Acceptance of COVID-19 Vaccine and Its Determinants in Bangladesh

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Abstract

Background: Bangladesh govt. launched a nationwide vaccination drive against SARS-CoV-2 infection from early February 2021. The objectives of this study were to evaluate the acceptance of the COVID-19 vaccines and examine the factors associated with the acceptance in Bangladesh.

Method: In between January 30 to February 6, 2021, we conducted a web-based anonymous cross-sectional survey among the Bangladeshi general population. The multivariate logistic regression was used to identify the factors that influence the acceptance of the COVID-19 vaccination.

Results: 61.16% (370/605) of the respondents were willing to accept/take the COVID-19 vaccine. Among the accepted group, only 35.14% showed the willingness to take the COVID-19 vaccine immediately, while 64.86% would delay the vaccination until they are confirmed about the vaccine's efficacy and safety or COVID-19 become deadlier in Bangladesh. The regression results showed age, gender, location (urban/rural), level of education, income, perceived risk of being infected with COVID-19 in the future, perceived severity of infection, having previous vaccination experience after age 18, having higher knowledge about COVID-19 and vaccination were significantly associated with the acceptance of COVID-19 vaccines.

Conclusion: The research reported a high prevalence of COVID-19 vaccine refusal and hesitancy in Bangladesh. To diminish the vaccine hesitancy and increase the uptake, the policymakers need to design a well-researched immunization strategy to remove the vaccination barriers. To improve vaccine acceptance among people, false rumors and misconceptions about the COVID-19 vaccines must be dispelled (especially on the internet) and people must be exposed to the actual scientific facts.

Keywords: COVID-19 Vaccine; Vaccine acceptability; Vaccine perception; Knowledge, belief and attitude; Determinants; Bangladesh

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1 Introduction

The COVID-19 (the disease triggered by Severe Acute Respiratory Syndrome Coronavirus 2 (SARSCOV-2)) infection, declared as a "pandemic" by the World Health Organization, has spread to all the countries of the world and as of February 20, 2021, infected more than 111 million people and claimed more than 2.4 million innocent lives [1]. The emergence of COVID-19 has had a devastating effect on global healthcare systems with a ripple impact on every aspect of human life as we experience it. It has been branded as a black swan occurrence [2] and compared to the economic scene of World War Two [3]. With no proven treatments or medicines found, governments across the world imposed border blackouts, travel bans, and quarantine [4] in a bid to halt the spread of the virus that caused a voluminous economic downturn. The pandemic overwhelmed the healthcare systems worldwide as they cannot cope with the unprecedented number of patients requiring ICUs [5] and other special care. Numerous doctors, nurses, and other healthcare professionals were infected with the virus since they are in direct contact with COVID-19 patients and a significant portion of them died. Therefore, healthcare professionals have been affected by the increased burden of mental health issues [6]. As of today, the pandemic continues to ravage the world.

Scientists and researchers throughout the world have been working relentlessly to find a way to get rid of the lethal disease. To combat communicable diseases, vaccines are considered effective in developing a long-lasting immune system. About 2-3 million deaths per year are avoided by vaccination [7]. In pandemics such as 1957, 1968, 1976, and 1977 outbreaks and the H5N1 outbreak (1997-1998), and the 2009 H1N1 outbreak, many vaccines were developed [8]. In the case of the COVID-19 pandemic, about 100 vaccines are in pre-clinical/clinical trials and some of them have already been approved

for mass inoculation [9]. With the approval of vaccines for COVID-19, it is being expected that the pandemic can be controlled.

However, the development of vaccines is not the last thing to put an end to such a ubiquitous and devastating virus. Scholars of vaccine hesitancy and adoption are warning policymakers and the scientific community that a successful vaccine is only the beginning. Based on previous experiences with pandemic vaccines and vaccine hesitancy more broadly, a well-researched strategy for rollout and adoption might be required in every country [10]. Most current disease outbreak experience–the H1N1 outbreak in 2009, witnessed poor immunization amongst adults, one study showing that 26 percent of refusers were worried about safety and 17 percent did not believe in the vaccine [11]. A recent study conducted in the USA revealed that approximately 68% of all respondents are willing to get vaccinated against the COVID-19 with concerns about side effects and efficacy [12]. In a comprehensive survey of 19 nations conducted in June 2020, 72% of participants suggested they were either likely or very likely to take a vaccine, ranging from 89% in China to only 55% in Russia [13].

The question arises, "Why are people unwilling to get vaccinated against a devastating disease?". There is a plethora of research on the factors that influence vaccine uptake. Prior studies on seasonal and H1N1 influenza vaccinations have shown that vaccine attitudes and beliefs are linked to vaccination intentions, which are a good predictor of vaccination uptake [14,15]. According to one UK-based study, higher vaccination intentions were linked to the belief that the COVID-19 disease would last a lot longer, while lower vaccination intentions were linked to the belief that the dangers of COVID-19 had been inflated by the media [16]. Another study examined the links between vaccine intention and sociodemographic characteristics, concluding that lower vaccination intention was connected to younger age and Black and minority ethnicity [17]. However, the factors affecting vaccine intention and uptake might vary substantially by territory, culture, and socioeconomic conditions.

In Bangladesh, from the very beginning of the pandemic, a substantial amount of unawareness, rumors, and misinformation among general people about COVID-19 have been reported [18]. It is also expected that there might be considerable misinformation and hesitancy in taking COVID-19 vaccines. Bangladesh govt. has revised its plan to inoculate 3.5 million instead of 6 million in February 2021 due to lukewarm response to online registration for COVID-19 vaccination [19]. It also relaxed the age limit to 40 years from previously stated 55 years for general people. This points to the unwillingness of the people of Bangladesh about receiving a COVID-19 vaccine. Bangladesh govt. has ordered and paid for at least 30 million doses of Oxford-AstraZeneca vaccine that will be delivered in installments across 2021 and also will receive another 68 million shots under the Covax initiative [20], led by the World Health Organization and Gavi, the Vaccine Alliance [19].

The Bangladesh govt has done a tremendous job in securing a good amount of shots of vaccines. Now, the challenge is to persuade people to take the vaccines. This study aims at investigating the knowledge, attitudes, and intention of people towards COVID-19 vaccines and the factors associated with the intention to be vaccinated in Bangladesh. For these purposes, we conducted an online anonymous survey between January 30 to February 6, 2021. The importance of conducting such a study in context to Bangladesh cannot be stressed enough as it would act as a guide for the Bangladesh govt. to encourage uptake among the general population.

2 Methods

2.1 Study Design and study participants

In this study, we conducted a cross-sectional, web-based anonymous survey between January 30 to February 6, 2021. The participants were self-interviewed using an electronic questionnaire. They were able to take part in the survey after an eligibility check step. One who was aged 18 or over and lived in Bangladesh was able to participant in this survey. The question was translated into Bangla, which was developed in English. The respondents were informed that their participation was voluntary and after completing the survey they were requested to share the link with their contacts or acquaintances. Prior to circulating the questionnaire online, the questionnaire was validated and pilot tested.

