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COVID-19 vaccine barriers and perception among rural adults: A qualitative study in Bangladesh

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Abstract

Objective COVID-19 pandemic continues to pose challenges for global public healthcare, even with the authorization of several vaccines worldwide. To better understand rural communities' knowledge, attitudes, perceptions, and barriers towards these vaccines, we conducted a qualitative cross-sectional study with adults in rural Bangladesh.

Setting Rural areas of Sylhet and Natore in Bangladesh.

Participants Our study involved 15 in-depth interviews with rural adults and 2 key informant interviews with health workers.

Results We analysed data thematically, resulting in four main themes: (1) knowledge and perception aspects, (2) myths and misconceptions, (3) practice and attitude, and (4) barriers and challenges of COVID-19 vaccines.

Conclusions The findings indicate that rural populations lack sufficient knowledge about COVID-19 vaccines, but they have a more favourable attitude towards them. Misconceptions, beliefs, and personal experiences were found to be the main reasons for vaccine avoidance. To address these challenges and dispel the spread of misinformation, health education programs play a pivotal role in improving vaccine management. Policymakers should initiate these programs without delay to create a well-informed and enlightened community, given that the coronavirus is still spreading.

Keywords: COVID-19 vaccine, perception, barrier, rural, Bangladesh

Strengths and limitations of this study

- The study sheds light on people's perspectives and attitudes towards the COVID-19 vaccine.
- The implementing institution's competence and trust facilitate the acceptance of administering investigational products of COVID-19 clinical research to participants.
- The researchers had to go to various households to locate potential participants, the study may have been subject to selection bias, which could limit the generalizability of the findings.
- Since the study was conducted at a specific time, its findings may only be relevant for that period, and further research is needed to explore the long-term effects.

Introduction

The emergence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), a novel strain, has transformed COVID-19 into a critical global public health issue. This virus continues to be present in many countries worldwide, posing a significant threat to human health (1). As per the latest figures released by the World Health Organization (WHO), there have been a staggering 760,897,555 reported cases of COVID-19 globally, which have resulted in the unfortunate loss of 6,874,585 lives (2). Bangladesh is at much greater risk since it has the highest population density in the world, making concepts like "social separation" impossible to implement (3). As a result, it reported 2,037,024 positive cases and 29,439 domestic deaths as of December 30, 2022 (4). Since SARS-CoV-2 is a highly contagious virus that affects people worldwide, vaccination is the most effective method of protecting the population from COVID-19 (5-7). Although vaccines may not be 100% effective, high coverage in a community can significantly improve disease control (8). Five key factors—access, affordability, awareness, activation, and acceptance are crucial in ensuring maximum coverage (9).

In clinical trials, COVID-19 vaccine candidates have shown effective rates of up to 95% in preventing symptomatic infections (10). Based on research findings, it is believed that vaccinating approximately 82% of a nation's population may be necessary to attain herd immunity against SARS-CoV-2. However, the emergence of new virus variants may require individuals to receive multiple vaccinations (11, 12). In the current context, vaccine hesitancy, which ranges from vaccination approval to denial, has emerged as the most critical public health concern. Despite the availability of vaccination services, it refers to delays in acceptance or refusal of immunizations (13). There are several factors that contribute to vaccine hesitancy, such as apprehensions regarding vaccine safety and efficacy, potential adverse health effects, misunderstandings surrounding the value of vaccination, a lack of trust in the healthcare system, and insufficient community education regarding vaccine-preventable illnesses (14). Acceptance of COVID-19 vaccines varies greatly among different nations and regions of the world (9, 15, 16). Public mistrust and resistance to vaccination could impede the success of the COVID-19 vaccination campaign (17, 18).

Herd immunity and the ease of vaccination are likely to be impacted by people's knowledge of COVID-19 vaccines, level of acceptability, and perception of immunization concerns. However, currently, there needs to be more prior research on this subject. Therefore, this study aimed to assess Bangladeshi rural adults' opinions on vaccination and their comprehension and acceptance of COVID-19 vaccines.

Methods

Study area

The study was conducted in two rural areas of Bangladesh. We conducted in-depth interviews with a total of fifteen participants and also conducted two key informant interviews (KII) with government officials who were involved in dealing with COVID-19 vaccination activities.

Data collection

Through conducting in-depth interviews with individuals who have either not received the COVID-19 vaccine or have dropped the second dose, we aimed to capture the depth and uniqueness of their experiences and perceptions regarding vaccination. This paper presents the results of our in-depth interviews with a purposively selected group of participants (n=15), as well as two key informant interviews with nurses and vaccine administration personnel. We conducted this cross-sectional survey between August 2021 to February 2022. The interviews were conducted in private, with no other individuals present, and guided by pre-tested data collection guidelines that were flexible enough to accommodate any additional feedback. The interviews were digitally recorded, transcribed into Bangla, and then translated into English. To ensure the accuracy and quality of our work, we performed spot checks of the recordings and transcriptions, which were conducted by an anthropologist who is fluent in both Bangla and English. We also used data from an end-of-project survey (n=15) where appropriate to complement the qualitative findings.

Thematic area

To structure and organize our findings, we utilized this index as a framework to analyse post-programmatic data. Additionally, we have meticulously coded the qualitative data using the following four indicators:

1. Knowledge and perception aspects
2. Myths and misconceptions
3. Practice and attitude
4. Barriers and challenges

Data Analysis

We transcribed the audio-recorded interviews conducted in Bangla using MS Word files. These transcripts were translated by a research assistant and carefully reviewed for accuracy by the last author. To conduct a thematic analysis, we used Bernard's framework (19), wherein themes were identified from the data and categorized under various key domains. Initially, we developed a pre-existing codebook based on the interview guidelines, which was then manually coded for one interview by the first author. This was then reviewed and verified by an experienced qualitative researcher (the last author). The first author then manually coded all interviews while maintaining flexibility in incorporating any additional themes relevant to the study's objectives, thereby implementing both deductive and inductive coding while ensuring inter-coder reliability. Following this, thematic codes were categorized and, subsequently, grouped under four themes. Finally, the text pertaining to the five indicators was compiled into separate files.

Results

Demographic characteristics of the participants

A total of fifteen participants (nine males and six females) from two districts were interviewed. Four of the men and women were aged 16-25 years; two men and one woman were aged 25-36 years, with the other three 25-34 years. Among them, three of the men had no education (can sign names only) and three of them completed primary education; five of the women completed up to secondary education; and the rest of the men and women completed higher secondary education and graduation.

All of the participants were working in unskilled labor (such as day laborers, rickshaw or van pullers, drivers, and farmers). The average household income ranged from 9000 to 15000 (BDT). The maximum number of households was 5 to 10 members, and the rest had 2 to 4 members. The socio-demographic characteristics of the interviewees who participated in the IDIs are shown in Table 1.

Table 1 Participant and household characteristics

Indicators	**Male**	**Female**
Age range		
16-25 years	4	4
25-30 years	2	1
30-40 years	3	1
Occupations		
Daily labour/Mason	2	
Rickshaw/Van puller	3	
Driver	1	
Shopkeeper	1	
Farmer	2	
Housewife		6
Education		
Can signature only (own name)	3	
Primary	3	
Secondary	1	4
Higher secondary	1	2
Graduation	1	
Income		
5000-8000	1	
8000-15000	5	2
Above 15000	3	4
Family members		
2 to 4 members	3	2
4 to 10 members	6	4

Themes emerged

Upon analysis of the semi-structured in-depth and key informant interviews, four main themes emerged: knowledge and perception aspects, myths and misconceptions, practice and attitude, and barriers and challenges of COVID-19 vaccines.

Knowledge and perception aspects

All of the participants stated that they first learned about COVID-19, a highly contagious and life-threatening illness, through television, their neighbors, and social media. Regarding symptoms, most participants believed that the main indicators of COVID are fever, coughing, and a runny nose, with a few mentioning that shortness of breath is also a symptom. Additionally, some participants stated that the virus could spread through breathing, touching, and sneezing. Poor hygiene practices, such as not washing hands with soap, can make an individual more susceptible to contracting the disease. To prevent the spread of COVID, participants emphasized the importance of isolation, using separate utensils for eating, and maintaining social distance. One of the participants stated that receiving this immunization will prevent future occurrences of the condition. Through the mass media, they also learned about the numerous deaths caused by this contagion that have occurred worldwide. A respondent mentioned that,

> *"This illness is easily spreadable. Sneezing and physical activity can exacerbate its transmission. Nevertheless, adhering to recommended precautions like wearing a mask and practicing social distance can protect you from contracting the disease".*

The majority of the participants had a positive view regarding the COVID vaccine. They expressed trust in the vaccines' quality and believed that getting vaccinated reduces the risk of death and enables them to venture outside more freely. Additionally, they perceived that the vaccine protects against getting infected by others. Although the majority of the community had positive perceptions about the vaccine, most of them lacked information about its various types, administration methods, and frequency. All the study participants believed that pregnant women were not eligible to receive the vaccine.

> *"COVID-19 vaccine may have serious consequences for pregnant women. Hence, it is not recommended for them to receive it. I personally think that pregnant women should avoid getting the vaccine".*

Amidst the discussions, certain individuals brought up the topic of antibodies. They were unaware of the word and mistakenly referred them as antibiotics. A respondent mentioned:

> *"COVID-19 is a devastating illness, and our government has taken proactive measures to ensure the protection of our citizens by implementing a nationwide vaccination program. The vaccines work by generating antibiotics (antibodies) to combat the virus and keep people safe".*

A respondent also stated that the fate of a person's health and survival from this disease is ultimately determined by the Creator, regardless of whether or not they receive vaccinations. He believed that a person would not fall ill if he adhered to his religious principles.

Myths and misconceptions

It is common for misinformation and false beliefs about health and medical issues to spread in communities, particularly in rural areas where access to accurate information may be limited (20). All participants discussed side effects when the vaccination programme first started. They identified elderly people above the age of 60 as high-risk, which was the most frequently given response. Additionally, some participants reported that children have a high risk of getting infections.

> *"Elderly people with respiratory problems faced even more problems after taking the vaccine. Their immune systems weakened, leading to additional problems and, in some cases, death. I have seen or heard about these events on TV or from others".*

Some people's assumptions made the vaccination process difficult. There was also a common misconception that one dose of the vaccine would protect against the virus and there would be no need for additional doses. Some participants confidently shared information that was not accurate or held conspiracy theories about the COVID-19 vaccines. For example, one participant said about COVID-19 vaccines,

> *"Injections (vaccines) are sometimes given to reduce the number of dogs. However, many people have not yet received the COVID-19 vaccine due to concerns about potential side effects in humans."*

Practice and attitude

The majority of participants believed that the COVID-19 vaccine was safe to use, with the President and Ministers promoting it as a means to prevent the spread of the disease. Participants considered both personal and communal factors when deciding their stance toward vaccination.

