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Exploring the Prevalence and Determinants of COVID-19 Vaccine Acceptance among the Urban Slum Dwellers of Bangladesh: A Cross-Sectional Study

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ABSTRACT

Background: Despite the COVID-19 vaccine being proven safe and effective against the novel SARS CoV-2 virus, it has been challenging to bring the socio-economically disadvantaged urban slum dwellers of Bangladesh under vaccination coverage. Therefore, this study was conducted with the aim to determine the extent and determinants of COVID-19 vaccine acceptance among the urban slum-dwellers of Bangladesh.

Methodology: This cross-sectional study was conducted in seven urban slums of Dhaka city (capital of Bangladesh) in July 2021 with 318 participants via face-to-face interview using a semi-structured questionnaire. The association of various socio-demographic, economic, religious, knowledge, and health service-related factors with the COVID-19 vaccine acceptance was analyzed using a multivariate regression method.

Result: The majority of the participants were day-laborers (32.02%), and 58.49% were male. Only 8% of the household of slum dwellers earned above 25000 Tk, and 35.85% received no education. Almost 40% of the participants had elderly (>60 years old) family members in their households, and only 16 participants received a dose of COVID-19 vaccination at the study. Among the 302 participants who had not received the vaccination, 62.58% of participants stated their willingness to receive the COVID-19 vaccine in the future. The majority (58%) preferred local vaccine camps to receive vaccines rather than going to the designated healthcare facilities. The results from the multivariate logistic regression revealed that the participants who were 60 years or older (aOR: 1.78, CI: 0.56-5.68), had adequate knowledge regarding COVID-19 symptoms (aOR: 4.49, CI: 2.14 – 9.39), had comorbid patients in their households (aOR: 2.56, CI: 1.13 – 5.83), had no religious misconceptions ((aOR:6.38, CI: 3.31 - 12.29), and did not doubt the safety of the vaccine (aOR: 2.56, CI: 1.00 – 6.57) showed higher odds of COVID-19 vaccine acceptance.

Conclusion: Appropriate measures should be taken to enhance the knowledge and dispel the misconceptions of the urban slum-dwellers regarding the COVID-19 vaccine. Also, local vaccination camps should be set up in the slum areas to increase the vaccination coverage among the slum-dwellers to bring them under vaccination coverage as soon as possible.

Keywords

COVID-19, Pandemic, Vaccine, Urban Slum-Dwellers, Bangladesh

Introduction

The emergence of the COVID-19 virus was first reported in China on December 31, 2019, and consequently, it was declared a pandemic by the World Health Organization on March 11, 2020 [1]. Soon many countries around the world were overwhelmed with the growing number of COVID-19 patients and struggled to cope with the burden put by the pandemic on their communities. Till this date, COVID-19 has affected 216 million people and taken almost 4.5 million lives worldwide [2]. The health systems of most of these affected countries were struggling to deal with the high volume of patients affected by the novel SARS CoV-2 virus. The low- and middle-income countries (LMICs) suffered more from the pandemic due to their lack of resources and preparedness [3]. Due to its novel nature, the treatment protocol of COVID-19 was uncertain initially, and no known effective vaccine was there to control the surge of the disease. However, after continual efforts from researchers worldwide, various brands of vaccines for the COVID-19 virus were successfully developed around December 2020 [4]. Although there have been difficulties in producing the COVID-19 vaccine for the entire global population, the countries have continued efforts to inoculate as much as their people with the vaccine as soon as possible to reduce the burden of the disease. However, there have been variations in acceptance of the COVID-19 vaccine among many people, and the issue of 'vaccine hesitancy' among the public has been reported by other studies as well [5], [6], [7].

Being an overpopulated country with scarce resources and a weak health system, Bangladesh was also challenged when the COVID-19 pandemic began [8]. As of October 30, 2021, the country has around 1.56 million confirmed cases and around 27 thousand deaths caused by COVID-19 [9]. The government of Bangladesh has taken several initiatives to ameliorate the situation, such as imposing a countrywide lockdown to curb the spread of the virus and establishing many dedicated COVID-19 hospitals to treat the affected patients [10], [11]. Conversely, the health system of the country struggled with a lack of personal protective gears for their healthcare workers and scarcity of essential hospital equipment (e.g., oxygen cylinder, ventilators, ICU facilities, essential medicine, and diagnostic facilities, etc.), which made it extremely difficult to manage the overall situation resulting from the pandemic [12], [13]. Therefore, when the COVID-19 vaccine was developed in December 2020, the Bangladesh government took measures to procure vaccines for their population, and the inauguration of the first dose of COVID-19 vaccination was done in the country on January 27, 2021 [14]. Due to the insufficiency of the received vaccine initially, registration of the vaccine through the government app called 'Surokkha' was restricted to priority groups of people only (e.g., healthcare workers, police, citizens above 50 and older). Gradually, with the procurement of more vaccines, the

government started to lower the bar for the age group and began vaccinating the younger population groups as well. The government initially targeted to vaccinate 10 million people each month to achieve 80% vaccination coverage by 2021 in the country to obtain herd immunity in the communities [15], [16]. However, the issue of hesitancy in taking the vaccine by the people has been proven to be a key challenge in many countries worldwide [17]. A lower level of knowledge and awareness regarding the symptoms, transmission routes, and consequences of COVID-19, socio-political ideology, fear and stigma regarding the safety and effectiveness of the vaccine etc. have been identified as some crucial reasons behind the unwillingness of general people to take the COVID-19 vaccine by other studies [18], [19], [20].