2.2 Sample size

Since this study is aimed to examine the acceptability of the COVID-19 vaccine among the general population in Bangladesh and there was no previous literature from Bangladesh that examined the associated factors with this. We assumed that 50% of the general people have the factor of interest. And, we found the sample size is 591 using an online sample size calculator [21,22] by assuming a 65% percent response rate, 5% precision or margin error, and 50% proportion with a 95% confidence interval for the total population size of 1630046161 [23].

2.3 Instruments

The researchers shared and advertised the KoBoToolbox online survey link to the public throughout the social network platforms of Facebook, WhatsApp, and Email. The questionnaire consisted of 5 sections: (i) Demographic background; (ii) Knowledge about COVID-19 and COVID-19 vaccination (iii) Belief and attitude (iv) Perceived barrier, perceived likelihood, perceived severity (v) Vaccine acceptability. The questionnaire was based on previous research [24–26].

2.3.1 Demographic background

At the beginning of the survey, we completed the eligibility check by asking two questions "How old are you (in years)?" and "Do you currently live in Bangladesh?". This part of the questionnaire also contains personal details, including sex, religion, marital status, occupational status and monthly household income, and previous vaccination experience.

2.3.2 Knowledge about COVID-19 and COVID-19 vaccination

In this part, to measure the knowledge regarding COVID-19 and COVID-19 vaccination, participants were asked a series of yes/no questions. Such as "Is COVID-19 a lethal infectious disease?", "Is COVID-19 deadlier for elderly people (60+ years)?", "Do only elderly and sick people die of COVID-19?", "Can COVID-19 not spread from one to another by contact?", "Are hot and humid countries like Bangladesh safe from COVID-19?", "Is it human-made and deliberately released?", "Was the COVID-19 virus genetically engineered as part of a biological weapons program?", "Is this a normal disease like cold/cough and fever?", "Do people recover from it without any treatment?", "Is COVID-19 caused by the same virus that causes influenza (flu)?", "Testing can help people determine if they are infected with SARS-CoV-2, what do you think?", "Is there any effective medicine available for treating COVID-19/ coronavirus?".

2.3.3 Belief and attitude

In this part, we asked several questions with three options "Agree", "Neutral", "Disagree" to investigate the beliefs and attitudes of participants about COVID-19 and COVID-19 vaccination. For instance, the attitudes toward the COVID-19 and COVID-19 vaccination is an effective way to prevent and control a disease", "Young (less than 30) and children do not need any vaccination against COVID 19", "We need to prioritize going back to our normal routines (opening schools, colleges, Office) as soon as possible by maintaining safety protocols", "It should be a crime if people know that they have COVID-19 but they don't isolate them", "The Covid-19 vaccines that are being inoculated worldwide are effective and safe", "Vaccines should be marketed and distributed entirely by the government in Bangladesh- what do you think?".

2.3.4 Perceived berried, perceived likelihood, and perceived severity

We cover perceived likelihood by asking "What do you think is the chance that you will get COVID-19 in the future?" with options "Low chance", "Medium chance" and "Higher chance". The perceived severity was also covered by asking "How severe do you think it would be if you get COVID-19?" with three options "Not at all/ low severe", "Medium severe", "Higher severe". The perceived barriers toward the COVID-19 and COVID-19 vaccination were inspected by asking two questions "If I decided to get the COVID-19 vaccine, it would be herd to find a provider or clinic that could give me the vaccine." With three options "Agree", "Neutral" and "Disagree" and "The COVID-19 vaccine might have side effects" with similar three options.

2.3.5 Vaccine acceptability

Vaccine acceptability was the main outcome of this study. Firstly the participants who chose "Yes" to the question "Have you heard of any vaccine that is going to be inoculated in Bangladesh?" were asked, "Bangladesh Govt. is going to inoculate COVID-19 vaccine, will you take it?". If the respondent chose "No" then we observed the reasons for not accepting the covid-19 vaccine by asking a multiple-choice question. Otherwise, we asked "When will you or your family members take the vaccine?" with the options "Will take as soon as possible" "After 2-6 months if seems safe and effective", "If COVID-19 becomes deadlier in Bangladesh", and "Not sure". We also observed the willingness to pay for COVID-19 vaccination by asking "What should be the price of a complete dose of a vaccine?" with three options "should be free", "1-1000", "1000+". We also observed perception about vaccination priority group by asking "Considering the current scenarios, who do you think should receive the first shipment of the vaccine in Bangladesh?" with options "Healthcare workers/professionals", "Elderly people (60+ years)", "People who have underlying diseases", "Politicians", "Others".

2.4 Consent and Ethical Consideration

A voluntary online consent was taken by sharing a consent form on the timeline/inbox/WhatsApp of the respondents, which contained the outline of the research purpose and brief instructions regarding the survey.

2.5 Statistical analysis

The acceptance of the COVID-19 vaccine is the primary outcome of this study. We classified respondents into two groups (accept group and refuse group) based on the response to the question "Bangladesh Govt. is going to inoculate COVID-19 vaccine, will you take it?". Among the accept group who chose "will take as soon as possible" to the question "when will you or your family member take it?" further classified into vaccine "immediate" group. And others who selected any of

the options among "After 2-6 months if seems safe and effective", "If COVID-19 becomes deadlier in Bangladesh" and "Not sure" assigned to vaccine delay group[27]. We calculated the knowledge score for each of the participants based on the number of valid/correct answers for the 12 questions that were asked in the subsection Knowledge about COVID-19 and COVID-19 vaccination. Knowledge score can vary from 0 to 12.

We have done the exploratory analysis/descriptive statistics (bivariate analysis, frequencies analysis, means, graphs, etc.) to inspect the socio-demographic characteristics, perceived barriers, perceived likelihood, perceived severity, willingness to pay, beliefs, and attitudes toward COVID-19 and COVID-19 vaccination. The chi-square test was performed to compare the baseline information among two groups (accept group and refuse group; immediate and delay group). The multivariate logistic regression was also performed to identify the influencing factors in decision-making for accepting the COVID-19 vaccine among both pairs of groups (accept group and refuse group; immediate and delay group). Logistic regression produced the odds ratio (OR), 95% confidence interval (95% CI), and P-value. The factors were considered to be endorsed in the regression models which showed a statistically significant correlation (at 10% level of significance) within the bivariate analysis.

3 Results

Six hundred and forty-seven people opened the survey link. Among them, twenty-five people refused the survey, seventeen people were not eligible to complete the survey and six hundred and five people submitted the completed survey. The characteristics of participants are presented in Table 1. As desired, the sample is broadly representative of Bangladesh's general population (Islam 90.25%, Hinduism 8.26, Buddhism 0.83, and Christianity 0.66 [28]). The majority of the respondent tended to be aged between less than 50 (82.78%), and male (62.15%). More than half of the respondents live in urban areas (60.83%). A large proportion of respondents have a University degree (45.45%) while 26.94% are hon's running students and 27.60% respondents passed HSC/Alim/ Vocational degree/Nursing or less. A small portion of the participants (18.68%) had previous vaccination experience after age 18.

