to November 30, 2022.

Study Area
Mogadishu, the capital, and most densely populated city of Somalia houses the healthcare institution selected for this study under the administration of the Somali government. De Martino Hospital, a public general hospital with four main specialities in the eastern part of Mogadishu, provides free services to the community. It was a pivotal centre for managing severe COVID-19 cases during the initial and subsequent waves in Somalia. Presently, it functions as a general hospital catering to the needs of ordinary patients. Given its substantial patient volume and active involvement in the community, De Martino Hospital was an optimal choice for our study.

Study Population and Eligibility Criteria
The study encompassed all pregnant women attending the antenatal care clinic at De Martino Hospital, regardless of age or gestational stage, who provided consent to participate. Exclusions were made for individuals who were mentally unfit, unable to communicate verbally, or had hearing impairments.

Sample Size and Sampling Techniques

A standardized formula for cross-sectional studies was used to determine the required sample size.[26] The formula used was $n = Z^2_{\alpha/2} P(1-P)/d^2$, where $Z^2_{\alpha/2}$ corresponds to 1.96, P represents the estimated proportion of Covid-19 vaccine acceptance obtained from a previous similar study conducted in Cameron,[12] and d denotes the desired precision level of 0.05. Consequently, our study required a total sample size of 361 respondents, including a 10% non-response rate. However, this study recruited a total of 400 participants. A simple random sampling technique was used to select the study participants.

Research Instrument and Quality Control

A well-structured, reliable, and validated questionnaire was developed through an extensive literature review and assessed by three field experts.[1,4,6–8,10–14,18–24] Initially formulated in English, the questionnaire underwent meticulous forward-backwards translations by a language expert to ensure consistency. The Somali version of this tool was utilized for data collection. Content validity was evaluated by three external specialists in Infectious Diseases, Gynecology, and Epidemiology using the Item Objective Congruence (IOC) method.[27] Following this, a pilot study involving 25 participants with similar characteristics was conducted to enhance the questionnaire's reliability and improve respondent comprehension, resulting in a satisfactory Cronbach's Coefficient alpha value of 0.79.

The primary outcome variable was self-reported receipt of COVID-19 vaccines. Respondents reporting receipt of one or more doses were categorized as vaccinated, while those reporting no receipt of any dose were classified as unvaccinated. Those who had not received any dose were further queried about their reasons for not being vaccinated. Participants indicating vaccine receipt were then asked about the number of doses received, the vaccine type, and whether it was administered pre-pregnancy or during pregnancy.[28]

The questionnaire's independent variables encompassed three sections: (i) Socio-demographic characteristics, such as maternal age, marital status, employment status, and maternal and spouse education levels. ii) Pregnancy-related characteristics, including gestational age, Gravidity or parity, history and number of abortions, history of tetanus vaccination, and chronic comorbid diseases. iii) Respondents' perceptions regarding the COVID-19 vaccine, including their beliefs regarding COVID-19 risks, levels of perceived risk, awareness of the availability of COVID-19 vaccines in Somalia, vaccine acceptability, discussions about COVID-19 vaccines with healthcare providers, and the individuals involved in such discussions. iv) Details about the COVID-19 vaccination status, including whether participants received a dose, reasons for non-receipt if applicable, type and number of doses received, and whether it was administered pre-pregnancy or during pregnancy.

Data Collection Procedure

Two licensed medical professionals underwent a one-day training session to enhance their comprehension of the questionnaire's content. Their responsibilities encompassed assessing the eligibility of mothers for study participation, elucidating the study's objectives to eligible participants, and soliciting their involvement. Upon agreement to participate, individuals either signed a consent form or utilized fingerprinting for illiterate participants. Subsequently, the medical professionals conducted face-to-face interviews in a confidential setting after the women received ANC service. Each interview, utilizing the research instrument, lasted approximately 20 minutes per participant.

Data Analysis Procedure

The data underwent a rigorous process involving cleaning, coding, and entry into an Excel spreadsheet, which was then imported into SPSS version 20 (SPSS, Chicago, IL License) for comprehensive analysis. Descriptive statistics was used, and data presented frequencies with percentages due to all variables being categorical variables. Univariable and multivariable logistic regression analyses were used to identify factors associated with outcome variables. Variables displaying a p-value of ≤0.20 in the univariable logistic regression were selected as candidates for inclusion in the multivariable model. Bursac et al[29] highlighted that variables exhibiting a p-value of ≤0.20 in univariate logistic regression might be substantially associated with the final model's outcome, potentially due to confounding variables.