The hesitancy in taking vaccines has been reported by other studies conducted in Bangladesh as well, [21], which is alarming considering the effect of the COVID-19 disease and the limited capacity of their healthcare system to provide support to a large volume of patients. Simultaneously, there is evident health inequality among various population groups across Bangladesh, making the people from the marginalized and socio-economically disadvantaged section of the country more vulnerable to the consequences of the COVID-19 pandemic [22]. In particular, the urban slum dwellers in the country have always struggled financially and been deprived of proper access to quality healthcare services due to the country's inequitable healthcare delivery and financing structure. The level of education and awareness regarding health and well-being have also been low among them owing to their socio-economic struggles [23] [24]. The majority of the urban slum-dwellers of Bangladesh are low-income people who migrated from the rural and remote areas of the country in search of their livelihood. The environment and living conditions of these slums are quite poor and unhygienic. According to previous data, around 4 million people who live in slum areas of the country reside in a congested environment, and almost 75% of these families live in single rooms [25]. Almost 45% of slum inhabitants suffer from infectious and parasitic diseases on a regular basis. However, the majority of the slum population undergo severe financial struggle; thereby, nearly 65% of the population are unable to seek healthcare owing to their lack of money [23]. Consequently, 82.4% of slum dwellers seek healthcare from informal and unqualified healthcare providers, whereas only 13.9% are able to seek healthcare from formal healthcare professionals [26]. On top of that, the health and economic consequences of the pandemic have further added to their difficulties and harshly affected their lives from the very beginning [27]. Under these circumstances, the potential unwillingness of the slum-dwellers to take the COVID-19 vaccine can make them more vulnerable to the COVID-19 virus. Evidence from other countries has also found the vaccine refusal rate significantly higher among urban slum dwellers, especially older adults, including day laborers, rickshaw pullers, housemaids, homemakers, and low-educated people [21]. Therefore, it is important to assess the extent and determinants of COVID-19 vaccine acceptance among the urban slum dwellers of Bangladesh.

There have been some studies conducted on COVID-19 vaccine acceptance among the general population of Bangladesh. However, no studies have been done to our knowledge till this date that focused solely on the extent and determinants of COVID-19 vaccine acceptance among the urban slum-dwellers of the country.

Therefore, this study has been designed to assess the knowledge of the urban-slum dwellers of Bangladesh regarding the COVID-19 and identify the extent and determinants of COVID-19 vaccine acceptance among them. The findings of this study will help inform the government and policymakers of the country about the reasons behind the unwillingness and hesitancy to receive the COVID-19 vaccine by the urban slum-dwellers, which will help them develop effective interventions to remove these barriers and bring the slum-dwellers under the vaccination coverage as soon as possible.

Methodology

Study design and Sample Size

A cross-sectional survey was conducted in seven different slums of Dhaka, Bangladesh, between July 12 to July 19, 2021, for this research. Face-to-face interviews were done with the participants of the study methods to obtain data from using a semi-structured questionnaire. Considering the pandemic, data were collected to maintain all necessary safety protocols. In total, 318 slum-dwellers from various slums of Dhaka city participated in our study.

Data Collection

Data were collected from adults aged 18 or above from seven different slum areas of Dhaka (i.e., Korail, TB gate, Nabodoy housing, Adabor, Mirpur-1, Mirpur-12, and Rayer Bazar). The households in the slum were selected using a random sampling technique, and only one adult member from each selected household was interviewed. The objectives of the study and the rights of the participants were described in detail by the enumerators prior to the interview, and written informed consent was obtained from the respondents who were willing to participate. The study did not include anybody who did not want to participate or provide their consent. The interview was conducted in Bangla to understand the participants as it is the native language of Bangladesh. Participants were not given any incentives or remuneration for taking part in the study. The study questionnaire was developed based on literature review [28], [29], [30] and in consultation with the experts in the field. The questionnaire was divided into the following five sections: socio-demographic information, knowledge, attitude, and perception towards COVID-19, knowledge, and belief regarding COVID-19 vaccine, willingness to receive vaccination for COVID-19, and reasons behind the willingness or hesitancy.

Statistical Analysis

Following data collection, data processing, including editing, cleaning, coding, verifying the data, and checking them for consistency, was done to prepare the data for analysis. To analyze the collected data, STATA version 14.1 was used. To represent the nominal variables of the study, frequencies and proportions were applied. Consequently, bivariate logistic regression was performed from where the significant variables (p -value less than 0.05) were fitted into a multinomial regression model to identify the key determinants of COVID-19 vaccine acceptance among the participants. The findings were presented in terms of adjusted odds ratio (aOR) with a corresponding 95% confidence interval, and statistical significance was counted at a p -value of less than 0.05.

Result

Socio-demographic characteristics and prevalence of vaccine acceptance

Table 1 showcases the socio-demographic attributes of the study participants. This study included 318 participants from the urban slum regions of Dhaka, Bangladesh. The most common age group was 30-59 years (n = 186, 58.49%). Almost 60% of respondents were male (n= 187) and around 94% were married (n = 297). In the sample, 87.42% of participants were Muslim (n= 278), and the rest, 12.58%, were from the Hindu religion. Majority of our respondents had a primary education level (5 years of schooling) (n = 123, 38.68%) followed by illiteracy (0 years of schooling) (n = 114, 35.85%). The majority (n=105, 32.02%) of our participants were day laborers (those who earn daily labor). About 27% were small and medium business holders (n = 85), around 15% (n=46) 'Service holders' (those earning a monthly salary), and 20.13% (64) were housewives. Most of the participants (n = 104, 32.70%) of our study had an income of 10,000-15,000 BDT. The least earning group included people earning <5000 per month (n=26, 8.18%), whereas only 8% had an income of over 25000 taka. Almost an equal portion of participants belonged to small (4 people) (n = 170, 54.06%) and Large (5 people) (n = 148, 45.94%) families. Almost 40% of the participants had an elderly member (>60) in their family members (n =116, 36.48%). During the data collection period, only sixteen of the 318 participants had received at least one dosage of the COVID-19 vaccine. The remaining 302 individuals had not been immunized at that time. Among these 302 participants, around 62.58% showed willingness to receive the vaccine in the future, whereas the rest were hesitant/unwilling to take the vaccine.