> *"Though many people die even if they are vaccinated. Vaccination is necessary for us now because the disease is becoming deadly. To keep ourselves and others safe, we must get the corona vaccination".*

Some participants reported feeling a positive change in their social status after getting vaccinated as they received the vaccine initially. However, many were uncertain about getting vaccinated due to a lack of information. One participant preferred a specific vaccine brand, while others were willing to receive any vaccine that was available or offered to them.

When the vaccine program was initially launched, people were filled with fear and uncertainty. Many wanted to receive the vaccine but hesitated and waited for others to take it before deciding. This approach is not recommended, as each individual's health condition should be taken into consideration before getting vaccinated. One participant stated,

> *"When the vaccination programme was first started, some people thought they should observe the situation before deciding. With such conflicting thoughts in mind, many wanted to wait".*

Some participants reported symptoms of COVID-19 but were afraid to get tested due to the inconvenience of the testing facility being far from their homes and the risk of losing their job if they tested positive.

Barriers and challenges

An online registration system is required to receive the vaccine. Study participants reported receiving delayed SMS, and many did not see the SMS on their mobiles, causing a major problem with vaccine discontinuation. Some participants reported receiving their first dose of vaccine through the mass immunization program, but were not provided with vaccine registration cards for further doses, nor were their phone numbers collected for enrollment on the website. Even when they went to the center on the scheduled date, they could not receive their second dose of vaccine without their registration card and SMS. Findings also revealed that missing vaccine cards and a lack of knowledge about reprinting the cards are reported barriers to getting the vaccine. Most of the participants had lost their vaccine cards, so they were unable to receive the vaccine. Participants emphasized the importance of equitable vaccine distribution in their communities and preferred local sites to mass vaccination sites with long lines and crowds. One female participant said,

> *"I didn't notice the text reminder for the second dose of the vaccine. When I saw it, I went to the vaccination center at the Union Parishad, but the guard in charge told me that the vaccine was not available there. He told me to go to another vaccination center, but I didn't go there".*

Another participant stated,

> *"I received my first dose during the mass vaccination program, but when I went to the vaccine centre for my second dose, the authorities told me that they couldn't give me the vaccine without any documents like a vaccine card or SMS. However, they did not give me a card the first time".*

Dual-dose vaccine schedules were seen as an additional burden for individuals and families, as they needed to move frequently to support themselves. One participant stated,

> *"We leave our family behind and work in Dhaka. As poor people, we work ten days here today, twenty days in another area, and five days in another place. This means that I live in different regions at different times, so I could not get vaccinated. But I know this vaccination is necessary for us".*

Some women hesitated to get vaccinated due to concerns about social norms and religious veil traditions. They believe that being vaccinated by a male nurse goes against these beliefs. A male respondent mentioned:

> *"As a Muslim, I believe that female nurses should vaccinate women, as it is easier for women to maintain their veil with their hands open during the immunization process. This has resulted in many women skipping their vaccinations".*

Health workers often face challenges while administering vaccines, including a frequent shortage of staff, which leads to an increased workload.

Discussion

The purpose of this study was to delve into the perceptions and barriers regarding the COVID-19 vaccine among slum dwellers residing in rural areas of Bangladesh. Our research revealed that despite the widespread recognition of the COVID-19 vaccine, there remains a gap in understanding the details of its efficacy, adverse effects, and recommended usage. The participants have been exposed to a wide range of information and opinions about COVID-19 vaccines, including both accurate and inaccurate information as well as both positive and negative news. This highlights the importance of continuing to educate the public about these important aspects of the vaccine in order to promote confidence in its usage and ensure its successful implementation in controlling the pandemic.

Safety of vaccines and concern about side effects are significant issues that have been reported in earlier studies as a barrier to COVID-19 vaccine uptake (21). Although some participants in our study reported experiencing various temporary side effects such as soreness, discomfort, allergic reactions, swelling, fever, chills, fatigue, and headaches following COVID-19 vaccination, there have not been many reports of severe adverse reactions among COVID-19 vaccine recipients worldwide (22, 23). Our study found that social relationships significantly influence people's decision-making about getting the COVID-19 vaccine. Participants consider their personal beliefs, the opinions of those around them, and what is best for society when deciding whether or not to get vaccinated. They weigh the potential risks and benefits of getting the vaccine, such as concerns over side effects and efficacy, but also consider the greater good and what others may think. However, some participants were motivated to get vaccinated because they wanted things to return to "normal". Also, people's views about getting the COVID-19 vaccine are not just a balance between what is good for them and what is good for society. Instead, they consider it within a larger social context (24). For example, when someone recognizes the positive impact of vaccines in ending the pandemic but is hesitant to be among the first to get them because of fears about side effects, they are mindful of their role in society and the moral obligation that may come with it, influencing their decision-making (24). Our study revealed that almost all the participants were motivated to get vaccinated based on the perception that it would protect themselves and others and lead to a return to normalcy. This finding highlights the potential effectiveness of government-led campaigns to promote vaccination, especially as the fourth dose of the vaccine is now available.

Our study revealed that some might believe that one dose of the vaccine would suffice for protection against the virus. It's a concerning issue that many individuals have been skipping their second dose of the COVID-19 vaccine in our country. Experts suggest that the government's vaccine management system and campaigns are lacking in certain aspects. This may be due to a

decrease in the urgency to get vaccinated as the coronavirus transmission rate in our country has declined, as well as the relaxation of vaccine-related campaigns. In addition, many people may have believed that vaccinations are no longer necessary because the virus is no longer spreading (25). In Bangladesh, people living in rural areas have a lower literacy rate and tend to have less knowledge and less practice in preventing COVID-19 compared to urban people (26). We observed that vaccine hesitance among our participants was largely due to the prevalence of myths and misconceptions surrounding the COVID-19 disease and the vaccine. This issue is especially prevalent in rural areas, where access to reliable information about the vaccine's benefits and safety is limited. This could be because of their lower perception of risk and lower level of education, leading to a lower acceptance rate for the vaccine. In China, a study showed that the acceptance rate of the COVID-19 vaccine was lower among people living in rural areas as compared to those in urban areas (27). Similarly, a national survey conducted in the US found that people living in rural areas were more likely to be hesitant about getting vaccinated for COVID-19 (28). This highlights the need for customizing vaccine distribution strategies for different geographical populations. It is important for health authorities, community leaders, and healthcare providers to work together to educate and raise awareness about the reality of COVID-19 and the benefits of getting vaccinated in order to dispel these myths and misconceptions and promote public health. This can be done through community meetings, health campaigns, and the distribution of educational materials.

The third dose of the COVID-19 vaccination program was ongoing during the study period. COVID-19 is still spreading and causing serious illness and death, even in areas where cases have declined. The vaccines are a crucial tool in controlling the pandemic and ending the spread of the virus. Now that it appears that the fourth vaccine is in progress, this study's outcome and possible recommendations will help with the implementation of the government's further vaccine program. The government must strengthen its vaccine management system and campaigns, making sure that people receive the recommended four doses and preventing the spread of false information. A supportive social environment that encourages vaccination is also critical, as social relationships play a significant role in decision-making. By addressing these key issues, we can increase public confidence in the COVID-19 vaccine and successfully control the spread of the pandemic.

Limitations

The study has a few limitations that need to be acknowledged. Firstly, due to difficulty in securing potential participants, we were compelled to visit numerous households, which may have introduced selection bias. Secondly, because the study was cross-sectional, its conclusions might only be applicable to a specific point in time, and an extended investigation is necessary to examine the long-term implications. Finally, due to time constraints, we were unable to gather data from a more diverse range of locations.

Despite these limitations, this study provides valuable insights into individuals' experiences and perceptions surrounding the COVID-19 vaccine. By identifying potential barriers to accessing a fourth dose of the vaccine and developing strategies for addressing these barriers, further

qualitative research can be invaluable for public health officials and policymakers as they work to ensure equitable access to the vaccine.

Conclusion

In conclusion, our study found that the participants were positive towards receiving the COVID-19 vaccine, but lacked knowledge about it. Despite their positive attitude, there were significant barriers and challenges that they faced. Although the government's efforts to control the spread of the virus, ensuring proper safety measures has proven difficult due to socioeconomic factors. Therefore, it is crucial for policymakers and researchers to implement health education programs and interventions to improve the health and well-being of the population in Bangladesh, as the virus continues to spread even after three years and the fourth vaccination program is underway. To gain a more comprehensive understanding of the perceptions and barriers surrounding the COVID-19 pandemic in Bangladesh, further research is recommended.

Author Contributions

MK and KIS conceptualized and designed the study with TA. contributing. RSR and MK developed tools and supervised data collection. RSR, FA, MFR and TA analyzed the data. TA and MK developed the manuscript. MKH, MK and KIS critically reviews the draft paper. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement

The Ethical Review Committee of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) approved the study (Ref. PR-21125). Informed consent was obtained from each participant. Before the interviews were recorded, interviewees gave verbal consent, which was recorded. We assured interviewees that their participation was entirely voluntary and that all information provided would be de-identified, ensuring the anonymity and privacy of the information shared.

Data Availability Statement

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COVID-19 vaccine barriers and perception among rural adults: A qualitative study in Bangladesh

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Abstract

Objective COVID-19 pandemic continues to pose challenges for global public healthcare, even with the authorization of several vaccines worldwide. To better understand rural communities' knowledge, attitudes, perceptions, and barriers towards these vaccines, we conducted a qualitative cross-sectional study with adults in rural Bangladesh.

Setting This cross-sectional study was conducted in the rural areas of Sylhet and Natore in Bangladesh from August 2021 to February 2022.

Participants Our study involved 15 in-depth interviews with rural adults and 2 key informant interviews with health workers.

Results We analysed data thematically, resulting in four main themes: (1) knowledge and perception aspects, (2) myths and misconceptions, (3) practice and attitude, and (4) barriers and challenges of COVID-19 vaccines.

Conclusions The findings indicate that rural populations lack sufficient knowledge about COVID-19 vaccines, but they have a more favourable attitude towards them. Misconceptions, beliefs, and personal experiences were found to be the main reasons for vaccine avoidance. To address these challenges and dispel the spread of misinformation, health education programs play a pivotal role in improving vaccine management. Policymakers should initiate these programs without delay to create a well-informed and enlightened community, given that the coronavirus is still spreading.