Overall, 61.16% (370/605) of the respondents were classified as an accept group and among them, 35.14% (130/307) were willing to take it immediately, and the rest 47.84% (240/605) wanted to delay in taking a COVID-19 vaccine (see Fig 1). Most of the participants (71.74%) expressed that the COVID-19 vaccine should be free and the rest of the participants indicate they would like to pay out of pocket for a vaccine was (25.29%) Tk 1-1000, and (2.98%) more than 1000. To inspect the reasons behind the unwillingness of accepting the COVID-19 vaccine, we asked a question with multiple selection options. Among 235 participants who showed unwillingness to accept the COVID-19 vaccine, 78.52% were worried about the side effects or safety of the COVID-19 vaccine, 76.17% were doubtful about the efficacy of the COVID-19 vaccine. Some of the respondents (42%) were also doubtful about the COVID-19 Vaccine since it is coming from India (Oxford-AstraZeneca vaccine produced by Serum Institute, India). Almost 36% of respondents thought vaccination is not necessary since COVID-19 is going away or they are young (See Fig 2).

The results from multivariate logistic regressions are shown in Table 4. Parameter estimates of the multivariate logistic regression indicate the odds of occurring the event into the concerned categories of the predictor variable compared to the odds of occurring the event into the reference category of the same predictor variable. Here, the odds of accepting the vaccine is defined as the ratio of the probability of accepting the vaccine and the probability of rejecting the vaccine [29]. The model was based on 605 cases with complete data and showed an association between willingness to be vaccinated (yes/no) and predictor variables. Another model was based on 370 cases (vaccine accepted group) that explored the association between willingness to immediate vaccination and predictor variables. The potential predictors were trained in the model if they showed significant association (at a 10% level of significance) with the corresponding response variable in Table 3. The findings indicate that the odds of acceptance of the COVID-19 vaccine among female respondents is 62% lower than the male respondents. The respondents aged 30 to 50 and 51 to 70 had a 6.79 and 7.89 times higher (respectively) chance to accept the COVID-19 vaccine compared to respondents aged 18 to 29. The odds of accepting the COVID-19 vaccine among respondents who live in rural areas is 81% lower in comparison with the respondents who live in urban areas. The participants who have a university degree and who are hon's (undergrad) running students had 21.38 times higher odds of taking the COVID-19 vaccine compared to the participants who had a lower educational qualification (HSC/Alim/Vocational education/Nursing or less). Respondents with income 30.000 to 39,999 showed 4.35 times higher odds, income 40,000-49,999 had 8.95 times higher odds, income 50,000-74,999 displayed 8.44 times higher odds, and income 75,000 or over had 6.31 times higher odds to accept the COVID19 vaccine compared to respondents with income less than 30,000. Respondents with previous vaccination experience after the age of 18 years had 4.79 times higher odds compared to respondents who do not have any vaccination after age 18 years. People who disagreed with the statement "the vaccines that are being inoculated worldwide are effective and safe" had a 90% lower likelihood to accept the COVID-19 vaccine relative to those who agreed with it. Participants who believe they have a medium and a high chance to be infected with COVID-19 in the future showed respectively 3.19 times and 8.68 times higher odds of taking the COVID-19 vaccine compare to the respondents who believe they have low or no chance to be infected with COVID-19 in future. Respondents who believe if they get infected with COVID-19 it would be highly severe demonstrated 4.47 times higher odds of being in the vaccine accept group compared to the respondents who believe if they get infected with COVID-19 it would be mild. The people with good knowledge about COVID-19 and COVID-19 vaccines exhibited 22.23 times higher odds of accepting the COVID-19 vaccine compare to people with lower knowledge about COVID-19 and COVID-19 vaccine.

The odds of accepting vaccines immediately was 47% lower among female respondents than male. The odds of accepting the COVID-19 vaccine immediately was 2.03 times higher among rural respondents compared to urban respondents. Hindu participants displayed 3.79 times higher odds of taking the COVID-19 vaccine immediately compared to Muslim participants. The odds of taking the COVID-19 vaccine immediately was 84% lower for the respondents who heard about any vaccine (s) that have been approved globally for mass inoculation compare to respondents who did not hear about any vaccine (s) that have been approved globally for mass inoculation. Married people had almost 2 times higher odds of being vaccinated immediately compared to unmarried people. Participants who disagreed with the statement *"the vaccines that are being inoculated worldwide are effective and safe"* had a 68% lower likelihood to accept the COVID-19 vaccine immediately compared to those who agreed with it.

Participants were asked a series of yes/no questions to assess more general knowledge and belief about COVID-19 and COVID-19 Vaccination. The percentage of yes, no and don't know with the correct answer can be seen in Table 2. A large number of respondents (62.15%) think that COVID-19 is a lethal infectious disease. Almost half (51.40%) of respondents provided a positive answer with the question "Is COVID-19 deadlier for elderly people (60+ years)" and 84.63% of respondents provided the correct answer to the question "Do only elderly and sick people die of COVID-19?". Very few (30.51%) of the participants thought that COVID-19 is a normal disease like cold/cough and fever. The survey results showed overall 39.67% of respondents have good knowledge, 44.97% of respondents have medium knowledge and 16.36% have limited knowledge about COVID-19 and COVID-19 vaccination (Fig 3). Attitudes and beliefs towards vaccination, perceived barriers, and perceived risks were also inspected in Table 2. A large proportion of respondents (74.71 %) agreed with the statement "vaccination is an effective way to prevent and control a disease" while 15.54% disagreed and 9.75% were neutral. A small proportion of 10.91% agreed with the statement "Young (less than 30) and children do not need any vaccination against COVID 19" while 54.55% disagreed and 34.55% were neutral. A large proportion (39.01%) of respondents were neutral with the statement "The COVID-19 vaccines that are being inoculated worldwide are not effective and safe" while 37.85% agreed and 23.14% disagreed. A lower portion (28.10%) of the respondents reported that it would not be herd to find a provider or clinic that could give him/her the vaccine while 42.31% opposed the view. A small proportion of the respondents (34.05%) mentioned that there is a low chance to get COVID-19 in the future, while 40.17% mentioned medium chance, and 25.79% mentioned medium chance. Concerning perceived severity, 23.47% of respondents indicated that they would experience highly severe COVID-19 symptoms, 36.36%, and 40.17% indicated medium and low, respectively.

Variable		Number	Percent
Age			
	In between 18 to 29	157	25.59
	In between 30 to 50	346	57.19
	In between 51 to 70	77	12.73
	In between 71 to 100	25	4.13

Table 1: Participant characteristics (Only for "age" variable n=622 and for all other variables n=605).