Table 1: Socio-demographic characteristics and prevalence of vaccine acceptance among participants

| Variables | Categories | N (%) |
|----------------|----------------------------------|--------------|
| Age (Years) | 20-34 | 103 (30.39) |
| | 35-59 | 186 (58.49) |
| | ≤60 | 29 (9.12) |
| | Total | 318 (100.00) |
| Gender | Male | 187 (58.81) |
| | Female | 131 (41.19) |
| | Total | 318 (100.00) |
| Religion | Muslim | 278 (87.42) |
| | Hindu | 40 (12.58) |
| | Total | 318 (100.00) |
| Marital status | Married | 297 (93.40) |
| | Unmarried | 11 (3.46) |
| | Widow/divorced | 10 (3.14) |
| | Total | 318 (100.00) |
| Education | Illiterate | 114 (35.85) |
| | Primary | 123 (38.68) |
| | Secondary | 64 (20.13) |
| | Higher secondary | 13 (4.09) |
| | Graduation or above | 4 (1.26) |
| | Total | 318 (100.00) |
| Occupation | Service holders (Public/Private) | 46 (14.47) |
| | Day laborer | 105 (33.02) |
| | Business | 85 (26.73) |
| | Housewife | 64 (20.13) |
| | Unemployed | 10 (3.14) |
| | Others | 8 (2.52) |
| | Total | 318 (100.00) |

| | | |
|---|--------------------|--------------|
| Monthly Income (BDT) | <5000 | 26 (8.18) |
| | 5,000-10,000 | 67 (21.07) |
| | 10,000-15,000 | 104 (32.70) |
| | 15,000-20,000 | 73 (22.96) |
| | 20,000-25,000 | 23 (7.23) |
| | 25,000-30,000 | 18 (5.66) |
| | >30,000 | 7 (2.20) |
| | Total | 318 (100.00) |
| Family size | Small (≤ 4) | 170 (54.06) |
| | Large (≥ 5) | 148 (45.94) |
| | Total | 318 (100.00) |
| Elderly members (≥ 60) | Yes | 116 (36.48) |
| | No | 202 (63.52) |
| | Total | 318 (100.00) |
| Vaccine acceptance | Willing | 189(62.58) |
| | Hesitant | 113(37.42) |
| | Total | 302 |

Knowledge, attitude, and perception towards COVID-19

According to the World Health Organization (WHO), symptoms of COVID-19 were divided into three categories (1) common symptoms, (2) less common symptoms, and (3) severe symptoms. *Figure 1* shows the participants' knowledge regarding these three levels of COVID-19 symptoms among the slum dwellers. Each participant was asked about the symptoms of COVID-19, which were cross-checked thoroughly to collect the correct data. Among 318 participants, almost 79.25% knew the most common symptoms, 70.44% knew the less common symptoms, and almost more than half did not know the severe COVID-19 symptoms.

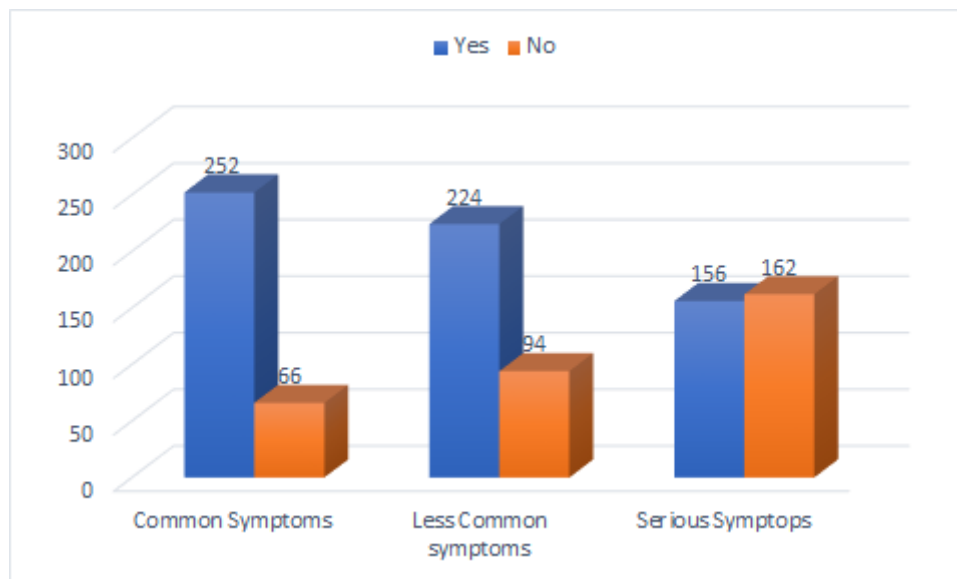
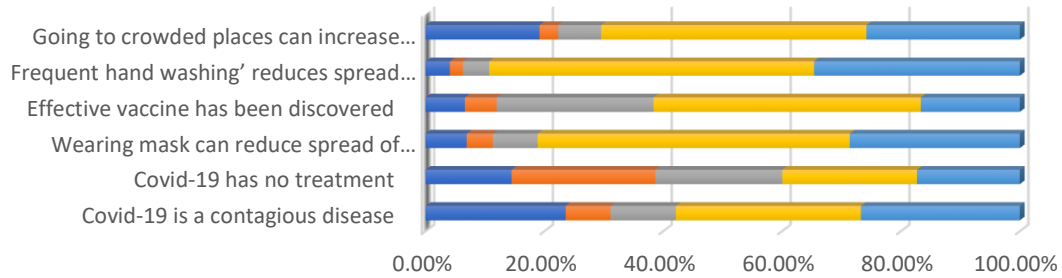