Keywords: COVID-19 vaccine, perception, barrier, rural, Bangladesh

Strengths and limitations of this study

- Employing purposive sampling of participants enables a comprehensive understanding of the topic under study through the comparison and contrast of participant viewpoints.
- The study's timing, amidst the nation's ongoing COVID-19 mass vaccination campaign, may have influenced the participants' opinions significantly.
- The adoption of a qualitative design impacts the study's external validity and restricts how far the results may be applied.
- By visiting various households to locate potential participants, the researchers might have introduced selection bias, potentially restricting the generalizability of the findings.
- Since the study was conducted at a specific time, the findings may only be relevant for that period, and further research is needed to explore the long-term effects.

Introduction

The emergence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), a novel strain, has transformed COVID-19 into a critical global public health issue. This virus continues to be present in many countries worldwide, posing a significant threat to human health [1]. As per the latest figures released by the World Health Organization (WHO), there have been a staggering 760,897,555 reported cases of COVID-19 globally, which have resulted in the unfortunate loss of 6,874,585 lives [2]. Bangladesh is at much greater risk since it has the highest population density in the world, making concepts like "social separation" impossible to implement [3]. As a result, it reported 2,037,024 positive cases and 29,439 domestic deaths as of December 30, 2022 [4]. Since SARS-CoV-2 is a highly contagious virus that affects people worldwide, vaccination is the most effective method of protecting the population from COVID-19 [5-7]. Although vaccines may not be 100% effective, high coverage in a community can significantly improve disease control [8]. Five key factors—access, affordability, awareness, activation, and acceptance are crucial in ensuring maximum coverage [9].

During December 2020, numerous COVID-19 vaccines were authorized for commercial use in various nations. These vaccines were developed by companies such as Pfizer-BioNTech, Moderna, Janssen, Sinopharm-BBIBP, Sputnik V, CoviVac, and Covaxin [10]. The government of Bangladesh had procured and made payments for around 30 million doses of the Oxford-AstraZeneca vaccine. Starting from February 7, 2021, Bangladesh initiated the administration of the AZD1222 vaccine, developed by Oxford AstraZeneca, to high-priority groups, such as healthcare workers and individuals aged over 40 [11]. By the end of October 2021, 25.1% of the total population in Bangladesh have received at least one dose of this vaccine [12]. Besides the Oxford-AstraZeneca vaccine, Bangladesh had authorized two other vaccines, the Gam-COVID-Vac (Sputnik V) and the BBIBP-CorV (Sinopharm COVID-19 vaccine), for emergency use [13, 14]. In June, the government of Bangladesh also started vaccinating its citizens with the Sinopharm vaccine [15]. Additionally, Bangladesh is scheduled to be provided with 68 million doses of the Covax vaccine through the efforts of the World Health Organization (WHO) and Gavi, the Vaccine Alliance [16].

The government of Bangladesh (GoB) had initiated the largest-ever state-wide vaccination program to vaccinate over 130 million individuals, which accounted for 80% of the total population [17]. This program was to be implemented in four phases [17], despite the fact that approximately 34% of the population was under the age of 18 [18]. A countrywide deployment and vaccination plan for COVID-19 were released by the GoB, which included the necessity of registering online to obtain the vaccine. The GoB aimed to vaccinate 117 million individuals aged 18 and above as per the vaccination plan. Nonetheless, as of 3rd August 2021, only 14% of the target population had registered to receive the vaccine. Out of those registered, 57% had received the first dose vaccine, with gender and administrative regions showing significant variations. Men (61%) were vaccinated more than women (39%), and Dhaka (19%) received more vaccinations than other administrative divisions [19]. In general, only 8% of the targeted population has received the first dose of the vaccine, and 4% have received the second dose of the vaccine [19].

In clinical trials, COVID-19 vaccine candidates have shown effective rates of up to 95% in preventing symptomatic infections [20]. Based on research findings, it is believed that vaccinating approximately 82% of a nation's population may be necessary to attain herd immunity against SARS-CoV-2. However, the emergence of new virus variants may require individuals to receive multiple vaccinations [21, 22]. In the current context, vaccine hesitancy, which ranges from vaccination approval to denial, has emerged as the most critical public health concern. Despite the availability of vaccination services, it refers to delays in acceptance or refusal of immunizations [23]. There are several factors that contribute to vaccine hesitancy, such as apprehensions regarding vaccine safety and efficacy, potential adverse health effects, misunderstandings surrounding the value of vaccination, a lack of trust in the healthcare system, and insufficient community education regarding vaccine-preventable illnesses [24]. Acceptance of COVID-19 vaccines varies greatly among different nations and regions of the world [9, 25, 26]. Public mistrust and resistance to vaccination could impede the success of the COVID-19 vaccination campaign [27, 28].

Herd immunity and the ease of vaccination are likely to be impacted by people's knowledge of COVID-19 vaccines, level of acceptability, and perception of immunization concerns. However, currently, there needs to be more prior research on this subject. Therefore, this study aimed to

assess Bangladeshi rural adults' opinions on vaccination and their comprehension and acceptance of COVID-19 vaccines.

Methods

Study area

The study was conducted in rural areas of the Sylhet and Natore districts in Bangladesh, with careful consideration given to logical and transportation concerns. Given the ongoing COVID-19 pandemic and the prevalence of severe cases in the country, we selected locations closer to Dhaka to minimize the risk of disruption in the event of sudden lockdowns. It is worth noting that on August 11th, 2021, the government of Bangladesh lifted the hard lockdown that had been in effect since July 2021.

Natore is a northern district of Bangladesh covering an area of 1896.05 sq. km. According to the 2022 census, its population stands at 18,59,924 [29]. The district city is situated on the bank of the Natroe river. Natore comprises of 6 upazilas (sub-districts), 8 pourashavas (municipalities), and 1366 villages. Sylhet, located in the northeast of Bangladesh, is one of the four districts in the Sylhet Division, covering an area of 3452.07 square kilometers. According to the 2022 census, its population is 38,97,037 [29]. The district comprises of 11 upazilas (sub-districts), 2 municipalities, 1693 mouzas, and 3249 villages. Both Natore and Sylhet districts have a well-developed road network that ensures easy connectivity with Dhaka.

Patient and public participation

Patients and the public were not involved in this study.

Training of the data collectors

The research assistants, two qualified males with master's degrees in anthropology from Jahangirnagar University, Dhaka, Bangladesh. They were skilled and experienced in qualitative

research methods, specifically conducting in-depth interviews (IDIs) and key informant interviews (KIIs). Prior to commencing the data collection process, the research assistants underwent a comprehensive 4-day training program on interviewing techniques. This training consisted of 2 days of theoretical sessions covering topics such as the basic principles of qualitative research, study objectives, research ethics and informed consent in human subjects' research, and the KII and IDI interview guide. Additionally, a practical fieldwork session was conducted on the third day to provide hands-on experience in conducting interviews and obtaining informed consent.

Throughout the training, each research assistant provided feedback on the other's performance during IDIs, and the trainer provided feedback and guidance on group dynamics, participant interaction, body language, conflict avoidance, conflict management. On the second day, the team was taken into a nearby neighbourhood to conduct IDIs with the local communities. The resulting KII and IDIs were transcribed and thoroughly analysed. Based on the analyzed data and feedback from the data collectors, the interview guides were revised.

Data collection

We conducted this cross-sectional survey between August 2021 to February 2022, aiming to investigate individuals' vaccination status regarding COVID-19. Our research involved IDIs with fifteen participants and two KIIs with government officials involved in COVID-19 vaccination activities. The selection process was purposive, starting from a landmark and proceeding to visit households. We specifically focused on individuals who had either not received the COVID-19 vaccine or had missed their second dose. By conducting in-depth interviews with their consent, we aimed to capture the depth and uniqueness of their experiences and perceptions regarding vaccination.

The interviews were conducted in privately, ensuring confidentiality for approximately one hour, and followed pre-tested data collection guidelines that allowed for flexibility to incorporate any additional feedback. We obtained their consent, outlining the objectives of our study in a comprehensive manner. Additionally, we provided them with a brief verbal overview, enlightening them about the purpose of our research, which aimed to explore the knowledge, attitudes, perceptions, and barriers related to the COVID-19 vaccine among the rural population of

Bangladesh. We assured them that their valuable information would be treated with utmost confidentiality. The significance of their responses is extremely important as they contribute greatly to the ongoing efforts in public education, fostering trust in the vaccine and securing its effective implementation in combating the pandemic.

The interviews were digitally recorded, transcribed into Bangla, and then translated into English. To ensure accuracy and quality of our work, spot checks of the recordings and transcriptions were performed by an anthropologist proficient in both Bangla and English.

Thematic area

To structure and organize our findings, we utilized this index as a framework to analyse post-programmatic data. Additionally, we have meticulously coded the qualitative data using the following four indicators:

1. Knowledge and perception aspects
2. Myths and misconceptions
3. Practice and attitude
4. Barriers and challenges

Data Analysis

We transcribed the audio-recorded interviews conducted in Bangla using MS Word files. These transcripts were translated and carefully reviewed by the research team and co-authors to ensure accuracy.

To conduct a thematic analysis, we used Bernard's framework [30], wherein themes were identified from the data and categorized under the four thematic areas. Initially, we developed a pre-existing codebook based on the interview guidelines, which was manually coded. This was then reviewed and verified by an anthropologist who conducted spot checks of the recordings and transcriptions.

The qualitative members subsequently coded all the interviews manually, while maintaining flexibility in incorporating any additional themes that were deemed relevant to the study's objectives. This approach allowed for a combination of both deductive and inductive coding, while ensuring inter-coder reliability [31]. Following the coding process, thematic codes were categorized and subsequently grouped under the four themes.

Quality assurance and control

Quality control were ensured through the following steps:

- Hiring knowledgeable and experienced data collectors who underwent a comprehensive five-day training program on both theoretical and practical aspects of the study to reduce interviewer bias.
- To enhance the accuracy and reliability of the collected data, data collectors were assigned to work in pairs.
- The interview guide was translated into the local language to ensure clear and effective communication with the participants.
- To accurately record and document conversations during IDIs and KIIs, data collectors used digital voice recorders and copious note taking.
- To maintain consistency and address any discrepancies, data collectors compared their notes and voice recordings at the end of each day.
- The investigators of the study cross checked the interview transcriptions with the audio records and field notes to ensure data credibility.

Results

Demographic characteristics of the participants

A total of fifteen participants (nine males and six females) from two districts were interviewed. Four of the men and women were aged 16-25 years; two men and one woman were aged 25-36 years, with the other three 25-34 years. Among them, three of the men had no education (can sign names only) and three of them completed primary education; five of the women completed up to

secondary education; and the rest of the men and women completed higher secondary education and graduation.

All of the participants were working in unskilled labor (such as day laborers, rickshaw or van pullers, drivers, and farmers). The average household income ranged from 9000 to 15000 (BDT). The maximum number of members in any households was 5 to 10 members, and the rest had 2 to 4 members. The socio-demographic characteristics of the interviewees who participated in the IDIs are shown in Table 1.