The Hosmer-Lemeshow goodness-of-fit test was utilized to evaluate the final model's goodness of fit.[30] In the multi-variable logistic regression, variables with p-values less than 0.05 were deemed statistically significant.

Results

COVID-19 Vaccine Uptake and Related Chrematistics

A total of 400 pregnant women participated in this study and revealed that 107 (26.8%) reported receiving a COVID-19 vaccine dose, with only 14.9% of them receiving it during pregnancy. Moreover, 76.6% of the participants who received a COVID-19 vaccine reported receiving two doses, while the Oxford-AstraZeneca COVID-19 vaccine was the most common (66.3%) vaccine type received. The reasons for not uptake the COVID-19 vaccine were a lack of information about the vaccine (47.4%), concerns about its adverse effects on personal health (33.8%) and misconceptions regarding impacts on fertility or menstrual cycles (14.3%), belief in the vaccine's inefficacy (3.4%) and feared adverse effects on their fetus (0.7%) (Table 1).

Sociodemographic Characteristics

The majority (80%) of participants belonged to the 20 to 35-year-old age group, with 368 individuals (92%) being married. In addition, 342 pregnant women (85.5%) and 63.7% of their husbands had received informal education. Moreover, 42 individuals (10.5%) were employed (Table 2).

Maternal Characteristics

According to this study's findings, the majority (34.75%) of pregnant women experienced chronic diseases. In addition, 35.3% were multiparous in the third trimester, 7.2% reported that they had a history of 2 or more abortions, and 96.5% had previously received a tetanus toxoid vaccination (Table 3).

The Perception of Respondents Toward the COVID-19 Vaccine

The study findings revealed that 84.2% of the participants did not perceive themselves to be at risk for COVID-19. Additionally, 98.5% of respondents reported being familiar with the COVID-19 vaccine and its availability in Somalia.

Table 1 COVID-19 Vaccine Uptake and Related Chrematistics

Variables	N	%
COVID 19 Vaccine status		
Un vaccinated	293	73.2
Vaccinated	107	26.8
Doses of vaccine received (n= 107)		
1 dose	25	23.4
2 dose	82	76.6
Type of vaccine received (n= 107)		
Oxford-AstraZeneca's COVID-19 vaccine	71	66.3
Johnson & Johnson vaccine	36	33.7
When received the vaccine (n= 107)		
Pre-pregnancy	91	85.1
During pregnancy	16	14.9
Reasons for not uptake the COVID-19 vaccine (n= 293)		
No idea about COVID-19 vaccine	139	47.4
The vaccine harms my health	99	33.8
The Vaccine affects fertility and menstrual cycle	42	14.3
The Vaccine has no efficacy	10	3.4
The Vaccine adversely affected my fetus	2	0.7
Others	1	0.3

Table 2 Socio-Demographic Characteristics of Pregnant Women

Characteristics	Total (%)	COVID-19 Vaccine Uptake		COR (95% CI)	P value
		Vaccinated n (%)	Non-vaccinated n (%)		
Maternal age (Years)					
<20 years	66 (16.5)	19 (17.8)	47 (16)	I	
20 −35 years	320 (80)	82 (76.6)	238 (81.2)	1.17 (0.65–2.11)	0.539
>36 years	14 (3.5)	6 (5.6)	8 (2.7)	0.53 (0.16–1.76)	0.307
Maternal education					
Informal	342(85.5)	84 (78.5)	258 (88.1)	12.28(2.55–58.99)	0.002*
Primary	32 (8)	9 (8.4)	23 (7.8)	10.22 (1.81–57.69)	0.008*
Secondary	16 (4)	6 (5.6)	10 (3.4)	6.67 (1.04–42.43)	0.045*
Post-secondary	10 (2.5)	8 (7.5)	2 (0.7)	I	
Husband education					
Informal	255 (63.7)	56 (52.3)	199 (67.9)	2.83 (1.38–5.84)	0.005*
Primary	20 (5)	5 (4.7)	15 (5.1)	2.40 (0.71–8.02)	0.155
Secondary	89 (22.3)	30 (28)	59 (20.1)	1.57 (0.71–3.46)	0.261
Post-secondary	36 (9)	16 (15)	20 (6.8)	I	
Marital status					
Married	368 (92)	99(92.5)	269 (91.8)	I	
Divorced	32 (8)	8 (7.5)	24 (8.2)	1.10 (0.48–2.53)	0.816
Employment status					
Employed	42 (10.5)	15 (14)	27 (9.2)	I	
Unemployed	358 (89.5)	92 (86)	266 (90.8)	1.60 (0.81–3.15)	0.168

Notes: *Significant level at a *p-value <0.05*.