Gender

-			
	Male	376	62.15
	Female	229	37.85
	Region where the respondent lives		
	Urban	314	51.90
	Rural	291	48.10
	Marital status		
	Unmarried	403	66.61
	Married	191	31.57
	Divorced/Separated/Widowed	11	1.82
	Highest qualification		
	HSC/Alim/ Vocational/Nursing or less	167	27.60
	University degree (Hon's/MBBS/ Masters or above)	275	45.45
		1/2	26.04
	Hon's running	163	26.94
	Religion		
		546	90.25
	Islam		
	Islam Hindu	50	8.26

1		
Christian	5	0.83
Buddhism	4	0.66
Monthly average household income		
Less than 30,000	332	54.88
30,000–39,999	82	13.55
40,000–49,999	51	8.43
40,000-49,999	51	8.43
50,000–74,999	68	11.24
75,000 or over	50	8.26
Don't know/unwilling to reveal	22	3.64
Employment status		
Service holder (Govt./private)	179	29.59
Entrepreneur/business	148	24.46
Student	218	29.92
	07	14.00
Housewife/Retired/Unemployed/ Other#	97	16.03
Did you take any vaccine after 18 years of age?		
Dia jou une un joueente uter 10 yeurs et age.		
No	492	81.32
Yes	113	18.68

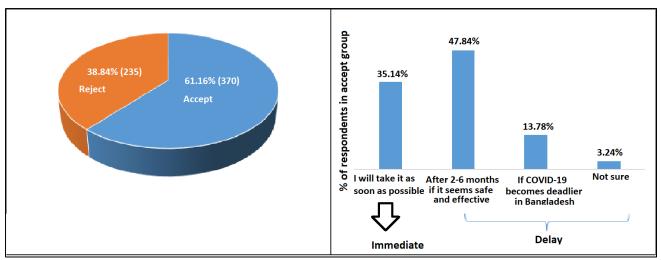


Figure 1: The acceptance of COVID-19 vaccine in Bangladesh

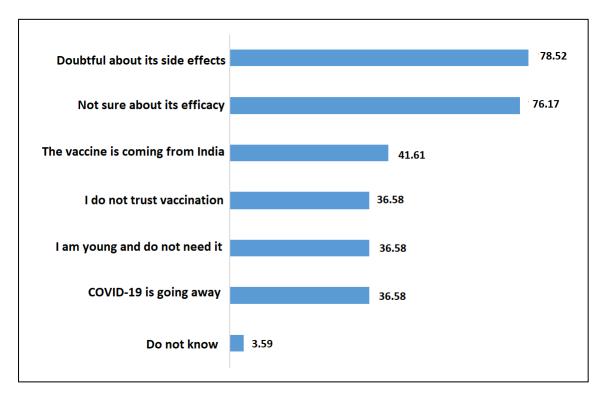
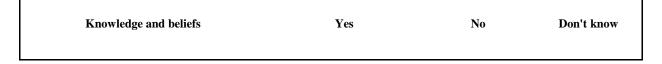


Figure 2: Reasons behind the rejection of COVID -19 vaccine (n=298)

Table 2: Descriptive statistics for items measuring knowledge, beliefs, and attitudes about COVID-19, COVID-19 vaccination (n=605)



Attitude and beliefs	Agree	Neutral	Disagree
Is there any effective medicine available for treating COVID-19/ coronavirus?	27.93 (169)	43.31 (262)	28.76 (174)
Testing can help people determine if they are infected with SARS-CoV-2, what do you think?	67.93 (411)	28.93 (175)	3.14 (19)
Is COVID-19 caused by the same virus that causes influenza (flu)?	27.60 (167)	70.41 (426)	1.98 (12)
Do people recover from it without any treatment?	27.44 (166)	68.93 (417)	3.64 (22)
Is this a normal disease like cold/cough and fever?	30.58 (185)	66.94 (405)	2.48 (15)
Was the COVID-19 virus genetically engineered as part of a biological weapons program?	6.78 (41)	90.74 (549)	2.48 (15)
Is it human-made and deliberately released?	40 (40)	89.92 (544)	3.47 (21)
Are hot and humid countries like Bangladesh safe from COVID-19?	6.12 (37)	90.74 (549)	3.14 (19)
Can COVID-19 not spread from one to another by contact?	66.28 (401)	30.91(187)	2.81 (17)
Do mostly elderly and sick people die of COVID-19?	12.89 (78)	84.63 (512)	2.48 (15)
Is COVID-19 deadlier for elderly people (60+ years)?	51.40 (311)	46.45 (281)	2.15 (13)
Is COVID-19 a lethal infectious disease?	62.15 (376)	34.21 (207)	3.64 (22)

Vaccination is an effective way to prevent and control a disease	74.71 (452)	9.75 (59)	15.54 (94)
Young (less than 30) and children do not need any vaccination against COVID 19	10.91 (66)	34.55 (209)	54.55 (330)
We need to prioritize going back to our normal routines (opening schools, colleges, offices) as soon as possible by maintaining safety protocols.	71.07 (430)	15.37 (93)	13.56 (82)
It should be a crime if people know that they have COVID-19 but they don't isolate them	74.22 (449)	11.07 (67)	14.71 (89)
The Covid-19 vaccines that are being inoculated worldwide are effective and safe	37.85 (229)	39.01 (236)	23.14 (140)
Vaccines should be marketed and distributed entirely by the government in Bangladesh- what do you think?	84.3 (510)	11.07 (67)	4.63 (28)
Perceived barriers	Agree	Not sure	Disagree
If I decided to get the COVID-19 vaccine, it would be herd to find a provider or clinic that could give me the vaccine.	42.31 (256)	29.59 (179)	28.10 (170)
The COVID-19 vaccine might have side effects.	21.32 (129)	38.35 (232)	40.33 (244)
Perceived risk	No or low	Medium	High
What do you think is the chance that you will get COVID-19 in the future?	34.05 (206)	40.17 (243)	25.79 (156)

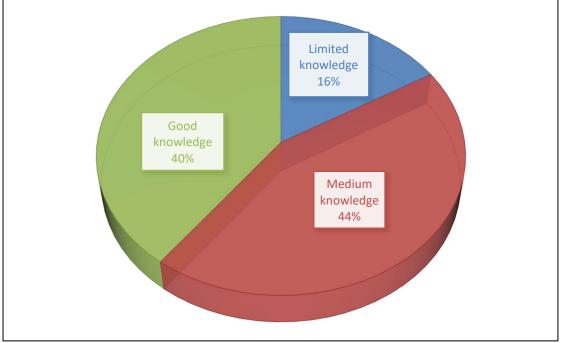


Figure 3: Knowledge distribution of participants (knowledge about COVID-19 and COVID-19 vaccination