Table 1 Participant and household characteristics

Indicators	**Male**	**Female**
Doses of vaccine		
No vaccine given	2	3
One dose of vaccine given	7	3
Age range		
16-25 years	4	4
25-30 years	2	1
30-40 years	3	1
Occupations		
Daily labour/Mason	2	
Rickshaw/Van puller	3	
Driver	1	
Shopkeeper	1	
Farmer	2	
Housewife		6
Education		
Can signature only (own name)	3	

Primary	3	
Secondary	1	4
Higher secondary	1	2
Graduation	1	
Income		
5000-8000	1	
8000-15000	5	2
Above 15000	3	4
Family members		
2 to 4 members	3	2
4 to 10 members	6	4

Data that support the findings in the study are included in the Supplementary Material.

Themes emerged

Upon analysis of the semi-structured in-depth and key informant interviews, four main themes emerged: knowledge and perception aspects, myths and misconceptions, practice and attitude, and barriers and challenges of COVID-19 vaccines.

Knowledge and perception aspects

Participants described COVID-19 as a highly contagious and life-threatening illness and stated they first learned about it through television, their neighbors, and social media. Regarding symptoms, most participants believed that the main indicators of COVID are fever, coughing, and a runny nose, with a few mentioning that shortness of breath is also a symptom. Additionally, some participants stated that the virus could spread through breathing, touching, and sneezing. Poor hygiene practices, such as not washing hands with soap, can make an individual more susceptible to contracting the disease. To prevent the spread of COVID, participants emphasized the importance of isolation, using separate utensils for eating, and maintaining social distance. One of

the participants stated that receiving this immunization will prevent future occurrences of the condition. Through the mass media, they also learned about the numerous deaths caused by this contagion that have occurred worldwide. A respondent mentioned that,

> *"This illness is easily spreadable. Sneezing and physical activity can exacerbate its transmission. Nevertheless, adhering to recommended precautions like wearing a mask and practicing social distance can protect you from contracting the disease".*

The majority of the participants had a positive view regarding the COVID vaccine. They expressed trust in the vaccines' quality and believed that getting vaccinated reduces the risk of death and enables them to venture outside more freely. Additionally, they perceived that the vaccine protects against getting infected by others. Although the majority of the community had positive perceptions about the vaccine, most of them lacked information about its various types, administration methods, and frequency. All the study participants believed that pregnant women were not eligible to receive the vaccine.

> *"COVID-19 vaccine may have serious consequences for pregnant women. Hence, it is not recommended for them to receive it. I personally think that pregnant women should avoid getting the vaccine".*

Some participants reported experiencing mild reactions after vaccination, such as slight fever, soreness, headaches etc., but nothing of serious concern. Amidst the discussions, certain individuals brought up the topic of antibodies. They were unaware of the word and mistakenly referred them as antibiotics. A respondent mentioned:

> *"COVID-19 is a devastating illness, and our government has taken proactive measures to ensure the protection of our citizens by implementing a nationwide vaccination program. The vaccines work by generating antibiotics (antibodies) to combat the virus and keep people safe".*

A respondent also stated that the fate of a person's health and survival from this disease is ultimately determined by the Creator, regardless of whether or not they receive vaccinations. He believed that a person would not fall ill if he adhered to his religious principles.

Myths and misconceptions

All participants discussed side effects when the vaccination programme first started. They stated elderly people above the age of 60 are at a high-risk of complications from vaccination, which was the most frequently given response.

> *"Elderly people with respiratory problems faced even more problems after taking the vaccine. Their immune systems weakened, leading to additional problems and, in some cases, death. I have seen or heard about these events on TV or from others".*

Furthermore, some participants reported that children are at a high risk of getting infections from the vaccine, despite the fact that the vaccination campaign for children had not even commenced at that time. It's just that they were merely making assumptions or had misconceptions regarding this matter.

Some people's assumptions made the vaccination process difficult. There was also a common misconception that one dose of the vaccine would protect against the virus and there would be no need for additional doses.

Some participants confidently shared information that was not accurate or held conspiracy theories about the COVID-19 vaccines. For example, one participant said about COVID-19 vaccines,

> *"Injections (vaccines) are sometimes given to reduce the number of dogs. However, many people have not yet received the COVID-19 vaccine due to concerns about potential side effects in humans."*

In 2009, Bangladesh had one of the highest rates of human deaths related to rabies worldwide. During that time, the government of Bangladesh resorted to indiscriminately killing dogs in an attempt to eliminate rabies across the country. This practice had been ongoing for decades, despite its ineffectiveness. However, in late 2011, as part of a new national strategy aimed at eliminating rabies, the government of Bangladesh began vaccinating dogs on a large scale instead of resorting to mass killings. So, some participants drew a parallel between this context and the COVID

vaccine, forming a conspiracy theory that the vaccine was invented with the intention of reducing the human population.

Practice and attitude

Vaccine hesitancy is intricately linked to specific contexts and exhibits variations across different periods, locations and socioeconomic class. When the vaccine program was initially launched, people were filled with fear and uncertainty. This can be attributed to various factors, including limited awareness, the presence of misleading information, lack of confidence in healthcare systems, and more.

Many wanted to receive the vaccine but hesitated and waited for others to take it before deciding. This approach is not recommended, as each individual's health condition should be taken into consideration before getting vaccinated. One participant stated,

> *"When the vaccination programme was first started, some people thought they should observe the situation before deciding. With such conflicting thoughts in mind, many wanted to wait".*

Some women hesitated to get vaccinated due to concerns about social norms and religious veil traditions. They believe that being vaccinated by a male nurse goes against these beliefs. A male respondent mentioned:

> *"As a Muslim, I believe that female nurses should vaccinate women, as it is easier for women to maintain their veil with their hands open during the immunization process. This has resulted in many women skipping their vaccinations".*

Over time, an increasing number of individuals displayed willingness to receive COVID-19 vaccinations as they observed the growing trend of community members getting vaccinated and it was free of cost. The majority of participants believed that the COVID-19 vaccine was safe to use, with the President and Ministers promoting it as a means to prevent the spread of the disease.

Participants considered both personal and communal factors when deciding their stance toward vaccination.

> *"Though many people die even if they are vaccinated. Vaccination is necessary for us now because the disease is becoming deadly. To keep ourselves and others safe, we must get the corona vaccination".*

Some participants reported feeling a positive change in their social status after getting vaccinated as they received the vaccine initially.

Barriers and challenges

An online registration system is required to receive the vaccine. Study participants reported receiving delayed SMS, and many did not see the SMS on their mobiles, causing a major problem with vaccine discontinuation. Some participants reported receiving their first dose of vaccine through the mass immunization program, but were not provided with vaccine registration cards for further doses, nor were their phone numbers collected for enrollment on the website. Even when they went to the center on the scheduled date, they could not receive their second dose of vaccine without their registration card and SMS. Findings also revealed that missing vaccine cards and a lack of knowledge about reprinting the cards are reported barriers to getting the vaccine. Most of the participants had lost their vaccine cards, so they were unable to receive the vaccine. Participants emphasized the importance of equitable vaccine distribution in their communities and preferred local sites to mass vaccination sites with long lines and crowds. One female participant said,

> *"I didn't notice the text reminder for the second dose of the vaccine. When I saw it, I went to the vaccination center at the Union Parishad, but the guard in charge told me that the vaccine was not available there. He told me to go to another vaccination center, but I didn't go there".*

Another participant stated,

> *"I received my first dose during the mass vaccination program, but when I went to the vaccine centre for my second dose, the authorities told me that they*

couldn't give me the vaccine without any documents like a vaccine card or SMS. However, they did not give me a card the first time".

Dual-dose vaccine schedules were seen as an additional burden for individuals and families, as they needed to move frequently to support themselves. One participant stated,

"We leave our family behind and work in Dhaka. As poor people, we work ten days here today, twenty days in another area, and five days in another place. This means that I live in different regions at different times, so I could not get vaccinated. But I know this vaccination is necessary for us".

Health workers often face challenges while administering vaccines, including a frequent shortage of staff, which leads to an increased workload.

Discussion

The purpose of this study was to delve into the perceptions and barriers regarding the COVID-19 vaccine among adults residing in rural areas of Bangladesh. Our research revealed that despite the widespread recognition of the COVID-19 vaccine, there remains a gap in understanding the details of its efficacy, adverse effects, and recommended usage. The participants have been exposed to a wide range of information and opinions about COVID-19 vaccines, including both accurate and inaccurate information as well as both positive and negative news. This highlights the importance of continuing to educate the public about these important aspects of the vaccine in order to promote confidence in its usage and ensure its successful implementation in controlling the pandemic.

Safety of vaccines and concern about side effects are significant issues that have been reported in earlier studies as a barrier to COVID-19 vaccine uptake [32]. Although some participants in our study reported experiencing various temporary side effects such as soreness, discomfort, allergic reactions, swelling, fever, chills, fatigue, and headaches following COVID-19 vaccination, there have not been many reports of severe adverse reactions among COVID-19 vaccine recipients worldwide [33, 34]. Our study found that social relationships significantly influence people's

decision-making about getting the COVID-19 vaccine. Participants consider their personal beliefs, the opinions of those around them, and what is best for society when deciding whether or not to get vaccinated. They weigh the potential risks and benefits of getting the vaccine, such as concerns over side effects and efficacy, but also consider the greater good and what others may think. However, some participants were motivated to get vaccinated because they wanted things to return to "normal". Also, people's views about getting the COVID-19 vaccine are not just a balance between what is good for them and what is good for society. Instead, they consider it within a larger social context [35]. For example, when someone recognizes the positive impact of vaccines in ending the pandemic but is hesitant to be among the first to get them because of fears about side effects, they are mindful of their role in society and the moral obligation that may come with it, influencing their decision-making [35]. Our study has revealed that almost all the participants were motivated to get vaccinated based on the perception that it would protect both themselves and others, ultimately leading our country towards a return to normalcy. This finding highlights the potential effectiveness of government-led campaigns to promote vaccination, especially as the fourth dose of the vaccine is now available.

Our study revealed that some might believe that one dose of the vaccine would suffice for protection against the virus. It's a concerning issue that many individuals have been skipping their second dose of the COVID-19 vaccine in our country. Experts suggest that the government's vaccine management system and campaigns are lacking in certain aspects. This may be due to a decrease in the urgency to get vaccinated as the coronavirus transmission rate in our country has declined, as well as the relaxation of vaccine-related campaigns. In addition, many people may have believed that vaccinations are no longer necessary because the virus is no longer spreading [36].