Table 3 Maternal Characteristics

Characteristics	Total n (%)	COVID-19 Vaccine Uptake		COR (95% CI)	P. value
		Vaccinated n (%)	Non vaccinated n (%)		
Gestational age					
4–13 weeks	88(22)	26(24.3)	62(21.2)	I	
14–26 weeks	127(31.8)	36(33.6)	91(31.3)	1.06 (0.58–1.92)	0.849
27–43 weeks	185(46.3)	45(42.1)	140(47.8)	1.31 (0.73–2.30)	0.359
Gravidity					
≤ 5	224(56)	67(62.6)	157(53.6)	I	
> 5	176(44)	40(37.4)	136(46.4)	1.45 (0.92–2.28)	0.108
Parity					
≤ 5	259(64.8)	74(69.2)	185(63.1)	I	
> 5	141(35.3)	33(30.8)	108(36.9)	1.31 (0.81–2.10)	0.265
Number of abortions					
< 2	371(92.8)	98(91.6)	273(93.2)	I	
≥ 2	29(7.2)	9(8.4)	20(6.8)	0.79 (0.35–1.181)	0.589
TT vaccine status					
Yes	386(96.5)	107(100)	279(95.2)	I	
No	14(3.5)	0(0)	14(4.8)	–	–
Chronic disease					
Yes	139(34.75)	32(58.2)	107(31.0)	3.09(1.729–5.540)	<0.001*
No	261(65.25)	23(41.8)	238(69.0)	I	

Notes: *Significant level at a *p-value <0.05*.

However, 79.7% expressed concerns about the inaccessibility of the COVID-19 vaccine. Moreover, a substantial 88.5% of participants indicated that they had never engaged in discussions regarding vaccines with a healthcare provider (Table 4).

Factors Associated with Covid-19 Vaccination

In the Univariable logistic regression model, nine (9) variables exhibited significant associations with COVID-19 vaccination at a significance level of 0.20. These variables included maternal and husband's education, maternal employment status, gravidity, presence of chronic disease, maternal beliefs regarding that they are at risk of COVID-19, their beliefs about vaccine accessibility, the level of those beliefs, perceptions about vaccine accessibility, and whether they had discussed the vaccine with a healthcare provider. These characteristics were candidates for inclusion in the multivariable logistic regression model. Upon adjustment, four (4) of these variables retained statistical significance, displaying p-values below 0.05 (Table 5).

Pregnant women with a history of chronic diseases were 3.27 times more likely (95% CI=1.992–6.145) to receive the COVID-19 vaccine compared to those without such medical history. Similarly, individuals who perceived themselves at risk of contracting COVID-19 were 3.81 (95% CI=2.11–5.10) times more likely to get vaccinated compared to those who did not perceive such a risk. Furthermore, the likelihood of receiving the COVID-19 vaccine was 4.34 times higher (95% CI=2.915–6.165) among those who believed that the vaccine was accessible to them, in contrast to those who held contrary beliefs. Individuals who reported discussing the COVID-19 vaccine with their healthcare provider were 3.91 times more likely (95% CI=2.123–7.878) to take the vaccine in comparison to those who did not engage in such discussions (Table 5).

Table 4 Perception of COVID-19 Vaccine in Pregnancy

Characteristics	Total n (%)	COVID-19 Vaccine Status		COR (95% CI)	P. value
		Vaccinated n (%)	Unvaccinated		
Do you believe that you are at risk for COVID-19?					
Yes	63 (15.8)	33 (30.8)	30 (10.2)	3.90 (2.24–6.83)	<0.001*
No	337 (84.2)	74 (69.2)	263 (89.8)	1	
If yes, how do you rate it?					
Low	48 (76.2)	22 (66.7)	26 (86.7)	0.30 (0.086–1.104)	0.071
High	15 (23.8)	11 (33.3)	4 (13.3)	1	
Have you ever heard of the COVID-19 vaccine?					
Yes	395 (98.5)	107 (100)	288 (98.3)	-	-
No	5 (1.5)	0 (0.00)	5 (1.7)	-	-
Are you aware that the COVID-19 Vaccine is available in Somalia?					
Yes	395 (98.5)	106 (99.1)	289 (98.6)	1.60 (0.234–10.91)	0.633
No	5 (1.5)	1 (0.90)	4 (1.4)	1	
Is COVID-19 Vaccine accessible to you?					
Yes	81 (20.3)	42 (39.3)	39 (13.3)	4.21 (2.571–7.036)	<0.001*
No	319 (79.7)	65 (60.7)	254 (86.7)	1	
Ever discussed the issue of vaccines with a healthcare provider?					
Yes	46 (11.5)	26 (24.3)	20 (6.8)	4.38 (2.325–8.256)	<0.001*
No	354 (88.5)	81 (75.7)	273 (93.2)	1	

Notes: *Significant level at a *p-value <0.05*.