		Willingness	to be vaccinate	ed	Willingness to i	mmediate vac	cination
Variable	Levels	No % (n)	Yes % (n)	P- valu e	delay % (n)	immediate % (n)	P- value
Age	In between 18 to 29	53.50 (84)	46.50 (73)		65.75 (48)	34.25 (25)	
	In between 30 to 50	30.06 (104)	69.94 (242)	0.00	68.18 (165)	31.82 (77)	0.06
	In between 51 to 70	41.56 (32)	58.44 (45)	0.00	48.89 (22)	51.11 (23)	0.06
	In between 71 to 100	60.00 (15)	40.00 (10)		50.00 (5)	50.00 (5)	
Gender	Male	32.71 (123)	67.29 (253)	0.00	61.66 (156)	38.34 (97)	0.06
	Female	48.91 (112)	51.09 (117)	0.00	71.79 (84)	28.21 (33)	0.06
Region where respondent lives	Urban	21.66 (68)	78.34 (246)	0.00	71.14 (175)	28.86 (71)	0.00
	Rural	57.39 (167)	42.61 (124)	0.00	52.42 (65)	47.58 (59)	0.00
Highest qualification	HSC/Alim/ Vocational/Nursi ng or less	82.63 (138)	17.37 (29)		37.93 (11)	62.07 (18)	
	University degree (Hon's/MBBS/ Masters or above)	11.64 (32)	88.36 (243)	0.00	63.79 (155)	36.21 (88)	0.00
	, Hon's running	39.88 (65)	60.12 (98)		75.51 (74)	24.49 (24)	
Religion	Islam	39.56 (216)	60.44 (330)		67.27 (222)	32.73 (108)	
	Hindu	34.00 (17)	66.00 (33)	0.64	39.39 (13)	60.61 (20)	0.01
	Cristian	20.00 (1)	80.00 (4)	0.64	50 (2)	50 (2)	0.01
	Buddhism	25.00 (1)	75.00 (3)		100 (3)	0 (0)	
Monthly average	Less than 30,000	47.29 (157)	52.71 (175)		65.14 (114)	34.86 (61)	
household income	30,000–39,999	26.83 (22)	73.17 (60)	0.00	60.00 (36)	40.00 (24)	0.12
	40,000–49,999	19.61 (10)	80.39 (41)	0.00	70.73 (29)	29.27 (12)	0.12
	50,000–74,999	29.41 (20)	70.59 (48)		77.08 (37)	22.92 (11)	

Table 3: Association of different factors with the willingness to be vaccinated and willingness to immediate vaccination

	75.000	24/42				· · · · · · · · · · · · · · · · · · ·	
	75,000 or over	24 (12)	76 (38)		55.26 (21)	44.74 (17)	
Marital Status	Don't know	63.64 (14)	36.36 (8)		37.50 (3)	62.50 (5)	
Marital Status	Unmarried	39.21 (158)	60.79 (245)		71.43 (175)	28.57 (70)	
	Married	38.22 (73)	61.78 (118)	0.96	51.69 (61)	48.31 (57)	0.00
	Divorced/Separat ed/Widowed	36.36 (4)	63.64 (7)		57.14 (4)	42.86 (3)	
Employment status	Service holder (govt/private)	32.96 (59)	67.04 (120)		61.67 (74)	38.33 (46)	
	Entrepreneur/bus iness	27.03 (40)	72.97 (108)	0.00	64.81 (70)	35.19 (38)	0.24
	Student	51.93 (94)	48.07 (87)	0.00	73.56 (64)	26.44 (23)	0.21
	Housewife/Retire d/Unemployed/ Other#	43.30 (42)	56.70 (55)		58.18 (32)	41.82 (23)	
Did you take any vaccine	No	44.11 (217)	55.89 (275)	0.00	66.55 (183)	33.45 (93)	0.24
after 18 years of age?	Yes	15.93 (18)	84.07 (95)	0.00	60.00 (57)	40.00 (38)	0.24
What do you think is the	No or low chance	42.72 (88)	57.28 (118)		69.49 (82)	30.51 (36)	
chance that you will get COVID-19 in the future?	Medium chance	46.09 (112)	53.91(131)	0.00	65.65 (86)	34.35 (45)	0.26
COVID-19 III the luture?	High chance	22.44 (35)	77.56 (121)		59.50 (72)	40.50 (49)	
How severe do you think it	No or low severe	42.80 (104)	57.20 (139)		66.91 (93)	33.09 (46)	
would be if you get COVID-	medium severe	45.91 (101)	54.09 (119)	0.00	66.39 (79)	33.61 (40)	0.54
19?	Very severe	21.13 (30)	78.87 (112)		60.71 (68)	39.29 (44)	
We need to prioritize going	Agree	42.79 (184)	57.21 (246)		64.63 (159)	35.37 (87)	
back to our normal	Not sure	29.03 (27)	70.97 (66)		65.15 (43)	34.85 (23)	
routines (opening schools, colleges, offices) as soon as possible by maintaining safety protocols.		20100 (27)	, 0.07 (00)	0.01	00120 (10)	0 (20)	0.99
	Disagree	29.27 (24)	70.73 (58)		65.52 (38)	34.48 (20)	
Have you heard of any	No	43.75 (189)	56.25 (243)		62.14 (151)	37.86 (92)	
vaccine (s) that have been approved globally for mass inoculation?	Yes	26.59 (46)	73.41 (127)	0.00	70.08 (89)	29.92 (38)	0.12
The vaccines that are being	Agree	27.07 (62)	72.93 (167)		47.90 (80)	52.10 (87)	
inoculated worldwide are	Neutral	33.47 (79)	66.53 (157)	0.00	75.80 (119)	24.20 (38)	0.00
effective and safe	Disagree	67.14 (94)	32.86 (46)		89.13 (41)	10.87 (5)	
Vaccines should be	Agree	39.02 (199)	60.98 (311)		63.34 (197)	36.66 (114)	
marketed and distributed	Neutral	43.28 (29)	56.72 (38)		78.95 (30)	21.05 (8)	
entirely by the government- what do you				0.24			0.15
think?	Disagree	25.00 (7)	75.00 (21)		61.90 (13)	38.10 (8)	
If I decided to get the	Agree	26.56 (68)	73.44 (188)		60.11 (113)	39.89 (75)	
COVID-19 vaccine, it would be herd to find a provider	Not sure	27.93 (50)	72.07 (129)	0.00	74.42 (96)	25.58 (33)	0.02
or clinic that could give me the vaccine.	Disagree	68.82 (117)	31.18 (53)	0.00	58.49 (31)	41.51 (22)	0.02
The COVID-19 vaccine	Agree	78.29 (101)	21.71 (28)		67.86 (19)	32.14 (9)	
might have side effects.	Not sure	32.33 (75)	67.67 (157)	0.00	61.78 (97)	38.22 (60)	0.56
	Disagree	24.18 (59)	75.82 (185)	5.00	67.03 (124)	32.97 (61)	0.50
Considering the current	Healthcare	27.10 (33)	, 5.02 (105)		57.05 (124)	52.57 (01)	
scenarios, who do you think should receive the	workers/professi onals	42.42 (154)	57.58 (209)		60.77 (127)	39.23 (82)	
first shipment of the	Elderly people	33.33 (23)	66.67 (46)		65.22 (30)	34.78 (30)	
vaccine in Bangladesh?	(60+ years) people who have underlying	36.21 (21)	63.79 (37)	0.25	64.86 (24)	23.88 (16)	0.23
	diseases		. ,			. /	
	Politicians	33.00 (33)	67.00 (67)		76.12 (51)	16.42 (11)	
	Other (specify)	26.67 (4)	73.33 (11)		72.73 (8)	27.27 (3)	
	Limited	89.90 (89)	10.10 (10)	0.00	60.00 (6)	40.00 (4)	0.86
	knowledge		\ - <i>\</i>			× /	