The vaccination's geographical location has a significant impact on uptake, [37] as it directly influences accessibility. In Bangladesh, people living in rural areas have a lower literacy rate and tend to have less knowledge and less practice in preventing COVID-19 compared to urban people [38]. We observed that vaccine hesitance among our participants was largely due to the prevalence

of myths and misconceptions surrounding the COVID-19 disease and the vaccine. This issue is especially prevalent in rural areas, where access to reliable information and awareness about the advantages and safety of the vaccine is limited. This could be because of their lower perception of risk and lower level of education, leading to a lower acceptance rate for the vaccine. In China, a study showed that the acceptance rate of the COVID-19 vaccine was lower among people living in rural areas as compared to those in urban areas [39]. Similarly, a national survey conducted in the US found that people living in rural areas were more likely to be hesitant about getting vaccinated for COVID-19 [40]. This highlights the need for customizing vaccine distribution strategies for different geographical populations. Additionally, it was discovered that organising vaccinations through university, school, workplace increased uptake [9]. It is important for health authorities, community leaders, and healthcare providers to work together to educate and raise awareness about the reality of COVID-19 and the benefits of getting vaccinated in order to dispel these myths and misconceptions and promote public health. This can be done through community meetings, health campaigns, and the distribution of educational materials.

Our study revealed that, as time passed, a rising number of individuals wanted to receive COVID-19 vaccinations. This willingness was influenced by the fact that the vaccinations were provided free of cost. Several studies investigated the influence of non-financial costs on the acceptance of vaccines, with time-related constraints emerging as the primary non-financial barriers to affordability [41]. However, in our study, due to their work schedules and frequent movements from one place to another, these people faced challenges in getting vaccinated in a timely manner. Moreover, the multiple doses required for the COVID vaccine added an additional burden for them. Since they are day laborers, they cannot afford to take a single day off work as their wages would be deducted for that day.

The third dose of the COVID-19 vaccination program was ongoing during the study period. COVID-19 is still spreading and causing serious illness and death, even in areas where cases have declined. The vaccines are a crucial tool in controlling the pandemic and ending the spread of the virus. Now that it appears that the fourth vaccine is in progress, this study's outcome and possible recommendations will help with the implementation of the government's further vaccine program.

The government must strengthen its vaccine management system and campaigns, making sure that people receive the recommended four doses and preventing the spread of false information. A supportive social environment that encourages vaccination is also critical, as social relationships play a significant role in decision-making. By addressing these key issues, we can increase public confidence in the COVID-19 vaccine and successfully control the spread of the pandemic.

Limitations

The study has a few limitations that need to be acknowledged. Firstly, due to difficulty in securing potential participants, we were compelled to visit numerous households, which may have introduced selection bias. Secondly, because the study was cross-sectional, its conclusions might only be applicable to a specific point in time, and an extended investigation is necessary to examine the long-term implications. Finally, due to time constraints, we were unable to gather data from a more diverse range of locations.

Despite these limitations, this study provides valuable insights into individuals' experiences and perceptions surrounding the COVID-19 vaccine. By identifying potential barriers to accessing a fourth dose of the vaccine and developing strategies for addressing these barriers, further qualitative research can be invaluable for public health officials and policymakers as they work to ensure equitable access to the vaccine.

Conclusion

In conclusion, our study found that the participants were positive towards receiving the COVID-19 vaccine, but lacked knowledge about it. Despite their positive attitude, there were significant barriers and challenges that they faced. Although the government's efforts to control the spread of the virus, ensuring proper safety measures has proven difficult due to socioeconomic factors. Therefore, it is crucial for policymakers and researchers to implement health education programs and interventions to improve the health and well-being of the population in Bangladesh, as the virus continues to spread even after three years and the fourth vaccination program is underway.

To gain a more comprehensive understanding of the perceptions and barriers surrounding the COVID-19 pandemic in Bangladesh, further research is recommended.

Author Contributions: MK and KIS conceptualized and designed the study with TA. contributing. RSR and MK developed tools and supervised data collection. RSR, FA, MFR and TA[1] analyzed the data. TA[1] and MK developed the manuscript. MKH, MK and KIS critically reviewed the draft paper. All authors have read and agreed to the published version of the manuscript.

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Ethics Approval Statement: The Ethical Review Committee of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) approved the study (Ref. PR-21125). Informed consent was obtained from each participant. Before the interviews were recorded, interviewees gave verbal consent, which was recorded. We assured interviewees that their participation was entirely voluntary and that all information provided would be de-identified, ensuring the anonymity and privacy of the information shared.

Data Availability Statement: The Guidelines for IDI that support the findings in the study are included in the Supplementary Material; further inquiries can be directed to the corresponding author.

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Barriers and perceptions of taking the COVID-19 vaccine among poor Bangladeshi adults: a cross-sectional mixed-methods survey

In-depth interview guidelines

General Information

1. Respondent's general information (division, district, age, gender, occupation of both spouses, income, education (if informal education like a scholar or an Islamic scholar, mention that), number of household members, sanitation facilities (water and toilet facilities).

Concept of COVID-19

2. Have you heard about COVID-19? Where or from whom did you hear about it? What was your initial perception when you first heard about this disease? (Please provide details.) Did the coronavirus have any economic or social impact on your household? (For example: work situation, communication and social barriers with relatives, etc.)
3. What are the symptoms of the coronavirus? (e.g., dry cough, fever, fatigue, sore throat, sneezing, upset stomach, diarrhoea, vomiting, headache, body aches, feeling cold, and breathing difficulties). Did you experience any of these symptoms of COVID-19? (For example: if you experienced symptoms, did you get tested? What were the test results? If you didn't get tested, why not, and what actions did you take if you tested positive?)
4. How does the coronavirus spread? (For example: by shaking hands with an infected person, touching an infected person, being in close proximity to an infected person without any form of contact, through respiratory droplets, not washing hands after using the toilet, touching surfaces in the infected area and then touching the face or nose, or consuming contaminated food.) What preventive measures could be taken to control the spread of this illness?

Perceptions of COVID-19 Vaccination

1. What were the general perceptions regarding the COVID vaccine? (effectiveness, benefits)

2. Did you have any reactions or side effects after receiving the COVID-19 vaccine? If so, what were they?
3. How did anyone's religious beliefs influence their perception of COVID-19 and the role of vaccines?
4. How did you perceive the role of the government in implementing a nationwide vaccination programme?

Misconceptions towards COVID-19 Vaccination

9. What were the initial concerns about side effects during the vaccination programme? (For example: perception of side effects, specific concerns, fear, religious beliefs, any myths, misinformation.)
10. Is there any specific group of people that you believe should not receive vaccines? (For example: specific age groups, individuals with certain medical conditions, pregnant women)

Attitude towards COVID-19 Vaccination

11. What is your attitude towards the COVID-19 vaccine? Do you believe that the COVID-19 vaccine helps control or prevent the spread of the coronavirus? (For example: why or why not?) Do you know how many doses are required for the COVID-19 vaccination to be effective in controlling the virus? What are your thoughts on the benefits of the COVID-19 vaccination? (For example: mental peace, immunity, social acceptance, physical well-being, etc.)

Barriers to COVID-19 Vaccination

12. Have you received the COVID-19 vaccine? Can you tell me why you chose to get vaccinated or not? (For example: gender/family members' preferences, cost, perceived unnecessariness, age, non-communicable diseases, vaccine expiration, feeling well without vaccination, short-term efficacy, natural protection against COVID-19, receiving the vaccine from abroad or another country, and pregnancy complications.)

13. Which vaccine does he/she want to take (if no vaccine preference has been mentioned so far)?

Opportunities and Benefits of Vaccination, Vaccine Supply, and Management

14. Did you face any barriers when registering for the vaccine through the website? If yes, what type of barrier was it? (Note: did not have internet access, did not know the procedure for registration, did not receive any SMS, there was a delay in receiving SMS, received one dose but no vaccine supply, the vaccination centre was far from my area, had to roll up the sleeves during vaccine administration, had to stand in a long queue, and Indian vaccine).
15. What are the main barriers to the management of COVID-19 vaccines? (Note: need to go to the hospital, time-consuming, inadequate behaviour of vaccine workers, difficulties for young children and in the workplace, etc.)
16. In order to bring everyone within the ambit of vaccination, what kind of steps do you think the government needs to take? Do you have any recommendations on this matter? If so, please elaborate.

Manuscript: COVID-19 vaccine barriers and perception among rural adults: A qualitative study in Bangladesh

Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

Developed from:
Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	Page 5
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	Page 5
3. Occupation	What was their occupation at the time of the study?	Page 5 and 6
4. Gender	Was the researcher male or female?	Page 5
5. Experience and training	What experience or training did the researcher have?	Page 5
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	Page 6 .
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	Page 6
8. Interviewer characteristics	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	Page 6

Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Page 5 and 6
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Page 6
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	Page 5 and 6
12. Sample size	How many participants were in the study?	Page 6
13. Non-participation	How many people refused to participate or dropped out? Reasons?	N/A
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	Page 6 .
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	Page 6 Inferred as one to one interviews
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	Page 6
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Supplementary file and page 5
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	Page 7
20. Field notes	Were field notes made during and/or after the interview or focus group?	Page 7

21. Duration	What was the duration of the interviews or focus group?	Page 6
22. Data saturation	Was data saturation discussed?	Page 7
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	Page7
25. Description of the coding tree	Did authors provide a description of the coding tree?	Page 7
26. Derivation of themes	Were themes identified in advance or derived from the data?	Page 7
27. Software	What software, if applicable, was used to manage the data?	N/A
28. Participant checking	Did participants provide feedback on the findings?	No
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Page 10 to 15
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes, there was. Page 8 to 15
31. Clarity of major themes	Were major themes clearly presented in the findings?	Yes. they were. From page 8 to 15
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Discussion of major themes From page 15 to 18

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COVID-19 vaccine barriers and perception among rural adults: A qualitative study in Bangladesh

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Abstract

Objective The COVID-19 pandemic continues to pose challenges for global public healthcare, even with the authorization of several vaccines worldwide. To better understand rural communities' knowledge, attitudes, perceptions, and barriers towards these vaccines, we conducted a qualitative cross-sectional study with adults in rural Bangladesh.

Setting This cross-sectional study was conducted in the rural areas of Sylhet and Natore in Bangladesh from August 2021 to February 2022.

Participants Our study involved 15 in-depth interviews with rural adults and 2 key informant interviews with health workers.

Results We analysed data thematically, resulting in four main themes: (1) knowledge and perception aspects, (2) myths and misconceptions, (3) practice and attitude, and (4) barriers and challenges of COVID-19 vaccines.