Table 5 Factors Associated with Covid-19 Vaccination

Characteristics	AOR (95% CI)	P value
Chronic disease		
Yes	3.27 (1.992–6.145)	0.002*
No	1	
Do you believe that you are at risk for COVID-19?		
Yes	3.81 (2.11–5.10)	0.002*
No	1	
Is COVID-19 Vaccine accessible to you?		
Yes	4.34 (2.915–6.165)	0.001*
No	1	
Have you ever discussed the issue of vaccines with a healthcare provider?		
Yes	3.91 (2.123–7.878)	0.001*
No	1	

Notes: *Significant level at a *p-value <0.05*.

Discussion

Out of 400 pregnant women who participated in this study, only a slidably greater than a quarter reported receiving at least one dose of the COVID-19 vaccine, with only 14.9% receiving it during pregnancy. In the battle against this pandemic, the development and authorization of COVID-19 vaccines stand as pivotal milestones. These vaccines, authorized for emergency use across the globe, have played a crucial role in curbing the spread of the virus and reducing severity and hospitalizations.[3,4]

A similar study in Sub-Saharan African countries reported a low COVID-19 vaccine uptake, and this might explain several factors including limited access to vaccines, infrastructure deficiencies, including inadequate storage facilities and healthcare resources, COVID-19 hesitancy driven by misinformation, distrust in healthcare systems, and socioeconomic factors that might contribute lower vaccination rates.[23] Pregnant women in this region have low knowledge and awareness about COVID-19 and its vaccine, leading to COVID-19 hesitancy and concerns about vaccine safety and quality.[31,32] In addition, mistrust of the healthcare system has also contributed to the low acceptance of vaccines among pregnant women.[33] However, targeted strategies are needed to improve vaccine confidence among pregnant women in Somalia.

This study revealed that nearly half of the unvaccinated pregnant women lacked sufficient information about the COVID-19 vaccine. About one-third expressed concerns about potential adverse effects on their health, while 14.3% reported misconceptions about impacts on fertility or menstrual cycles as reasons for not accepting the vaccine. Family or husband pressure, common in this area, might contribute to these false beliefs and vaccine refusal. Previous studies have highlighted doubts about the effectiveness of various vaccine types due to inadequate research on their effects during pregnancy.[21,34–36] An Indian study also supported this, indicating that many pregnant women fear the vaccine could harm their babies.[37] This study reiterates the importance of addressing misinformation, increasing awareness, and providing accurate information about the vaccine's safety profile for pregnant women. These efforts are crucial in encouraging vaccine uptake within this demographic.

This study reported pregnant women with a history of chronic diseases were three times more likely to receive the COVID-19 vaccine compared to those without such medical history. This might explain why healthcare providers often recommend vaccination to individuals with chronic diseases due to their increased susceptibility to severe illness this might influence the decision-making process and contribute to higher vaccine uptake among this population. In addition, during the vaccine rollout phases, the study country prioritized individuals with chronic diseases or underlying health conditions in the early stages of vaccination campaigns, which could lead to higher vaccination rates among this population. A Study has shown that pregnant women with chronic autoimmune disease can safely receive the COVID-19 vaccine without exacerbation of their disease.[38] In addition, a study investigating vaccine willingness among chronic disease patients reported a high vaccine willingness and acceptance reasoned their beliefs that they are

a high-risk group.[39] Moreover, similar studies investigating chronic and non-chronic diseases in the study area reported good knowledge and awareness toward vaccines.[40–43] However, while many individuals with chronic diseases have a higher vaccine uptake, efforts to address concerns, provide accurate information, and improve access to vaccination remain crucial to ensure broader immunization coverage within this population.