Figure 1: Knowledge regarding COVID-19 symptoms

When asked about their perception regarding the COVID-19 disease, only 23.58% of participants strongly disagreed with the statement that COVID-19 is contagious. Then, on the issue of curative treatment for COVID-19, around 40% stated that COVID-19 has no curative treatment. About 62% of participants said that effective vaccines for the COVID-19 virus had been discovered. Additionally, the majority of the participants felt that frequently washing hands (89%) and avoiding crowded places (70%) can reduce the risk of infection. (See *Figure 2*)

Knowledge about Prevention of Covid-19



| | Covid-19 is a contagious disease | Covid-19 has no treatment | Wearing mask can reduce spread of infection | Effective vaccine has been discovered | Frequent hand washing' reduces spread of virus | Going to crowded places can increase chances of infection |
|-------------------|----------------------------------|---------------------------|---|---------------------------------------|--|---|
| Strongly Disagree | 23.58% | 14.47% | 6.92% | 6.60% | 4.09% | 19.18% |
| Disagree | 7.55% | 24.21% | 4.40% | 5.35% | 2.20% | 3.14% |
| Neutral | 11.01% | 21.38% | 7.55% | 26.42% | 4.40% | 7.23% |
| Agree | 31.13% | 22.64% | 52.52% | 44.97% | 54.72% | 44.65% |
| Strongly Agree | 26.73% | 17.30% | 28.62% | 16.67% | 34.59% | 25.79% |

Figure 2: Knowledge regarding COVID-19 prevention

The majority of the participants think one should seek a professional medical doctors' advice if infected by COVID-19 or any suggestive symptom appears (strongly agreed 39.62% and agreed 45.92%). 19.50% of the participants were neutral that one should be hospitalized if infected, 6.92% strongly disagreed, and 9.75% disagreed that one needs to go to the hospital when infected by the COVID-19 virus. However, almost 86% of the participants disagreed with the effectiveness of going to informal healthcare providers such as faith healers, religious practitioners, etc., if infected by the COVID-19 virus. Around 65% of all participants agreed/strongly agreed to take the vaccine to prevent the disease (see Figure 3).

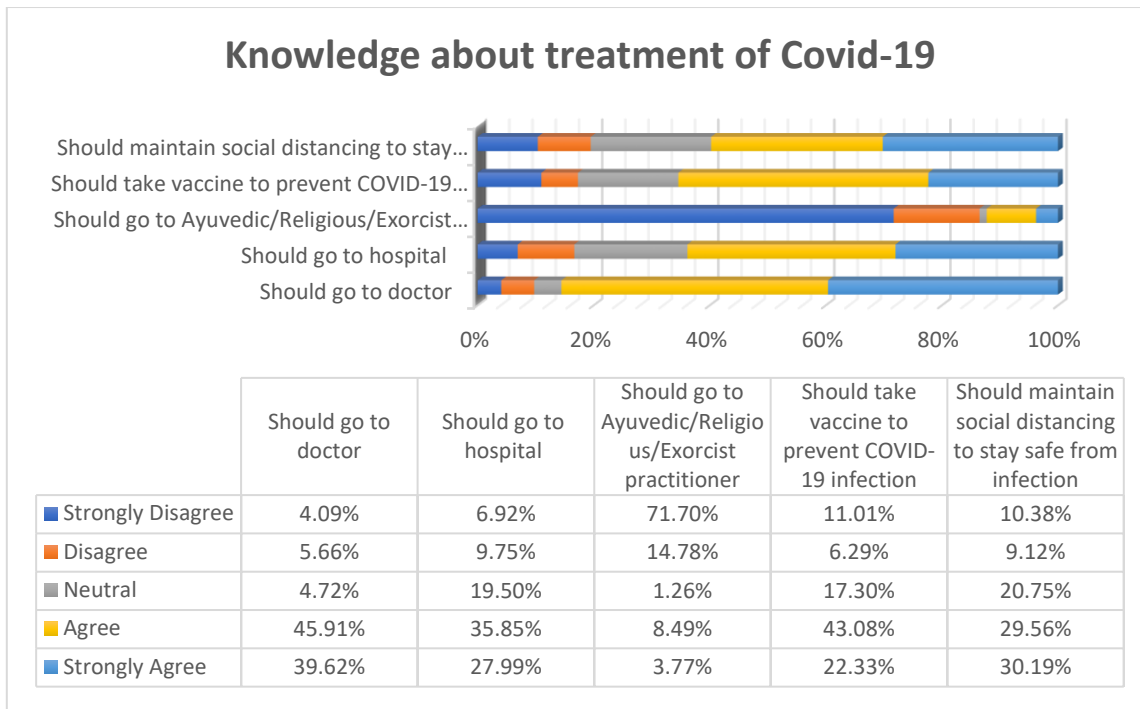


Figure 3: Knowledge regarding COVID-19 treatment

Sources of information regarding COVID-19

Figure 5 shows the sources of information about the COVID-19 virus and the vaccination process. Participants reported having multiple sources of information regarding COVID-19. For instance, most participants relied on their self-assumption (58.94%) and the information they received from their friends/neighbours (95.70%), whereas 48.68% also added mass media as a key source of information during the COVID-19 pandemic.