Conclusions The findings indicate that rural populations lack sufficient knowledge about COVID-19 vaccines but have a more favourable attitude towards them. Misconceptions, beliefs, and personal experiences were found to be the main reasons for vaccine avoidance. To address these challenges and dispel the spread of misinformation, health education programs play a pivotal role in improving vaccine management. Policymakers should initiate these programs without delay to create a well-informed and enlightened community, given that the coronavirus is still spreading.

Keywords: COVID-19 vaccine, perception, barrier, rural, Bangladesh

Strengths and limitations of this study

- Employing purposive sampling of participants enables a comprehensive understanding of the topic under study through comparing and contrasting participant viewpoints.
- The study's timing, amidst the nation's ongoing COVID-19 mass vaccination campaign, may have influenced the participants' opinions significantly.
- The adoption of a qualitative design impacts the study's external validity and restricts how far the results may be applied.
- By visiting various households to locate potential participants, the researchers might have introduced selection bias, potentially restricting the generalizability of the findings.
- Since the study was conducted at a specific time, the findings may only be relevant for that period, and further research is needed to explore the long-term effects.

Introduction

The emergence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), a novel strain, has transformed COVID-19 into a critical global public health issue. This virus continues to be present in many countries worldwide, posing a significant threat to human health [1]. As per the latest figures released by the World Health Organization (WHO), there have been a staggering 760,897,555 reported cases of COVID-19 globally, which have resulted in the unfortunate loss of 6,874,585 lives [2]. Bangladesh is at much greater risk since it has the highest population density in the world, making concepts like "social separation" impossible to implement [3]. As a result, it reported 2,037,024 positive cases and 29,439 domestic deaths as of December 30, 2022 [4]. Since SARS-CoV-2 is a highly contagious virus that affects people worldwide, vaccination is the most effective method of protecting the population from COVID-19 [5-7]. Although vaccines may not be 100% effective, high coverage in a community can significantly improve disease control [8]. Five key factors—access, affordability, awareness, activation, and acceptance are crucial in ensuring maximum coverage [9].

In December 2020, numerous COVID-19 vaccines were authorized for commercial use in various nations. These vaccines were developed by companies such as Pfizer-BioNTech, Moderna, Janssen, Sinopharm-BBIBP, Sputnik V, CoviVac, and Covaxin [10]. The government of Bangladesh had procured and made payments for around 30 million doses of the Oxford-AstraZeneca vaccine. Starting from February 7, 2021, Bangladesh initiated the administration of the AZD1222 vaccine, developed by Oxford AstraZeneca, to high-priority groups, such as healthcare workers and individuals aged over 40 [11]. By the end of October 2021, 25.1% of the total population in Bangladesh have received at least one dose of this vaccine [12]. Besides the Oxford-AstraZeneca vaccine, Bangladesh had authorized two other vaccines, the Gam-COVID-Vac (Sputnik V) and the BBIBP-CorV (Sinopharm COVID-19 vaccine), for emergency use [13, 14]. In June, the government of Bangladesh also started vaccinating its citizens with the Sinopharm vaccine [15]. Additionally, Bangladesh is scheduled to be provided with 68 million doses of the Covax vaccine through the efforts of the World Health Organization (WHO) and Gavi, the Vaccine Alliance [16].

The government of Bangladesh (GoB) initiated the largest-ever state-wide vaccination program to vaccinate over 130 million individuals, which accounted for 80% of the total population [17]. This program was to be implemented in four phases [17] despite approximately 34% of the population being under 18 [18]. A countrywide deployment and vaccination plan for COVID-19 were released by the GoB, which included the necessity of registering online to obtain the vaccine. The GoB aimed to vaccinate 117 million individuals aged 18 and above as per the vaccination plan. Nonetheless, as of 3rd August 2021, only 14% of the target population had registered to receive the vaccine. Out of those registered, 57% had received the first dose vaccine, with gender and administrative regions showing significant variations. Men (61%) were vaccinated more than women (39%), and Dhaka (19%) received more vaccinations than other administrative divisions [19]. In general, only 8% of the targeted population has received the first dose of the vaccine, and 4% have received the second dose of the vaccine [19].

In clinical trials, COVID-19 vaccine candidates have shown effective rates of up to 95% in preventing symptomatic infections [20]. Based on research findings, it is believed that vaccinating approximately 82% of a nation's population may be necessary to attain herd immunity against SARS-CoV-2. However, the emergence of new virus variants may require individuals to receive multiple vaccinations [21, 22]. In the current context, vaccine hesitancy, which ranges from vaccination approval to denial, has emerged as the most critical public health concern. Despite the availability of vaccination services, it refers to delays in acceptance or refusal of immunizations [23]. Several factors contribute to vaccine hesitancy, such as apprehensions regarding vaccine safety and efficacy, potential adverse health effects, misunderstandings surrounding the value of vaccination, a lack of trust in the healthcare system, and insufficient community education regarding vaccine-preventable illnesses [24]. Acceptance of COVID-19 vaccines varies greatly among different nations and regions of the world [9, 25, 26]. Public mistrust and resistance to vaccination could impede the success of the COVID-19 vaccination campaign [27, 28].

Herd immunity and the ease of vaccination are likely to be impacted by people's knowledge of COVID-19 vaccines, level of acceptability, and perception of immunization concerns. However, currently, there needs to be more prior research on this subject. Therefore, this study aimed to

assess Bangladeshi rural adults' opinions on vaccination and their comprehension and acceptance of COVID-19 vaccines.

Methods

Study area

The study was conducted in rural areas of the Sylhet and Natore districts in Bangladesh, with careful consideration given to logical and transportation concerns. Given the ongoing COVID-19 pandemic and the prevalence of severe cases in the country, we selected locations closer to Dhaka to minimize the risk of disruption in the event of sudden lockdowns. It is worth noting that on August 11, 2021, the government of Bangladesh lifted the hard lockdown that had been in effect since July 2021.

Natore is a northern district of Bangladesh covering an area of 1896.05 sq. km. According to the 2022 census, its population stands at 18,59,924 [29]. The district city is situated on the bank of the Narode river. Natore comprises 6 upazilas (sub-districts), 8 pourashavas (municipalities), and 1366 villages. Sylhet, located in the northeast of Bangladesh, is one of the four districts in the Sylhet Division, covering an area of 3452.07 square kilometers. According to the 2022 census, its population is 38,97,037 [29]. The district comprises 11 upazilas (sub-districts), 2 municipalities, 1693 mouzas, and 3249 villages. Both Natore and Sylhet districts have a well-developed road network that ensures easy connectivity with Dhaka.

Patient and public participation

Patients and the public were not involved in this study.

Training of the data collectors

Two qualified male research assistants with master's degrees in Anthropology were from Jahangirnagar University, Dhaka, Bangladesh. They were skilled and experienced in qualitative

research methods, specifically conducting in-depth interviews (IDIs) and key informant interviews (KIIs). Before commencing the data collection process, the research assistants underwent a 4-day training program on interviewing techniques. This training consisted of 2 days of theoretical sessions covering topics such as the basic principles of qualitative research, study objectives, research ethics and informed consent in human subjects' research, and the KII and IDI interview guide. Additionally, a practical fieldwork session was conducted on the third day to provide hands-on experience in conducting interviews and obtaining informed consent.

Throughout the training, each research assistant provided feedback on the other's performance during IDIs, and the trainer provided feedback and guidance on group dynamics, participant interaction, body language, conflict avoidance, and conflict management. On the second day, the team was taken into a nearby neighbourhood to conduct IDIs with the local communities. The resulting KII and IDIs were transcribed and thoroughly analysed. The interview guides were revised based on the analyzed data and feedback from the data collectors.

Data collection

We conducted this cross-sectional survey between August 2021 to February 2022, aiming to investigate individuals' vaccination status regarding COVID-19. Our research involved IDIs with fifteen participants and two KIIs with government officials involved in COVID-19 vaccination activities. The selection process was purposive, starting with a landmark and proceeding to visit households. We specifically focused on individuals who had either not received the COVID-19 vaccine or had missed their second dose. We asked the participants who were willing to participate and interviewed them accordingly. In that case, no one refused to participate or dropped out. By conducting in-depth interviews with their consent, we aimed to capture the depth and uniqueness of their experiences and perceptions regarding vaccination. We chose individual interviews over focus group discussions because of the ongoing Covid-19 restrictions at that time. It was not permitted to gather multiple individuals in one place at a time.

The interviews were conducted privately, ensuring confidentiality for approximately one hour, and followed pre-tested data collection guidelines that allowed for flexibility to incorporate any additional feedback. We obtained their consent, outlining the objectives of our study thoroughly.

Additionally, we provided them with a brief verbal overview, enlightening them about the purpose of our research, which aimed to explore the knowledge, attitudes, perceptions, and barriers related to the COVID-19 vaccine among the rural population of Bangladesh. We assured them that their valuable information would be treated with utmost confidentiality. The significance of their responses is extremely important as they contribute greatly to the ongoing efforts in public education, fostering trust in the vaccine and securing its effective implementation in combating the pandemic.

The interviews were digitally recorded, transcribed into Bangla, and then translated into English. To ensure accuracy and quality of our work, spot checks of the recordings and transcriptions were performed by an anthropologist proficient in both Bangla and English. As this was a cross-sectional study, no repeat interviews were conducted and transcripts were not returned to the participants for feedback.

Thematic area

To structure and organize our findings, we utilized this index as a framework to analyse post-programmatic data. Additionally, we have meticulously coded the qualitative data using the following four indicators:

1. Knowledge and perception aspects
2. Myths and misconceptions
3. Practice and attitude
4. Barriers and challenges

Data Analysis

We transcribed the audio-recorded interviews conducted in Bangla using MS Word files. The research team and co-authors translated and carefully reviewed these transcripts to ensure accuracy.

To conduct a thematic analysis, we used Bernard's framework [30], wherein themes were identified from the data and categorized under the four thematic areas. Initially, we developed a pre-existing codebook based on the interview guidelines, which was manually coded. This was then reviewed and verified by an anthropologist who conducted spot-checks of the recordings and transcriptions.

The qualitative members subsequently coded all the interviews manually while maintaining flexibility in incorporating any additional themes that were deemed relevant to the study's objectives. This approach allowed for a combination of both deductive and inductive coding while ensuring inter-coder reliability [31]. Following the coding process, thematic codes were categorized and subsequently grouped under the four themes.

Quality assurance and control

Quality control was ensured through the following steps:

- Hiring knowledgeable and experienced data collectors who underwent a comprehensive five-day training program on the study's theoretical and practical aspects to reduce interviewer bias.
- To enhance the accuracy and reliability of the collected data, data collectors were assigned to work in pairs.
- The interview guide was translated into the local language to ensure clear and effective communication with the participants.
- To accurately record and document conversations during IDIs and KIIs, data collectors used digital voice recorders and copious note-taking.
- To maintain consistency and address any discrepancies, data collectors compared their notes and voice recordings at the end of each day.
- The investigators of the study cross-checked the interview transcriptions with the audio records and field notes to ensure data credibility.