This study revealed that individuals who perceived themselves at risk of contracting COVID-19 were more likely to get vaccinated than those who did not perceive such a risk. In general, factors such as the perceived susceptibility to the virus based on age, health status, or living conditions, alongside access to reliable information and education about the severity of COVID-19 and vaccine effectiveness. Moreover, in the study area, social influences, including family opinions and trust in healthcare authorities, strongly shape risk perceptions and subsequent vaccination decisions. In addition, personal exposure to COVID-19 or exposure to their loved ones can heighten perceived risk, encouraging vaccination. A similar study supported and reported pregnant women who were aware of disease severity and benefits of vaccination and had a supportive environment were more willing to receive the vaccine.[44] A higher perception of personal risk tends to lead individuals to seek vaccination as a preventive measure against COVID-19, coupled with behavioral changes and adopting other protective measures. Gunkaya OS et al l[44] reported that healthcare professionals played a crucial role in providing information and influencing the vaccination choice of pregnant women since this study found individuals who discussed healthcare provider about the COVID-19 vaccine were more likely to take the vaccine in comparison, to those who did not engage in such discussions.

Finally, the likelihood of receiving the COVID-19 vaccine in this study was higher among those who believed it was accessible to them, in contrast to those who held contrary beliefs. Accessible locations, easy appointment scheduling, and widespread availability can encourage more people to vaccinate. In addition, accessible information about the vaccine's safety, benefits, cost, and transportation can influence people's perceptions and play a pivotal role in accessibility. If the vaccine is free or affordable, available at convenient locations, and does not pose logistical hurdles, more individuals are likely to get vaccinated.

A previous study reported that after receiving a tele-educational program about COVID-19 vaccination, women planning for pregnancy and breastfeeding mothers reported significantly higher vaccination rates and lower COVID-19 hesitancy compared to the control group.[45–48] Numerous vaccines, including the HBV vaccine, have faced hesitancy in the study area, largely due to prolonged conflicts and a lack of knowledge about the vaccine and its importance. This issue is particularly pronounced among individuals living with chronic diseases, such as hypertension.[49–52] However, by increasing community awareness and delivering comprehensive medical education, especially through digital health tools effective solutions can be developed to enhance vaccine knowledge within the community.[53,54]

Limitations of the Study

While this study has notable strengths, such as being the first of its kind in the study area, it is important to recognize its limitations. As a cross-sectional design, it is unable to establish causal relationships between the factors examined and the outcomes observed.

Conclusion

Pregnant women in Mogadishu, Somalia, face challenges with sub-optimal COVID-19 vaccine uptake due to several reasons, including limited information about the vaccine, concerns about potential adverse effects on personal health, misconceptions surrounding its impact on fertility or menstrual cycles, doubts about its efficacy, and fears regarding its effects on the fetus. To address these and enhance vaccine uptake, targeted implementations should focus on improving awareness of COVID-19 risks and facilitating discussions between healthcare providers and pregnant women covering the vaccine's safety for pregnant women and their embryos. In addition, efforts to provide reliable information about the vaccine, alleviate concerns about its adverse effects, and dispel misconceptions about fertility, menstrual cycles, efficacy, and foetal impact are crucial.

Abbreviations

COVID-19: Coronavirus Disease 2019, ANC: Antenatal Care, WHO: World Health Organization, CDC: Centers for Disease Control and Prevention, ICUs: Intensive Care Units.

Data Sharing Statement

All datasets produced and scrutinized during this study are comprehensively presented in this article.

Ethics Approval

This study followed the rules of the World Medical Association Declaration of Helsinki. Ethical approval for this research was granted by the Ethical Committee on Human Research at SIMAD University in Mogadishu, Somalia, operating under Protocol Number (2022/SU-IRB/FMHS/P005). Before data collection, authorization was obtained from the medical director of De Martino Hospital. All eligible participants were briefed on the study's objectives and invited to participate. In cases where the participant is illiterate or is under 18, legally authorized representatives or parents provided informed consent, whereas literate individuals signed consent forms. Participants were duly informed of their freedom to participate or withdraw from the interview without facing any consequences. The questionnaires ensured anonymity, and data were presented in aggregated form without any individual-specific details.

Publication Consent

All authors affirm they do not require publication consent. Participant publication consent was not applicable in this study.

Acknowledgment

The authors express gratitude to the healthcare professionals at the study hospital and the participants for their collaboration and for furnishing essential information.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

Disclosure

The authors report no conflicts of interest in this work.

References

1. Ghamri RA, Othman SS, Alhiniah MH, Alelyani RH, Badawi AM, Alshahrani AA. Acceptance of COVID-19 vaccine and associated factors among pregnant women in Saudi Arabia. *Pat Prefer Adher*. 2022;Volume 16:861–873. doi:10.2147/PPA.S357653
2. World Health Organization. Global Situation of coronavirus (COVID-19) - Morbidity and Mortality. Available from: https://covid19.who.int/.2023. Accessed August 28, 2024.
3. Baden LR, El Sahly HM, Essink B, et al. Efficacy and safety of the mRNA-1273 SARS-CoV-2 vaccine. *N Engl J Med*. 2021;384(5):403–416. doi:10.1056/NEJMoa2035389
4. Greenwood B. The contribution of vaccination to global health: past, present and future. *Philos Trans R Soc B*. 2014;369(1645):20130433. doi:10.1098/rstb.2013.0433
5. Wastnedge EA, Reynolds RM, Van Boeckel SR, et al. Pregnancy and COVID-19. *Physiol Rev*. 2020.