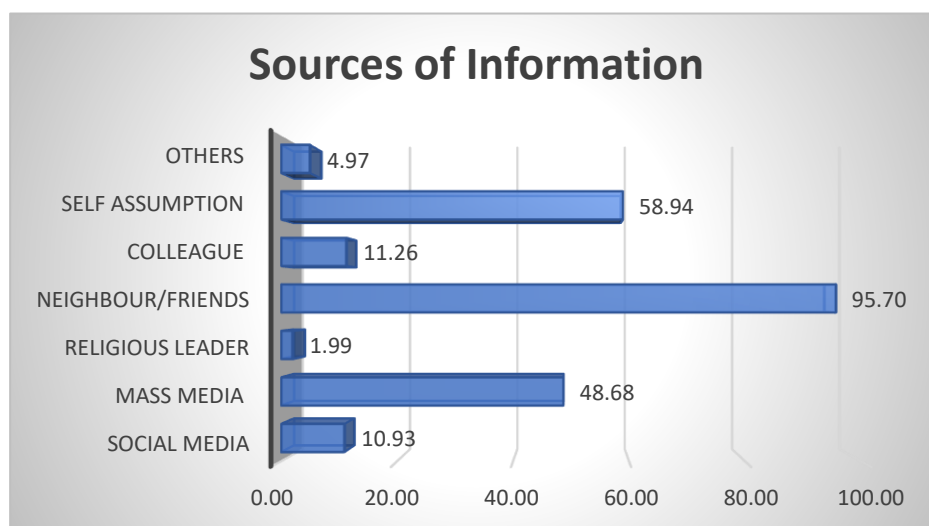


Figure 4: Sources of information (%)

Preferred location for COVID-19 vaccination

Figure 5 depicts the preferred location for receiving vaccination among the urban slum residents who participated in our study. Participants who did not receive the vaccine yet were asked their preferred method of taking the vaccine. The majority (58%) preferred to receive the vaccine through vaccination campaigns at their localities, whereas only 13% were willing to go to the hospitals to receive the vaccine.

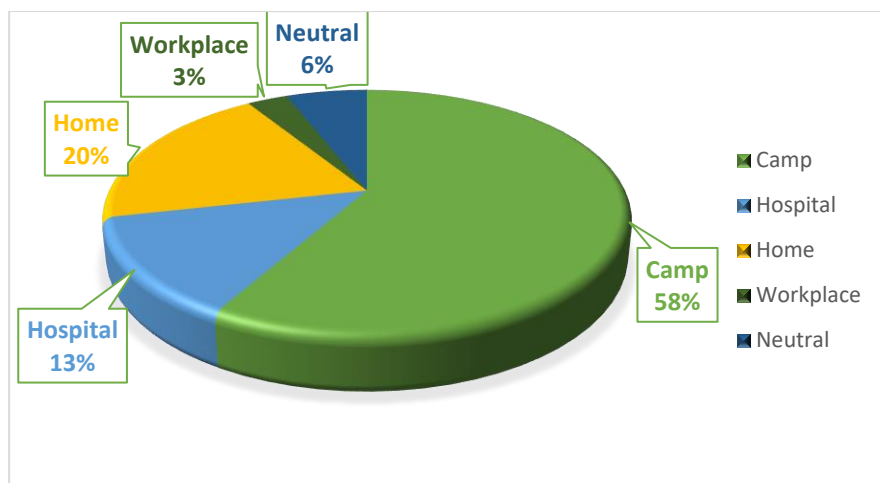


Figure 5: Preferred location to get vaccinated

Factors associated with COVID-19 vaccine acceptance

Table 2 presents the findings from bivariate analysis where the association of various factors, such as monthly family income, religion, family size, comorbidities, knowledge, and information regarding COVID-19, socio-cultural prejudice, and awareness regarding vaccine registration and inoculation procedure has been shown with the prevalence of COVID-19 vaccine acceptance. Participants who had not previously been vaccinated with any dose of the COVID-19 vaccine (n=308) were asked whether they were willing to receive the vaccination in the future. Several follow-up questions were asked, followed by their response to identifying the reasons behind their answers. Our findings showed that 37.82% of the people with family income below the median showed hesitancy in receiving COVID-19 vaccination, whereas 36.70% of those above the median showed hesitancy. Among the participants from the Hindu religion, 81.25% were interested in getting the vaccination, while 60.37% of Muslims were willing to get the vaccination. Individuals who were aware of the symptoms of COVID-19 had a higher level of interest in receiving the vaccination (69.17%) compared to the others. Participants having comorbid patients (such as diabetes) in the family were more interested in the vaccination (73.33%). Only 53 individuals voiced concerns about vaccine safety out of 302 participants who had not yet received the vaccination. Participants who had no concerns regarding vaccination safety showed a greater willingness to take the vaccination (65.46%). Participants who believed that 'side effects of the vaccination might hinder their daily life activities were less interested in taking the vaccine (45.45%). Also, individuals who believed they had strong immunity capable of surviving the COVID-19 disease exhibited significant hesitancy (73.08%) in taking the vaccine.

Conversely, intent to get vaccinated was higher among those who did not have any socio-cultural or religious misconceptions (84.89%) compared to others. People who believed the vaccination could contain 'haram' (proscribed by Islamic law) ingredients were more hesitant (55.56%) towards the vaccine. In contrast, those who did not believe in such a notion were more accepting of the vaccination produced by other religious adherents. Furthermore, those (n=25) who thought that vaccination was merely a conspiracy of industrialized countries towards financial gain exhibited significant hesitation (52.0%) in taking the vaccine.