Knowledge about COVID- 19 and COVID-19	Medium knowledge	38.72 (103)	61.28 (163)	63.80 (104)	36.20 (59)
vaccination	Good knowledge	17.92 (43)	82.08 (197)	65.99 (130)	34.01 (67)

Table 4: Results of the multivariate logistic regressions analyzing the associations with acceptance of vaccination and acceptance of immediate vaccination

Variable	Levels	Willingness to be va	iccinated	Willingness to imme vaccination	diate
		OR (95% CI)	P-value	OR (95% CI)	P-value
Age	In between 18 to 29	Ref		Ref	
	In between 30 to 50	6.79 (2.63-17.55)	0.00	0.64 (0.34-1.2)	0.16
	In between 51 to 70	7.89 (2.05-30.39)	0.00	0.8 (0.32-1.98)	0.63
	In between 71 to 100	0.87 (0.13-5.98)	0.88	0.95 (0.16-5.62)	0.95
Gender	Male	Ref		Ref	
	Female	0.38 (0.18-0.79)	0.01	0.59 (0.34-1.03)	0.06
Region where respondent	Urban	Ref		Ref	
lives	Rural	0.19 (0.09-0.4)	0.00	2.03 (1.22-3.37)	0.01
Highest qualification	HSC/Alim/ Vocational/Nursing or less University degree (Hon's/MBBS/ Masters	Ref 21.38 (7.02-65.14)	0.00	Ref 0.35 (0.14-0.85)	0.02
	or above) Hon's running	2.01 (0.72-5.59)	0.18	0.31 (0.12-0.84)	0.02
Religion	Islam	2.01 (0.72 5.55)	0.10	Ref	0.02
	Hinduism	Not retained		3.79 (1.68-8.56)	0.00
	Buddhism			1.42 (0.14-14.67)	0.77
	Christian			1.12 (0.11 1.107)	0.77
Monthly average household	Less than 30,000	Ref			
income	30,000–39,999	4.35 (1.52-12.47)	0.01		
	40,000–49,999	8.95 (1.91-41.82)	0.01		
	50,000–74,999	8.44 (2.19-32.59)	0.00	Not retained	
	75,000 or over	6.3 (0.75-52.95)	0.09		
	Don't know	1.25 (0.15-10.53)	0.84		
Marital Status	Unmarried			Ref	
	Married	Not rotaina	4	2.15 (1.22-3.8)	0.01
	Divorced/Separated/Wid owed	Not retained		0.8 (0.09-7.05)	0.84
Employment status	Service holder (govt/private)	Ref			
	Entrepreneur/business	11.83 (3.48-40.25)	0.00	Niat vatairs ad	
	Student	2.3 (0.74-7.17)	0.15	Not retained	
	Housewife/Retired/Une mployed/ Other#	2.2 (0.66-7.29)	0.20		
Did you take any vaccine	No	Ref		Not retained	
after 18 years of age?	Yes	4.79 (1.65-13.9)	0.00	Not retained	
	No or low chance	Ref			
	Medium chance	3.19 (1.29-7.9)	0.01	Not retained	

What do you think is the chance that you will get COVID-19 in the future?	High chance	8.68 (2.87-26.27)	0.00		
How severe do you think it	No or low severe	Ref			
would be if you get COVID- 19?	medium severe	1.02 (0.45-2.32)	0.97	Not retained	
15:	Very severe	4.47 (1.66-12.08)	0.00		
We need to prioritize going	Agree	Ref			
back to our normal routines (opening schools, colleges,	Not sure	2.46 (0.91-6.69)	0.08	Not retained	
offices) as soon as possible by maintaining safety protocols.	Disagree	2.55 (0.85-7.64)	0.10	Not retained	
Have you heard of any	No	Ref			
vaccine (s) that have been approved globally for mass inoculation?	Yes	1.57 (0.73-3.4)	0.25	Not retained	
The vaccines that are being inoculated worldwide are effective and safe	Agree	Ref		Ref	
effective and safe	Neutral	0.27 (0.11-0.67)	0.01	0.44 (0.26-0.75)	0.00
	Disagree	0.1 (0.04-0.29)	0.00	0.32 (0.13-0.8)	0.01
If I decided to get the COVID-19 vaccine, it would	Agree	Ref		Ref	
be herd to find a provider or clinic that could give me the	Not sure	1.79 (0.73-4.41)	0.21	0.61 (0.35-1.08)	0.09
vaccine.	Disagree	0.05 (0.02-0.12)	0.00	1.12 (0.56-2.25)	0.75
The COVID-19 vaccine might have side effects.	Agree	Ref			
	Not sure	3.64 (1.32-10.05)	0.01	Not retained	
	Disagree	8.58 (3.15-23.35)	0.00		
	Limited knowledge	Ref			
	Medium knowledge	8.39 (1.96-35.97)	0.00	Not retained	
Knowledge score	Good knowledge	22.23 (4.53-109.11)	0.00		

COVID-19 = coronavirus disease 2019; OR indicates Odds Ratio; CI = confidence interval; Ref = reference group; Not retained indicates that the corresponding predictor excluded from the model.