6. Mohamud AK, Inchon P, Suwannaporn S, Prasert K, Dirie NI. Assessment of prevalence and risk factors associated with Hepatitis B virus infection among blood donors in Mogadishu Somalia. *BMC Public Health*. 2024;24(1):690. doi:10.1186/s12889-024-18136-2

7. Wenling Y, Junchao Q, Xiao Z, Ouyang S. Pregnancy and COVID-19: management and challenges. *Rev Inst Med Trop São Paulo*. 2020;62. doi:10.1590/s1678-9946202062062

8. Badell ML, Dude CM, Rasmussen SA, Jamieson DJ. Covid-19 vaccination in pregnancy. *BMJ*. 2022;378. doi:10.1136/bmj-2021-069741

9. World Health Organization (WHO). Update on Interim recommendations on COVID-19 vaccination of pregnant and lactating women. 2021. Available from: https://www.who.int/groups/strategic-advisory-group-of-experts-on-immunization. Accessed August 28, 2024.

10. Bhattacharya O, Siddiquea BN, Shetty A, Afroz A, Billah B. COVID-19 vaccine hesitancy among pregnant women: a systematic review and meta-analysis. *BMJ open*. 2022;12(8):e061477. doi:10.1136/bmjopen-2022-061477

11. Rikard-Bell M, Elhindi J, Lam J, et al. COVID-19 vaccine acceptance among pregnant women and the reasons for hesitancy: a multi-centre cross-sectional survey. *Aust N Z J Obstetrics Gynaecol*. 2023;63(3):335–343. doi:10.1111/ajo.13622

12. Gunawardhana N, Baecher K, Boutwell A, et al. COVID-19 vaccine acceptance and perceived risk among pregnant and non-pregnant adults in Cameroon, Africa. *PLoS One*. 2022;17(9):e0274541.

13. Bianchi FP, Stefanizzi P, Di Gioia MC, Brescia N, Lattanzio S, Tafuri S. COVID-19 vaccination hesitancy in pregnant and breastfeeding women and strategies to increase vaccination compliance: a systematic review and meta-analysis. *Exp Rev Vacc*. 2022;21(10):1443–1454. doi:10.1080/14760584.2022.2100766

14. Toure AA, Traore FA, Camara G, et al. Facilitators and barriers to COVID-19 vaccination among healthcare workers and the general population in Guinea. *BMC Infect Dis*. 2022;22(1):1–8. doi:10.1186/s12879-022-07742-3

15. United Nation Population Fund (UNFPA), The Somali Health and Demographic Survey, 2020, Available from: https://somalia.unfpa.org/en/publications/somali-health-and-demographic-survey-2020. Accessed August 28, 2024.

16. Nur MA, Dahie HA, Hassan NA, et al. Seroprevalence of SARS-CoV-2 virus antibodies and sociodemographic features of pregnant women in Mogadishu, Somalia: a cross-sectional survey study. *BMJ open*. 2022;12(6):e059617. doi:10.1136/bmjopen-2021-059617

17. Adam MH, Mohamoud JH, Mohamood AS, Mohamed AA, Garba B, Dirie NI. Seroprevalence of anti-SARS-CoV-2 antibodies in Benadir region, Somalia. *Vaccines*. 2022;10(2):220. doi:10.3390/vaccines10020220

18. Mohamed SA, Odongo AO, Kariuki JG. Determinants of COVID-19 Vaccine Uptake among Health Care Workers: a Case Study of Mogadishu City, Somalia. *Asian J Med Health*. 2023;21(7):17–27. doi:10.9734/ajmah/2023/v21i7824

19. Dahie HA, Mohamoud JH, Adam MH, et al. COVID-19 vaccine coverage and potential drivers of vaccine uptake among healthcare workers in Somalia: a cross-sectional study. *Vaccines*. 2022;10(7):1116. doi:10.3390/vaccines10071116

20. Ibrahim AM, Hamayoun M, Farid M, et al. COVID-19 Vaccine Acceptance and Hesitancy in Health Care Workers in Somalia: findings from a Fragile Country with No Previous Experience of Mass Adult Immunization. *Vaccines*. 2023;11(4):858. doi:10.3390/vaccines11040858

21. Chionuma JO, Kuku-Kuye TO, Olalere FH, Olumodeji AM. *COVID-19 Vaccine Acceptance and Hesitance among Pregnant Women and Nursing Mothers in Nigeria*. 2023.