Table 2: Factors associated with vaccine acceptance (willing or hesitant)

| Factors | Hesitant/Resistant n (%) | Willingness n (%) | P value |
|---|--------------------------|-------------------|---------|
| Monthly family income | | | |
| Below median | 73 (37.82) | 120 (63.49) | <.001 |
| Above median | 40 (36.70) | 69 (63.30) | |
| Religion | | | |
| Muslim | 107 (39.63) | 163 (60.37) | <.01 |
| Hindu | 6 (18.75) | 26 (81.25) | |
| Family size (Large) | | | |
| Large | 62 (43.97) | 79 (56.03) | <.01 |
| Small | 51 (31.68) | 110 (68.32) | |
| Knowledge regarding COVID-19 symptoms | | | |
| Adequate | 74 (30.83) | 166 (69.17) | <.001 |
| Inadequate | 39 (62.90) | 23 (37.10) | |
| Knowledge regarding COVID-19 vaccine | | | |
| Adequate | 95 (44.19) | 120 (55.8) | <.001 |
| Inadequate | 18 (20.69) | 69 (79.31) | |
| Comorbidities in family | | | |
| Yes | 16 (26.67) | 44 (73.33) | <.05 |
| No | 97 (40.08) | 145 (59.92) | |
| Doubt regarding the safety of the vaccine | | | |
| Yes | 27 (50.94) | 26 (49.06) | <.05 |
| No | 86 (34.54) | 163 (65.46) | |
| Thought side effects of the vaccine can hamper daily life | | | |
| Yes | 30 (54.55) | 25 (45.45) | <.001 |
| No | 83 (33.60) | 164 (66.40) | |
| Believed in the strength of their immune system | | | |
| Yes | 38 (73.08) | 14 (26.92) | <.001 |
| No | 75 (30.12) | 174 (69.88) | |
| Had religious misconceptions | | | |
| Yes | 92 (56.44) | 71 (43.56) | <.001 |
| No | 21 (15.11) | 118 (84.89) | |
| Thought that vaccine may contain 'haram' (forbidden) ingredients | | | |
| Yes | 10 (55.56) | 8 (44.44) | <.05 |
| No | 103 (36.27) | 181 (63.73) | |
| Not willing to take vaccines made by other religious followers | | | |
| Yes | 9 (56.25) | 7 (43.7) | <.05 |
| No | 104 (36.49) | 181 (63.51) | |
| Believed that vaccination is propaganda by developed countries | | | |
| Yes | 13 (52.00) | 12 (48.00) | <.05 |
| No | 99 (35.87) | 177 (64.13) | |

(*** $p < .01$, ** $p < .05$, * $p < .1$; cOR: Crude Odds Ratio; CI: Confidence Interval)

Finally, the multivariate logistic regression (Table-3) has revealed a significant association of several independent variables with COVID-19 vaccine acceptance among the participants. Older adults were more likely to accept the vaccine than young people, with the 35-59 and above 60 age groups being more eager to receive the vaccine (aOR: 1.55, CI: 0.78-3.07 and aOR: 1.78, CI: 0.56-5.68 respectively). Moreover, participants aware of COVID-19 symptoms were more likely to take the vaccine than those unaware of COVID-19 symptoms (aOR: 4.49, CI: 2.14 – 9.39). Participants with at least one family member with comorbid conditions showed more interest in getting the vaccine (aOR: 2.56, CI: 1.13 – 5.83). Those who felt that COVID-19 vaccines are needed disregard the status/strength of their immune system showed a higher likelihood of getting vaccinated than those who believed that their immune system is strong enough to combat

COVID-19 without the vaccine (aOR: 5.31, CI: 2.31 – 12.21). Participants not harboring any religious misconceptions (e.g., COVID-19 is a curse by God and God can only save them from the disease, not vaccine) showed significant acceptance towards the vaccine compared to the other group (aOR:6.38, CI: 3.31 - 12.29). Moreover, the odds of vaccine acceptance were higher among the participants who did not doubt the safety of the COVID-19 vaccine (aOR: 2.56, CI: 1.00 – 6.57).

Table 3: Multivariate analysis of determinants of COVID-19 vaccine acceptance

| Factors | Crude OR | 95% CI | Adjusted OR | 95% CI |
|--|----------|-------------|-------------|--------------|
| Education | | | | |
| ≤Primary | 1 | 1 | 1 | 1 |
| > Primary | 1.29 | .74 - 2.28 | 1.31 | 0.62 - 2.81 |
| Gender | | | | |
| Female | 1 | 1 | 1 | 1 |
| Male | 1.42 | .89 - 2.28 | 1.18 | 0.61 - 2.80 |
| Age | | | | |
| <35 | 1 | 1 | 1 | 1 |
| 35-59 | 1.05 | .63 - 1.73 | 1.55 | 0.78 - 3.07 |
| >60 | .82 | 1.11 - 2.48 | 1.78 | 0.56 - 5.68 |
| Religion | | | | |
| Muslim | 1 | 1 | 1 | 1 |
| Hindu | 2.84** | 1.13 - 7.14 | 1.14 | 0.37 - 3.47 |
| Family size | | | | |
| Large | 1 | 1 | 1 | 1 |
| Small | 1.69** | 1.06 - 2.71 | 2.51*** | 1.34 - 4.69 |
| Occupation | | | | |
| Unemployed | 1 | 1 | 1 | 1 |
| Service holders | 1.6 | .36 - 7.07 | 2.69 | 0.40 - 18.24 |
| Day laborer | 1.26 | .32 - 4.97 | 2.56 | 0.43 - 15.31 |
| Businessman | 1.27 | .32 - 5.10 | 2.80 | 0.45 - 17.39 |
| Housewife | 1.91 | .34 - 5.71 | 3.98 | 0.58 - 27.44 |
| Others | 2.4 | .30 - 19.04 | 5.49 | 0.36 - 83.24 |
| Knowledge regarding COVID-19 symptoms | | | | |
| Inadequate | 1 | 1 | 1 | 1 |
| Adequate | 3.80*** | 2.12 - 6.82 | 4.49*** | 2.14 - 9.39 |
| Had comorbid family members | | | | |
| No | 1 | 1 | 1 | 1 |
| Yes | 1.84** | .98 - 3.44 | 2.56*** | 1.13 - 5.83 |
| Side effects of the vaccine can hamper daily life | | | | |
| Yes | 1 | 1 | 1 | 1 |
| No | 2.37*** | 1.31 - 4.29 | 2.01 | 0.92 - 4.38 |