4 Discussion

We conducted a cross-sectional study among randomly selected individuals across the whole country to inspect the potential acceptance of the COVID-19 vaccines and factors associated with the acceptance. Almost 61.16% (370/605) of the respondents would like to accept the COVID-19 vaccine. Among the vaccine accepted group, only 35.14% have shown the willingness to take the COVID-19 vaccine immediately, while 61.62% would delay the vaccination until they are confirmed about vaccine's efficacy and safety or COVID-19 becomes deadlier in Bangladesh. And the remaining 3.24% would delay the vaccination but they don't know the reasons for the delay (Fig 1). However, still, a large proportion (38.84% or 235/605) of respondents showed unwillingness to accept the COVID-19 vaccine and reported several reasons behind it. The main reasons include doubt about the side effects (78.52%), worries about the vaccine's effectiveness (76.17). Some of the respondents indicated unwillingness because they think they do not need vaccine (36.58%), some do not want the vaccine since it is coming from India (36.58%), and some do not believe in vaccination (36.58) Fig 2. For the newly introduced vaccine, safety has been reported as one of the major concerns [30,31]. Several new vaccines have been developed worldwide and one of them (Oxford-AstraZeneca) has been selected to circulate in Bangladesh. No clinical trial was conducted in Bangladesh for the Oxford-AstraZeneca vaccine and the govt. approved the vaccine following the approval of India without any study of their own. There was no evidence for reference about the COVID-19 vaccine's safety in the context of Bangladesh. This might be one of the main probable reasons for observing vaccine delay in this study. The vaccine confidence in the public would lower because of the uncertainties of new vaccines and new infectious diseases [32]. Although estimates of herd immunity and vaccination are changing rapidly, some of the estimates indicated at least 60% of a population needs to be vaccinated to achieve herd immunity. To ensure equitable distribution of COVID-19 vaccine, it is crucial to make a projection of the acceptance in public and identify the predictors associated with vaccine acceptance [25,33]. However, without any projection, in Bangladesh, a nationwide COVID-19 vaccination campaign started on February 7, 2021, and 0.26% of people were registered to receive the COVID-19 vaccine and 0.1% were vaccinated till February 27, 2021[34]. On March 24 the dose administration rate in Bangladesh was 3%. Although this is a good achievement for Bangladesh, this vaccination rate is still lower than many countries such as UK (46%), United States (38%), Maldives (41%), India (3.6%) [35].

In this study, we attempted to identify factors that influence the decision-making of respondents of accepting the COVID-19 vaccines. We found that COVID-19 vaccine acceptability has a statistically significant correlation with sociodemographic characteristics such as age, gender, higher educational qualification, employment status (See Table 2). Table 3 presents the results of regressions by modeling the acceptability of the COVID-19 vaccine and willingness to be vaccinated immediately.

Determining the factors of acceptability of vaccine or immediate vaccination are complex and context-specific and the factors vary with time, place, and type of vaccines [31,36]. In this study, the vaccine acceptability was higher among males, older, and highly educated people. Higher acceptability was also found among people who live in urban areas and have higher incomes. The socio-demographic factors were also found as significant factors for pandemic vaccine acceptability in the UK, France, Australia, US, and Japan [25,26,37–39]. In Saudi Arabia, only age and marital status were found as significant factors in determining the willingness of accepting the COVID-19 vaccines [36]. We found that one of the strong correlates of vaccine acceptability was previous vaccination experience in adulthood. People who think they are at a higher risk of being infected with COVID -19, who believe that COVID-19 might be highly severe for them and good knowledge about COVID-19 and COVID-19 vaccination were also found to be significantly linked with vaccine acceptability. The previous vaccination, vaccination beliefs, and attitudes about COVID-19 symptoms, transmission routes, and prevention and control measures against COVID-19 were found associated with willingness of accepting COVID-19 among general population vaccine in Greec[41].

Although the COVID-19 vaccine acceptance rate was found a bit higher (61.16%) among the public in Bangladesh, there are some barriers in the way of converting from the vaccination intention to real uptake attitudes. A large proportion of people (64.86%) with the willingness to be vaccinated would delay taking the vaccine until the safety and efficacy of the COVID-19 vaccine are confirmed. Vaccine safety has been reported as the main barrier for deciding for immediate vaccination among people especially for vaccines that are newly developed [37,42,43]. For instance, in a large vaccine accepted group (67%) in Australia, 13% of them wanted to delay in vaccination to see the efficacy and safety [11]. Several factors were identified in our study that are influencing the immediate vaccination intention among the public in Bangladesh. Gender, religion, region, and marital status were found to be associated with immediate vaccination experience after the age of 18 was significantly associated with vaccine acceptance, though, it was not a significant factor for immediate vaccination which conflicts with other studies in different countries [11,37,38]. Employment status and knowledge about COVID-19 and COVID-19 vaccination were not significant in immediate vaccination decision-making among the Bangladeshi people.

Our results may be used to develop successful vaccination plans and immunization services for people who are afraid and/or hesitant of taking COVID-19 vaccines. To increase vaccine acceptability among rural people, baseless rumors and myths (especially on social media) against the COVID-19 vaccines must be checked and they should be reached out with scientific facts describing the safety and efficacy of the vaccines. To inspire females to get vaccinated, specialist doctors' opinions can be spread through social media, television, radio, and print media. General people and celebrities who have already taken the vaccine should share their experience (of no, mild, or severe side-effects) on social media and other mass media. Topics on infectious diseases, their preventive measures, and vaccination should be included in the textbooks to better prepare for future pandemics.

To the best of our knowledge, this is the first study to inquiry about the acceptability of the newly developed COVID-19 vaccine among Bangladeshi people. Our study divided participants based on the acceptance levels (immediate or delayed acceptance or refusal to accept) and provides associated factors that influence the vaccine acceptability and immediate vaccination. This study sheds light on the current scenarios of public attitudes and willingness regarding COVID-19 vaccination. Based on the findings, policymakers can identify the most priority groups (older than 70, rural, and women) or communities that need special attention in COVID-19 vaccination campaigns. Since a higher vaccination rate is the key factor to achieve herd immunity, mass people must be inspired to get vaccinated [44]. This research will help the policymakers make an effective vaccination strategy for a greater uptake rate of vaccines in a bid to control the COVID-19 pandemic.

However, this study has some limitations. Since the offline face-to-face survey is not possible during the COVID-19 pandemic, we have used the online platform to collect information that may limit the representativeness of the sample. We only reached out to those who had access to the internet and smart devices. A similar study was necessary before developing the COVID-19 vaccine to understand the changes in vaccination intention. Since self-reported information may lead to information bias, the findings of this study may differ from the real scenario. Further study is needed to inspect the changes in vaccination intention and its' determinants during the pandemic.

5 Conclusion

A high prevalence of refusal and hesitancy about COVID-19 vaccination in Bangladesh was observed in the study. The safety concern seemed to be the main reason for the unwillingness to accept vaccines. To increase the immediate vaccination and vaccine acceptance rate among the public which is touted to be the best way to get rid of the devastating COVID-19 pandemic, vaccination campaigns need to be designed. Special emphasis should be given to inspire rural people, females, and senior citizens (70+). Besides, evidence-based communications and health education can reduce public vaccine hesitancy and concern about vaccine safety.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Reference