22. Worede DT, Kassahun M, Endalew B. COVID-19 vaccine acceptance and predictors among pregnant women in Ethiopia: systematic Review and Meta-Analysis. *Public Health Pract*. 2023;5:100386. doi:10.1016/j.puhip.2023.100386

23. Ayieko S, Baker K, Messiah SE, Lewis B, Markham C. Determinants of COVID-19 Vaccination Decision-Making Behaviors among Pregnant Women in Sub-Saharan Africa: a Scoping Review. *Vaccines*. 2023;11(7):1233. doi:10.3390/vaccines11071233

24. Jelle M, Seal AJ, Mohamed H, et al. Understanding multilevel barriers to childhood vaccination uptake among Internally Displaced Populations (IDPs) in Mogadishu, Somalia: a qualitative study. *BMC Public Health*. 2023;23(1):2018. doi:10.1186/s12889-023-16153-1

25. Mohamud AK, Ahmed OA, Ali IA, Dirie NI. Demographical, clinical, and complication differences between vaccinated and unvaccinated hospitalized children with measles in Mogadishu Somalia: a hospital-based retrospective cohort study. *Ann Med Surg*. 2023;85(5):1550. doi:10.1097/MS9.0000000000000672

26. Charan J, Biswas T. How to calculate sample size for different study designs in medical research? *Ind J Psychol Med*. 2013;35(2):121–126. doi:10.4103/0253-7176.116232

27. Turner RC, Carlson L. Indexes of item-objective congruence for multidimensional items. *Int J Test*. 2003;3(2):163–171. doi:10.1207/S15327574IJT0302_5

28. Regan AK, Kaur R, Nosek M, Swathi PA, Gu NY. COVID-19 vaccine acceptance and coverage among pregnant persons in the United States. *Prevent Med Rep*. 2022;29:101977. doi:10.1016/j.pmedr.2022.101977

29. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. *Source Code Biol Med*. 2008;3(1):1–8. doi:10.1186/1751-0473-3-17

30. Hosmer DW, Lemeshow S, Sturdivant RX. *Applied Logistic Regression*. John Wiley & Sons; 2013.

31. Nalubega P, Namugumya R, Zalwango F, et al. COVID-19 disease and vaccination in pregnancy: understanding knowledge, perceptions and experiences among pregnant women and community leaders in Uganda. *Trans Royal Soc Trop Med Hygiene*. 2023;2023:trad028.

32. Amiebenomo OM, Osuagwu UL, Envuladu EA, et al. Acceptance and Risk Perception of COVID-19 Vaccination among Pregnant and Non Pregnant Women in Sub-Saharan Africa: a Cross-Sectional Matched-Sample Study. *Vaccines*. 2023;11(2):484. doi:10.3390/vaccines11020484

33. Chekol Abebe E, Ayalew Tiruneh G, Asmare Adela G, et al. COVID-19 vaccine uptake and associated factors among pregnant women attending antenatal care in Debre Tabor public health institutions: a cross-sectional study. *Front Public Health*. 2022;10:919494. doi:10.3389/fpubh.2022.919494

34. Butt S, Setlani P, Iftikhar M, et al. Determinants of Covid vaccine uptake and perinatal outcome in pregnant women at a tertiary care center. *J Pak Med Assoc*. 2023;73(6):1212–1216. doi:10.47391/JPMA.6593

35. Mohamud AK, Ali IA, Ali AI, et al. Assessment of healthcare workers' knowledge and attitude on Ebola virus disease in Somalia: a multicenter nationwide survey. *BMC Public Health*. 2023;23(1):1650. doi:10.1186/s12889-023-16562-2

36. Samaria D, Puspaningrum N. MOTIVATION AND HESITANCY TOWARDS THE COVID-19 VACCINE IN EXPECTING MOTHERS. *J Riset Kesehatan*. 2023;12(1):41–49. doi:10.31983/jrk.v12i1.9565

37. Khan S, Sohan K, Mohammed ZC, Bachan V. COVID-19 vaccine uptake, acceptance, and reasons for vaccine hesitancy: a cross-sectional study among pregnant women in Trinidad, West Indies. *Int J Women's Health*. 2023;15:343–354. doi:10.2147/IJWH.S396884