Results

Demographic characteristics of the participants

A total of fifteen participants (nine males and six females) from two districts were interviewed. Four of the men and women were aged 16-25 years; two men and one woman were aged 25-36 years, with the other three 25-34 years. Among them, three of the men had no formal education (can sign their names only), and three of them completed primary education; five of the women completed up to secondary education; and the rest of the men and women completed higher secondary education and graduation.

All of the participants were working in unskilled labor (such as day laborers, rickshaw or van pullers, drivers, and farmers). The average household income ranged from 9000 to 15000 (BDT). The maximum number of members in any household was 5 to 10, and the rest had 2 to 4 members. The socio-demographic characteristics of the interviewees who participated in the IDIs are shown in Table 1.

Table 1 Participant and household characteristics

Indicators	**Male**	**Female**
Doses of vaccine		
No vaccine given	2	3
One dose of vaccine given	**7**	3
Age range		
16-25 years	4	4
25-30 years	2	1
30-40 years	3	1
Occupations		
Daily labour/Mason	2	
Rickshaw/Van puller	3	
Driver	1	
Shopkeeper	1	
Farmer	2	
Housewife		6

Education		
No formal education (Can sign their name only)	3	
Primary	3	
Secondary	1	4
Higher Secondary	1	2
Graduation	1	
Income		
5000-8000	1	
8000-15000	5	2
Above 15000	3	4
Family members		
2 to 4 members	3	2
4 to 10 members	6	4

Data that support the findings in the study are included in the Supplementary Material.

Themes emerged

Upon analysis of the semi-structured in-depth, and key informant interviews, four main themes emerged: knowledge and perception aspects, myths and misconceptions, practice and attitude, and barriers and challenges of COVID-19 vaccines.

Knowledge and perception aspects

Participants described COVID-19 as a highly contagious and life-threatening illness and stated they first learned about it through television, their neighbors, and social media. Regarding symptoms, most participants believed that the main indicators of COVID are fever, coughing, and a runny nose, with a few mentioning that shortness of breath is also a symptom. Additionally, some

participants stated that the virus could spread through breathing, touching, and sneezing. Poor hygiene practices, such as not washing hands with soap, can make an individual more susceptible to contracting the disease. To prevent the spread of COVID-19, participants emphasized the importance of isolation, using separate utensils for eating, and maintaining social distance. One of the participants stated that receiving this immunization will prevent future occurrences of the condition. Through the mass media, they also learned about the numerous deaths caused by this contagion that have occurred worldwide. A respondent mentioned that,

> *"This illness is easily spreadable. Sneezing and physical activity can exacerbate its transmission. Nevertheless, adhering to recommended precautions like wearing a mask and practicing social distance can protect you from contracting the disease".*

The majority of the participants had a positive view regarding the COVID vaccine. They expressed trust in the vaccines' quality and believed that getting vaccinated reduces the risk of death and enables them to venture outside more freely. Additionally, they perceived that the vaccine protects against getting infected by others. Although the majority of the community had positive perceptions about the vaccine, most of them lacked information about its various types, administration methods, and frequency. All the study participants believed that pregnant women were not eligible to receive the vaccine.

> *"COVID-19 vaccine may have serious consequences for pregnant women. Hence, it is not recommended for them to receive it. I personally think that pregnant women should avoid getting the vaccine".*

Some participants reported experiencing mild reactions after vaccination, such as slight fever, soreness, headaches etc., but nothing serious. Amidst the discussions, certain individuals brought up the topic of antibodies. They were unaware of the word and mistakenly referred them as antibiotics. A respondent mentioned:

> *"COVID-19 is a devastating illness, and our government has taken proactive measures to ensure the protection of our citizens by implementing a nationwide*

vaccination program. The vaccines work by generating antibiotics (antibodies) to combat the virus and keep people safe".

A respondent also stated that the fate of a person's health and survival from this disease is ultimately determined by the Creator, regardless of whether or not they receive vaccinations. He believed that a person would not fall ill if he adhered to his religious principles.

Myths and misconceptions

All participants discussed side effects when the vaccination programme first started. They stated elderly people above the age of 60 are at a high-risk of complications from vaccination, which was the most frequently given response.

"Elderly people with respiratory problems faced even more problems after taking the vaccine. Their immune systems weakened, leading to additional problems and, in some cases, death. I have seen or heard about these events on TV or from others".

Furthermore, some participants reported that children are at a high risk of getting infections from the vaccine, despite the fact that the vaccination campaign for children had not even commenced at that time. It's just that they were merely making assumptions or had misconceptions regarding this matter.

Some people's assumptions made the vaccination process difficult. There was also a common misconception that one dose of the vaccine would protect against the virus and there would be no need for additional doses.

Some participants confidently shared information that was not accurate or held conspiracy theories about the COVID-19 vaccines. For example, one participant said about COVID-19 vaccines,

"Injections (vaccines) are sometimes given to reduce the number of dogs. However, many people have not yet received the COVID-19 vaccine due to concerns about potential side effects in humans."

In 2009, Bangladesh had one of the highest rates of human deaths related to rabies worldwide. During that time, the government of Bangladesh resorted to indiscriminately killing dogs in an

attempt to eliminate rabies across the country. This practice had been ongoing for decades, despite its ineffectiveness. However, in late 2011, as part of a new national strategy aimed at eliminating rabies, the government of Bangladesh began vaccinating dogs on a large scale instead of resorting to mass killings. So, some participants drew a parallel between this context and the COVID vaccine, forming a conspiracy theory that the vaccine was invented with the intention of reducing the human population.

Practice and attitude

Vaccine hesitancy is intricately linked to specific contexts and exhibits variations across different periods, locations and socioeconomic class. When the vaccine program was initially launched, people were filled with fear and uncertainty. This can be attributed to various factors, including limited awareness, the presence of misleading information, lack of confidence in healthcare systems, and more.

Many wanted to receive the vaccine but hesitated and waited for others to take it before deciding. This approach is not recommended, as each individual's health condition should be taken into consideration before getting vaccinated. One participant stated,

> *"When the vaccination programme was first started, some people thought they should observe the situation before deciding. With such conflicting thoughts in mind, many wanted to wait".*

Some women hesitated to get vaccinated due to concerns about social norms and religious veil traditions. They believe that being vaccinated by a male nurse goes against these beliefs. A male respondent mentioned:

> *"As a Muslim, I believe that female nurses should vaccinate women, as it is easier for women to maintain their veil with their hands open during the immunization process. This has resulted in many women skipping their vaccinations".*

Over time, an increasing number of individuals displayed willingness to receive COVID-19 vaccinations as they observed the growing trend of community members getting vaccinated, and it was free of cost. Most participants believed that the COVID-19 vaccine was safe to use, with the President and Ministers promoting it to prevent the spread of the disease. Participants considered both personal and communal factors when deciding their stance toward vaccination.

> *"Though many people die even if they are vaccinated. Vaccination is necessary for us now because the disease is becoming deadly. To keep ourselves and others safe, we must get the corona vaccination".*

Some participants reported feeling a positive change in their social status after getting vaccinated as they received the vaccine initially.

Barriers and challenges

An online registration system is required to receive the vaccine. Study participants reported receiving delayed SMS, and many did not see the SMS on their mobiles, causing a major problem with vaccine discontinuation. Some participants reported receiving their first dose of vaccine through the mass immunization program but were not provided with vaccine registration cards for further doses, nor were their phone numbers collected for enrollment on the website. Even when they went to the center on the scheduled date, they could not receive their second dose of the vaccine without their registration card and SMS. Findings also revealed that missing vaccine cards and a lack of knowledge about reprinting the cards are reported barriers to getting the vaccine. Most of the participants had lost their vaccine cards, so they could not receive the vaccine. Participants emphasized the importance of equitable vaccine distribution in their communities and preferred local sites to mass vaccination sites with long lines and crowds. One female participant said,

> *"I didn't notice the text reminder for the second dose of the vaccine. When I saw it, I went to the vaccination center at the Union Parishad, but the guard in charge told me that the vaccine was not available there. He told me to go to another vaccination center, but I didn't go there".*

Another participant stated,

> *"I received my first dose during the mass vaccination program, but when I went to the vaccine centre for my second dose, the authorities told me that they couldn't give me the vaccine without any documents like a vaccine card or SMS. However, they did not give me a card the first time".*

Dual-dose vaccine schedules were seen as an additional burden for individuals and families, as they needed to move frequently to support themselves. One participant stated,

> *"We leave our family behind and work in Dhaka. As poor people, we work ten days here today, twenty days in another area, and five days in another place. This means that I live in different regions at different times, so I could not get vaccinated. But I know this vaccination is necessary for us".*

Health workers often face challenges while administering vaccines, including a frequent shortage of staff, which leads to an increased workload.

Discussion

The purpose of this study was to delve into the perceptions and barriers regarding the COVID-19 vaccine among adults residing in rural areas of Bangladesh. Our research revealed that despite the widespread recognition of the COVID-19 vaccine, there remains a gap in understanding the details of its efficacy, adverse effects, and recommended usage. The participants have been exposed to a wide range of information and opinions about COVID-19 vaccines, including both accurate and inaccurate information as well as both positive and negative news. This highlights the importance of continuing to educate the public about these important aspects of the vaccine in order to promote confidence in its usage and ensure its successful implementation in controlling the pandemic.

Safety of vaccines and concern about side effects are significant issues that have been reported in earlier studies as a barrier to COVID-19 vaccine uptake [32]. Although some participants in our study reported experiencing various temporary side effects such as soreness, discomfort, allergic

reactions, swelling, fever, chills, fatigue, and headaches following COVID-19 vaccination, there have not been many reports of severe adverse reactions among COVID-19 vaccine recipients worldwide [33, 34]. Our study found that social relationships significantly influence people's decision-making about getting the COVID-19 vaccine. Participants consider their personal beliefs, the opinions of those around them, and what is best for society when deciding whether or not to get vaccinated. They weigh the potential risks and benefits of getting the vaccine, such as concerns over side effects and efficacy, but also consider the greater good and what others may think. However, some participants were motivated to get vaccinated because they wanted things to return to "normal". Also, people's views about getting the COVID-19 vaccine are not just a balance between what is good for them and what is good for society. Instead, they consider it within a larger social context [35]. For example, when someone recognizes the positive impact of vaccines in ending the pandemic but is hesitant to be among the first to get them because of fears about side effects, they are mindful of their role in society and the moral obligation that may come with it, influencing their decision-making [35]. Our study has revealed that almost all the participants were motivated to get vaccinated based on the perception that it would protect both themselves and others, ultimately leading our country towards a return to normalcy. This finding highlights the potential effectiveness of government-led campaigns to promote vaccination, especially as the fourth dose of the vaccine is now available.