| Had faith in the strength of their immune system | | | | |
|---|---------|--------------|---------|--------------|
| Yes | 1 | 1 | 1 | 1 |
| No | 6.29*** | 3.22 - 12.30 | 5.31*** | 2.31 - 12.21 |
| Had religious misconception | | | | |
| Yes | 1 | | 1 | |
| No | 7.28*** | 4.17 - 12.72 | 6.38*** | 3.31 - 12.29 |
| Doubted the safety of the vaccine | | | | |
| Yes | 1 | 1 | 1 | 1 |
| No | 1.31*** | 1.86 - 7.51 | 2.56** | 1 - 6.57 |

(*** $p < .01$, ** $p < .05$, * $p < .1$; cOR: Crude Odds Ratio; CI: Confidence Interval)

Discussion

The study was conducted to assess the knowledge of the urban slum-dwellers of Bangladesh regarding COVID-19 along with the extent and determinants of COVID-19 vaccine acceptance among them. Around 62.58% of our participants (who did not receive a single dose of COVID-19 at the time of data collection) showed willingness to receive the vaccine in the future. In contrast, the rest were hesitant/unwilling to take the vaccine. Findings from a study conducted among the slum-dwellers of Brazil also showed similar findings to ours and reported the willingness to receive the COVID-19 vaccine to be around 66% [31]. Interestingly, a previous study conducted on Bangladeshi adults showed the willingness to receive the COVID-19 vaccine among 74.6% of the study participants [21]. However, this study was conducted on the general population of Bangladesh, inclusive of all socio-economic groups. On the other hand, our study only included the urban slum dwellers of Bangladesh, who are considered as one of the socio-economically disadvantaged population groups in the country owing to their low level of education, income, and access to healthcare services [32]. These challenges experienced by the urban slum-dwellers of Bangladesh could attribute to their low acceptance rate of the COVID-19 vaccine.

Our study found that religious beliefs played a significant role in decision-making regarding vaccine acceptance among many participants. For instance, Muslim participants were comparatively more hesitant to take the COVID-19 vaccine than the participants from other religions due to their doubts and lack of knowledge regarding the components of the vaccine. Since the beginning of the COVID-19 vaccine development process, various misconceptions and myths have been spread among people, such as the vaccine contains 'haram' (religiously forbidden) ingredients like pig-derived products and so on; thereby, conflicting their decision-making regarding the vaccine acceptance. Similar misconceptions and doubts were previously noticed among people from certain religious groups in cases of other vaccines (e.g., polio) [33]. Study findings from Pakistan have found similar reasons associated with religious beliefs behind vaccine hesitancy among their people [34]. Some participants from our study also believed that COVID-19 is a punishment from God for the people who earn their livelihood in a haram manner. Consequently, they stated that because they do not earn or act in any such ways; therefore, God himself will protect them from the disease, which is why they

did not need to take any vaccine to protect themselves. Another study conducted among participants from India, Pakistan, and Bangladesh corroborated our findings as it also found that having such belief in God and karma acted as an important factor behind the COVID-19 vaccine hesitancy among people [35].

This study also found the overall level of knowledge about COVID-19 and the vaccine among the slum dwellers to be inadequate, which might have added to their unwillingness to receive the vaccine. Moreover, some people do not believe that COVID-19 is a contagious disease, so they were not concerned about getting infected easily by the virus and did not feel the urgency or were willing to receive the vaccine. Besides, our findings showed that the sources of information regarding COVID-19 and the vaccine to be mostly self-assumptions or hearsay evidence from their friends/neighbors, which led them to believe much misinformation regarding COVID-19 and misguided their decision-making regarding vaccine acceptance. Other studies also reported a similar effect of misinformation as a significant determinant behind vaccine hesitancy. Historically, the urban slum-dwellers of Bangladesh have low levels of education and awareness regarding health and well-being, resulting in an increased prevalence of various communicable and non-communicable diseases among them [23], [36]. Evidence from other countries has also found that inadequate knowledge and misinformation regarding the COVID-19 were a key cause behind the unwillingness to receive the COVID-19 vaccine among their participants [37]. Furthermore, the number of interventions/programs focused on educating the slum-dwellers on the necessity of preventative measures are quite limited in Bangladesh and no tailored vaccine intervention program was designed by the government for this vulnerable group of population either. This lack of appropriate information sources coupled with their own lack of awareness regarding the COVID-19 has resulted in lower vaccine acceptance among the urban slum-dwellers of Bangladesh.

Moreover, not having sufficient knowledge regarding COVID-19 disease and vaccine paired with the absence of reliable sources of information made them quite skeptical regarding the vaccine's safety. Accordingly, many participants were unwilling to accept the vaccine as they feared that the vaccine was not safe and would cause more physical harm in the long run if taken. A study on Brazilian slum dwellers also found that the willingness to get vaccinated depended on the participants' perception regarding the efficacy and side effects of the vaccine among people and the availability of adequate information to them [38]. Another study conducted on Jordanian people also showed that almost half of participants were unwilling to receive COVID-19 vaccines because of their skepticism regarding the vaccine's possible side effects [39]. Similarly, fear for the vaccine's side effects was found to be a vital factor behind vaccine hesitancy among Indian general people as well [40]. Another study conducted in the USA found that around 68% of people in the country did not oppose the vaccination campaign for COVID-19; however, they admitted to being worried about the vaccine's side effects, which created hesitancy among them regarding the COVID-19 vaccine inoculation [41]. Therefore, it is important for the government and policymakers of Bangladesh to develop targeted mass awareness campaigns for the urban slum-dwellers to resolve the misconceptions and paranoia regarding the vaccination among them. To increase these people's willingness to take vaccine, it is imperative to make them aware of the global and

national findings regarding the safety of the COVID-19 vaccines and assure them that the vaccines have been proven to be quite effective in reducing the prevalence and severity of symptoms of COVID-19 by several studies already [42], [43].