38. Giannopoulou N, Gupta L, Andreoli L, et al. COVAD Study Group. COVID-19 vaccine safety during pregnancy in women with systemic lupus erythematosus. *Autoimmunity Rev.* 2023;3(4):103292. doi:10.1016/j.autrev.2023.103292

39. Wang J, Yuan B, Lu X, et al. Willingness to accept COVID-19 vaccine among the elderly and the chronic disease population in China. *Hum Vaccines Immunother.* 2021;17(12):4873–4888. doi:10.1080/21645515.2021.2009290

40. Mohamud AK, Ahmed OA, Mohamud AA, Dirie NI. Prevalence of and factors associated with depression among adult patients living with HIV/AIDs undergoing ART unit in Banadir hospital, Mogadishu Somalia. *BMC Psychiat.* 2023;23(1):1–8. doi:10.1186/s12888-023-04723-x

41. Dirie NI, Adam MH, Garba B, et al. The prevalence of urolithiasis in subjects undergoing computer tomography in selected referral diagnostic centers in Mogadishu, Somalia. *Front Public Health.* 2023;11:1.

42. Mohamud AK, Mohamud BI. *Knowledge, Attitude, and Practice of Pregnant Women Toward Intermittent Preventive Treatment During Pregnancy in Selected Medical Centers in Banadir Region, Mogadishu Somalia; A Cross-Sectional Study,* 2022

43. Mohamud AK, Ahmed OA, Mohamud AA, Dirie NI. Magnitude of opportunistic infections and associated factors among adult people living with human immune deficient virus on art at selected public hospital, Mogadishu Somalia: cross-sectional study. *Ann Med Surg.* 2023;85(7):3364–3371. doi:10.1097/MS9.0000000000000880

44. Mohamud AK, Inchon P, Suwannaporn S, Prasert K. *Associations Between Knowledge, Attitudes, and Practices Regarding Hepatitis B Virus Infection and HBV Infection Among Blood Donors in Mogadishu, Somalia: A Hospital-Based Cross-Sectional Study.* 2024.

45. Phelps A, Sparks PL, de la Haye K, Young LE. Perceptions of social circle vaccine acceptance and COVID-19 vaccine initiation among postpriority vaccine eligible adults. *Health Psychol.* 2023;42(4):276–284. doi:10.1037/hea0001287

46. Soleimanpour H, Sarbazi E, Esmaeili ED, et al. Predictors of receiving COVID-19 vaccine among adult population in Iran: an observational study. *BMC Public Health.* 2023;23(1):490. doi:10.1186/s12889-023-15409-0

47. Ali AI, Aden AI, Mohamud AK. Dermoscopic findings in Tinea Capitis among under 18 children in dermatology polyclinic patients: a hospital-based cross-sectional study. *Ann Med Surg.* 2023;2023:10–97.

48. Ver AT, Notarte KI, Velasco JV, et al. A systematic review of the barriers to implementing human papillomavirus vaccination programs in low-and middle-income countries in the Asia-Pacific. *Asia-Pacific J Clin Oncol.* 2021;17(6):530–545. doi:10.1111/ajco.13513

49. Mohamud AK, Inchon P, Suwannaporn S, Prasert K, Dirie NI. *What are the risk factors associated with Hepatitis B Virus infection in Somalia?,* 2024.

50. Mohamud MF, Turfan S, Mohamed HH, et al. Exploring the prevalence, clinical spectrum, and determinants of uncontrolled hypertension in the emergency department: insights from a hospital-based study in Somalia. *Curr Prob Cardiol.* 2024;49(7):102589. doi:10.1016/j.cpcardiol.2024.102589

51. Hassan YS, Hassan SA, Ahmed NR. Uptake of hepatitis B vaccination and associated factors among health sciences students, Mogadishu, Somalia. *Front Public Health.* 2023;11:1203519. doi:10.3389/fpubh.2023.1203519

52. Ahmed MM, Asowe HA, Dirie NI, et al. The Nexus of Climate Change, Food Insecurity, and Conflict in Somalia: a Comprehensive Analysis of Multifaceted Challenges and Resilience Strategies. *F1000Res.* 2024;13:913. doi:10.12688/f1000research.154400.1

53. Hassan MM, Ali AN, Ali I, et al. *Somalia's Medical Education and Regulation: A Review of the Health Regulatory Landscape;* 2024.

54. Ahmed MM, Dirie NI, Mohamud AK, et al. Advancing digital healthcare in Somalia: a review of modern technologies and their implications. *BMC Digital Health.* 2024;2(1):49. doi:10.1186/s44247-024-00111-x