Our study revealed that some might believe that one dose of the vaccine would suffice for protection against the virus. It's a concerning issue that many individuals have been skipping their second dose of the COVID-19 vaccine in our country. Experts suggest that the government's vaccine management system and campaigns were lacking in certain aspects. This might be due to a decrease in the urgency to get vaccinated as the coronavirus transmission rate in our country has declined, as well as the relaxation of vaccine-related campaigns. In addition, many people may have believed that vaccinations are no longer necessary because the virus is no longer spreading [36].

The vaccination's geographical location has a significant impact on uptake, [37] as it directly influences accessibility. In Bangladesh, people living in rural areas have a lower literacy rate and tend to have less knowledge and less practice in preventing COVID-19 compared to urban people [38]. We observed that vaccine hesitance among our participants was largely due to the prevalence of myths and misconceptions surrounding the COVID-19 disease and the vaccine. This issue is especially prevalent in rural areas, where access to reliable information and awareness about the advantages and safety of the vaccine is limited. This could be because of their lower perception of risk and lower level of education, leading to a lower acceptance rate for the vaccine. In China, a study showed that the acceptance rate of the COVID-19 vaccine was lower among people living in rural areas as compared to those in urban areas [39]. Similarly, a national survey conducted in the US found that people living in rural areas were more likely to be hesitant about getting vaccinated for COVID-19 [40]. This highlights the need for customizing vaccine distribution strategies for different geographical populations. Additionally, it was discovered that organising vaccinations through universities, schools, and workplaces increased uptake [9]. It is important for health authorities, community leaders, and healthcare providers to work together to educate and raise awareness about the reality of COVID-19 and the benefits of getting vaccinated in order to dispel these myths and misconceptions and promote public health. This can be done through community meetings, health campaigns, and the distribution of educational materials.

Our study revealed that, as time passed, a rising number of individuals wanted to receive COVID-19 vaccinations. This willingness was influenced by the fact that the vaccinations were provided free of cost. Several studies investigated the influence of non-financial costs on the acceptance of vaccines, with time-related constraints emerging as the primary non-financial barriers to affordability [41]. However, in our study, due to their work schedules and frequent movements from one place to another, these people faced challenges in getting vaccinated in a timely manner. Moreover, the multiple doses required for the COVID vaccine added an additional burden for them. Since they are day laborers, they cannot afford to take a day off work as their wages would be deducted for that day.

The third dose of the COVID-19 vaccination program was ongoing during the study period. COVID-19 is still spreading and causing serious illness and death, even in areas where cases have declined. The vaccines are a crucial tool in controlling the pandemic and ending the spread of the virus. Now that it appears that the fourth vaccine is in progress, this study's outcome and possible recommendations will help with the implementation of the government's further vaccine program. The government must strengthen its vaccine management system and campaigns, ensuring people receive the recommended four doses and preventing the spread of false information. A supportive social environment encouraging vaccination is also critical, as social relationships play a significant role in decision-making. By addressing these key issues, we can increase public confidence in the COVID-19 vaccine and successfully control the spread of the pandemic.

Limitations

The study has a few limitations that need to be acknowledged. Firstly, due to the difficulty in securing potential participants, we were compelled to visit numerous households, which may have introduced selection bias. Secondly, because the study was cross-sectional, its conclusions might only be applicable to a specific point in time, and an extended investigation is necessary to examine the long-term implications. Finally, due to time constraints, we could not gather data from a more diverse range of locations.

Despite these limitations, this study provides valuable insights into individuals' experiences and perceptions surrounding the COVID-19 vaccine. By identifying potential barriers to accessing a fourth dose of the vaccine and developing strategies for addressing these barriers, further qualitative research can be invaluable for public health officials and policymakers as they work to ensure equitable access to the vaccine.

Conclusion

In conclusion, our study found that the participants were positive towards receiving the COVID-19 vaccine but lacked knowledge about it. Despite their positive attitude, they faced significant barriers and challenges. Although the government's efforts to control the spread of the virus,

ensuring proper safety measures has proven difficult due to socioeconomic factors. Therefore, it is crucial for policymakers and researchers to implement health education programs and interventions to improve the health and well-being of the population in Bangladesh, as the virus continues to spread even after three years and the fourth vaccination program is underway. Further research is recommended to gain a more comprehensive understanding of the perceptions and barriers surrounding the COVID-19 pandemic in Bangladesh.

Author Contributions: MK and KIS conceptualized and designed the study with TA. contributing. RSR and MK developed tools and supervised data collection. RSR, FA, MFR and TA[1] analyzed the data. TA[1] and MK developed the manuscript. MKH, MK and KIS critically reviewed the draft paper. All authors have read and agreed to the published version of the manuscript.

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Ethics Approval Statement: The Ethical Review Committee of the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) approved the study (Ref. PR-21125). Informed consent was obtained from each participant. Before the interviews were recorded, interviewees gave verbal consent, which was recorded. We assured interviewees that their participation was entirely voluntary and that all information provided would be de-identified, ensuring the anonymity and privacy of the information shared.

Data Availability Statement: The Guidelines for IDI that support the findings in the study are included in the Supplementary Material; further inquiries can be directed to the corresponding author.

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Conflicts of Interest: There is no conflict of interest

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Barriers and perceptions of taking the COVID-19 vaccine among poor Bangladeshi adults: a cross-sectional mixed-methods survey

In-depth interview guidelines

General Information

1. Respondent's general information (division, district, age, gender, occupation of both spouses, income, education (if informal education like a scholar or an Islamic scholar, mention that), number of household members, sanitation facilities (water and toilet facilities).

Concept of COVID-19

2. Have you heard about COVID-19? Where or from whom did you hear about it? What was your initial perception when you first heard about this disease? (Please provide details.) Did the coronavirus have any economic or social impact on your household? (For example: work situation, communication and social barriers with relatives, etc.)
3. What are the symptoms of the coronavirus? (e.g., dry cough, fever, fatigue, sore throat, sneezing, upset stomach, diarrhoea, vomiting, headache, body aches, feeling cold, and breathing difficulties). Did you experience any of these symptoms of COVID-19? (For example: if you experienced symptoms, did you get tested? What were the test results? If you didn't get tested, why not, and what actions did you take if you tested positive?)
4. How does the coronavirus spread? (For example: by shaking hands with an infected person, touching an infected person, being in close proximity to an infected person without any form of contact, through respiratory droplets, not washing hands after using the toilet, touching surfaces in the infected area and then touching the face or nose, or consuming contaminated food.) What preventive measures could be taken to control the spread of this illness?

Perceptions of COVID-19 Vaccination

1. What were the general perceptions regarding the COVID vaccine? (effectiveness, benefits)

2. Did you have any reactions or side effects after receiving the COVID-19 vaccine? If so, what were they?
3. How did anyone's religious beliefs influence their perception of COVID-19 and the role of vaccines?
4. How did you perceive the role of the government in implementing a nationwide vaccination programme?

Misconceptions towards COVID-19 Vaccination

9. What were the initial concerns about side effects during the vaccination programme? (For example: perception of side effects, specific concerns, fear, religious beliefs, any myths, misinformation.)
10. Is there any specific group of people that you believe should not receive vaccines? (For example: specific age groups, individuals with certain medical conditions, pregnant women)

Attitude towards COVID-19 Vaccination

11. What is your attitude towards the COVID-19 vaccine? Do you believe that the COVID-19 vaccine helps control or prevent the spread of the coronavirus? (For example: why or why not?) Do you know how many doses are required for the COVID-19 vaccination to be effective in controlling the virus? What are your thoughts on the benefits of the COVID-19 vaccination? (For example: mental peace, immunity, social acceptance, physical well-being, etc.)

Barriers to COVID-19 Vaccination

12. Have you received the COVID-19 vaccine? Can you tell me why you chose to get vaccinated or not? (For example: gender/family members' preferences, cost, perceived unnecessariness, age, non-communicable diseases, vaccine expiration, feeling well without vaccination, short-term efficacy, natural protection against COVID-19, receiving the vaccine from abroad or another country, and pregnancy complications.)

13. Which vaccine does he/she want to take (if no vaccine preference has been mentioned so far)?

Opportunities and Benefits of Vaccination, Vaccine Supply, and Management

14. Did you face any barriers when registering for the vaccine through the website? If yes, what type of barrier was it? (Note: did not have internet access, did not know the procedure for registration, did not receive any SMS, there was a delay in receiving SMS, received one dose but no vaccine supply, the vaccination centre was far from my area, had to roll up the sleeves during vaccine administration, had to stand in a long queue, and Indian vaccine).
15. What are the main barriers to the management of COVID-19 vaccines? (Note: need to go to the hospital, time-consuming, inadequate behaviour of vaccine workers, difficulties for young children and in the workplace, etc.)
16. In order to bring everyone within the ambit of vaccination, what kind of steps do you think the government needs to take? Do you have any recommendations on this matter? If so, please elaborate.

Manuscript: COVID-19 vaccine barriers and perception among rural adults: A qualitative study in Bangladesh

Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

Developed from:
Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	Page 5
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	Page 5
3. Occupation	What was their occupation at the time of the study?	Page 5 and 6
4. Gender	Was the researcher male or female?	Page 5
5. Experience and training	What experience or training did the researcher have?	Page 5
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	Page 6 .
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	Page 6
8. Interviewer characteristics	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	Page 6

Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	Page 5 and 6
Participant selection		
10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Page 6
11. Method of approach	How were participants approached? e.g. face-to-face, telephone, mail, email	Page 5 and 6
12. Sample size	How many participants were in the study?	Page 6
13. Non-participation	How many people refused to participate or dropped out? Reasons?	N/A
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	Page 6 .
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	Page 6 Inferred as one to one interviews
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	Page 6
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	Supplementary file and page 5
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	No
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	Page 7
20. Field notes	Were field notes made during and/or after the interview or focus group?	Page 7

21. Duration	What was the duration of the interviews or focus group?	Page 6
22. Data saturation	Was data saturation discussed?	Page 7
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	Page7
25. Description of the coding tree	Did authors provide a description of the coding tree?	Page 7
26. Derivation of themes	Were themes identified in advance or derived from the data?	Page 7
27. Software	What software, if applicable, was used to manage the data?	N/A
28. Participant checking	Did participants provide feedback on the findings?	No
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Page 10 to 15
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes, there was. Page 8 to 15
31. Clarity of major themes	Were major themes clearly presented in the findings?	Yes. they were. From page 8 to 15
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Discussion of major themes From page 15 to 18