In our study, another reason behind the lower COVID-19 vaccine acceptance among the urban slum-dwellers was found to be the confidence of people in their own immune system. The majority of the slum dwellers claimed that their immune system is far stronger than the wealthier quintiles of Bangladeshi population groups. Therefore, they felt that they did not need to receive the vaccine to stay protected from the COVID-19 virus. It can be said that the low level of education, socio-cultural stigmas, and lack of awareness among these people have led to such misguided beliefs regarding vaccination. Moreover, they also believed that COVID-19 is a disease of the rich, not for the poorer groups like them. The health and living condition of the urban slum-dwellers have always been poor. As stated earlier, they struggle with various communicable and non-communicable diseases on a regular basis, furthermore, their low-income levels make it difficult for them to seek healthcare on a regular basis even when they are sick [23], [24]. Living with such struggles for a long time has made them reluctant to the consequences of the COVID-19 disease, and they have developed the confidence that their bodies are capable of fighting the COVID-19 virus without taking the vaccine.

In addition, this study also identified the challenges with the vaccination location and hours for the urban slum-dwellers of Bangladesh. Many of our participants were day-laborer by profession, and they earn their livelihood on a daily basis. The financial struggle of the urban slum-dwellers of Bangladesh has been described by other studies as well [44], [45]. Because of the lockdown and closure of offices/businesses due to the COVID-19 pandemic, it became more challenging for them to find work and added further to their financial struggle. Therefore, it became extremely difficult for them to miss even half a day of their work to get the vaccine. Unfortunately, the official vaccination hour in the designated facilities of Bangladesh (10:00 AM to 2: 00 PM) coincides with the prime working hours of the slum-dwellers.

Moreover, vaccination was only available in a few designated hospitals of the city, which are often situated far away from the slum areas where our participants inhabited. Therefore, going to these vaccination centers and waiting in line to get vaccinated incurred a considerable opportunity cost, which discouraged many of them from getting vaccinated. During our study, when they were asked about their preferred location for vaccination which would make it convenient for them to receive vaccination, majority of them stated that arranging setting up vaccination camps in their localities would allow them to receive the vaccination without missing much work. Some of the participants preferred the method of receiving vaccination from home more, especially the women who are unable to leave their households during daytime owing to their responsibilities in the household and inability to go to a hospital without the presence of a male member of the family. A study conducted on the poor economic groups of people from Mumbai, India, also found that the house-to-house approach of giving polio vaccination successfully achieved 83% coverage and zero incidences of Polio in the three years prior to the study [46]. Therefore, the government of Bangladesh can consider either setting up

local vaccination camps or deploying health workers to provide vaccination at home to ensure the receipt of the COVID-19 vaccine by the urban slum-dwellers in the country.

It should be mentioned that this study has certain limitations. Firstly, the study was conducted only among the urban slum-dwellers of Bangladesh. However, there are other socio-economically disadvantaged groups in Bangladesh who are going through similar inequity in their access and utilization of healthcare services, especially during the pandemic. Secondly, the sample size of our study is not quite large which may make its generalizability limited. Nevertheless, this study has some notable strength in generating important data relevant to the current context of the COVID-19 pandemic. For instance, considering the countrywide lockdown and social isolation protocols in place, most of the surveys on the vaccine acceptance issues in Bangladesh are being conducted online, which invariably excludes the socio-economically marginalized population groups who have limited knowledge and access to the necessary device to participate in an online survey. Therefore, the data we collected from the urban slum-dwellers through a face-to-face interview on this highly important topic of public health will be of immense value for the researchers and government policymakers. Furthermore, findings from this study can be used to compare the perspectives and opinions regarding COVID-19 vaccine acceptance among the general population and a marginalized group like the urban slum-dwellers, thereby providing a measure of inequity in access and utilization of healthcare in Bangladesh. We sincerely believe that our study has provided some insightful information that the policymakers should consider to develop appropriate mechanisms to vaccinate the urban slum-dwellers of Bangladesh against the COVID-19 virus and help improve their health and well-being during this period of unprecedented crisis.

Conclusion

The findings from this study have demonstrated some key challenges of implementing the COVID-19 vaccination program among the urban slum-dwellers of Bangladesh. This is a concerning topic since many Bangladeshi populations live in the slum areas and harbor various socio-cultural prejudice and misconception regarding the vaccination process. It has been evident from our study that the cumulative effect of the low level of education, lack of appropriate knowledge, social and religious misbeliefs regarding the vaccine has resulted in such hesitancy or resistance towards the COVID-19 vaccine among the slum dwellers. Therefore, appropriate measures should be taken to dispel the misconceptions of the urban slum-dwellers regarding the COVID-19 vaccine, and local vaccination camps should be set up to increase the vaccination coverage among this group of people in order to meet the goal of the COVID-19 vaccination campaign in Bangladesh.

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Author's contribution

All the authors designed and implemented the study together. After analysing the data, they prepared the manuscript and reviewed it before giving final approval for publication.

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Availability of data and material

The dataset of the current study is available from the corresponding author only upon reasonable request.

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