- [1] Coronavirus Update (Live): 111,234,365 Cases and 2,462,703 Deaths from COVID-19 Virus Pandemic Worldometer 2021. https://www.worldometers.info/coronavirus/ (accessed February 20, 2021).
- [2] Resilient leadership responding to COVID-19 | Deloitte Insights 2021. https://www2.deloitte.com/global/en/insights/economy/covid-19/heart-of-resilient-leadership-responding-to-covid-19.html (accessed February 20, 2021).
- [3] Reuters. ECB asset purchase programme boosts Euro. The Guardian 2020. http://www.theguardian.com/world/2020/mar/19/ecb-asset-purchase-programme-boosts-euro (accessed February 20, 2021).
- [4] Coronavirus: Travel restrictions, border shutdowns by country 2021. https://www.aljazeera.com/news/2020/6/3/coronavirus-travel-restrictions-border-shutdowns-bycountry (accessed February 20, 2021).
- [5] COVID-19 pandemic in Brazil has overwhelmed its health systems, analysis shows. ScienceDaily 2021. https://www.sciencedaily.com/releases/2021/01/210117132223.htm (accessed February 20, 2021).
- [6] Mahmud S, Hossain S, Muyeed A, Islam MM, Mohsin M. The Global Prevalence of Depression, Anxiety, Stress, and, Insomnia and Its Changes Among Health Professionals During Covid-19 Pandemic: A Rapid Systematic Review and Meta-Analysis. Rochester, NY: Social Science Research Network; 2021. https://doi.org/10.2139/ssrn.3770223.
- [7] Immunization 2021. https://www.who.int/news-room/facts-in-pictures/detail/immunization (accessed February 20, 2021).
- [8] Wood JM. Developing vaccines against pandemic influenza. Philos Trans R Soc Lond B Biol Sci 2001;356:1953–60. https://doi.org/10.1098/rstb.2001.0981.
- [9] Zimmer C, Corum J, Wee S-L. Coronavirus Vaccine Tracker. N Y Times 2021.
- [10] Attwell K, Lake J, Sneddon J, Gerrans P, Blyth C, Lee J. Converting the maybes: Crucial for a successful COVID-19 vaccination strategy. PLOS ONE 2021;16:e0245907. https://doi.org/10.1371/journal.pone.0245907.
- [11] Eastwood K, Durrheim DN, Jones A, Butler M. Acceptance of pandemic (H1N1) 2009 influenza vaccination by the Australian public. Med J Aust 2010;192:33–6. https://doi.org/10.5694/j.1326-5377.2010.tb03399.x.
- [12] Pogue K, Jensen JL, Stancil CK, Ferguson DG, Hughes SJ, Mello EJ, et al. Influences on Attitudes Regarding Potential COVID-19 Vaccination in the United States. Vaccines 2020;8:582. https://doi.org/10.3390/vaccines8040582.
- [13] Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, et al. A global survey of potential acceptance of a COVID-19 vaccine. Nat Med 2021;27:225–8. https://doi.org/10.1038/s41591-020-1124-9.
- [14] Lehmann BA, Ruiter RAC, Chapman G, Kok G. The intention to get vaccinated against influenza and actual vaccination uptake of Dutch healthcare personnel. Vaccine 2014;32:6986–91. https://doi.org/10.1016/j.vaccine.2014.10.034.
- [15] Renner B, Reuter T. Predicting vaccination using numerical and affective risk perceptions: the case of A/H1N1 influenza. Vaccine 2012;30:7019–26. https://doi.org/10.1016/j.vaccine.2012.09.064.

- [16] Williams L, Gallant AJ, Rasmussen S, Nicholls LAB, Cogan N, Deakin K, et al. Towards intervention development to increase the uptake of COVID-19 vaccination among those at high risk: Outlining evidence-based and theoretically informed future intervention content. Br J Health Psychol 2020;25:1039–54. https://doi.org/10.1111/bjhp.12468.
- [17] Thorneloe R, Wilcockson H, Lamb M, Jordan CH, Arden M. Willingness to receive a COVID-19 vaccine among adults at high-risk of COVID-19: a UK-wide survey 2020. https://doi.org/10.31234/osf.io/fs9wk.
- [18] Al-Zaman MdS. COVID-19-related online misinformation in Bangladesh. J Health Res 2021;ahead-of-print. https://doi.org/10.1108/JHR-09-2020-0414.
- [19] Online Registration for Vaccination: Plan revised as response poor. Dly Star 2021. https://www.thedailystar.net/frontpage/news/online-registration-vaccination-plan-revised-response-poor-2038809 (accessed February 20, 2021).
- [20] COVAX 2021. https://www.who.int/initiatives/act-accelerator/covax (accessed February 20, 2021).
- [21] Abir T, Kalimullah NA, Osuagwu UL, Yazdani DMN-A, Mamun AA, Husain T, et al. Factors Associated with the Perception of Risk and Knowledge of Contracting the SARS-Cov-2 among Adults in Bangladesh: Analysis of Online Surveys. Int J Environ Res Public Health 2020;17:5252. https://doi.org/10.3390/ijerph17145252.
- [22] Dhand NK, Khatkar MS. Statulator: An online statistical calculator. Sample Size Calculator for Estimating a Single Proportion n.d. http://statulator.com/SampleSize/ss1P.html (accessed February 5, 2021).
- [23] Population, total Bangladesh | Data. World Bank n.d. https://data.worldbank.org/indicator/SP.POP.TOTL?locations=BD (accessed May 28, 2020).
- [24] Uddin MdJ, Wahed T, Saha NC, Kaukab SST, Khan IA, Khan AI, et al. Coverage and acceptability of cholera vaccine among high-risk population of urban Dhaka, Bangladesh. Vaccine 2014;32:5690–5. https://doi.org/10.1016/j.vaccine.2014.08.021.
- [25] Sherman SM, Smith LE, Sim J, Amlôt R, Cutts M, Dasch H, et al. COVID-19 vaccination intention in the UK: results from the COVID-19 vaccination acceptability study (CoVAccS), a nationally representative cross-sectional survey. Hum Vaccines Immunother 2020;0:1–10. https://doi.org/10.1080/21645515.2020.1846397.
- [26] Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. EClinicalMedicine 2020;26:100495. https://doi.org/10.1016/j.eclinm.2020.100495.
- [27] Wang J, Jing R, Lai X, Zhang H, Lyu Y, Knoll MD, et al. Acceptance of COVID-19 Vaccination during the COVID-19 Pandemic in China. Vaccines 2020;8:482. https://doi.org/10.3390/vaccines8030482.
- [28] Bangladesh Bureau of Statistics Population and Housing Census 2011-National volume 2: Union Statistics. Dhaka 2015. http://www.bbs.gov.bd/WebTestApplication/userfiles/Image/National (accessed May 30, 2020).
- [29] Mahmud S, Islam MA, Hossain SS. Analysis of rainfall occurrence in consecutive days using Markov models with covariate dependence in selected regions of Bangladesh. Theor Appl Climatol 2020:1–16.
- [30] Acceptance of a pandemic influenza vaccine: a systematic review of surveys of the general public n.d. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3215344/ (accessed February 28, 2021).
- [31] Larson HJ, Jarrett C, Eckersberger E, Smith DMD, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: A systematic review of published literature, 2007–2012. Vaccine 2014;32:2150–9. https://doi.org/10.1016/j.vaccine.2014.01.081.
- [32] Henrich N, Holmes B. The public's acceptance of novel vaccines during a pandemic: a focus group study and its application to influenza H1N1. Emerg Health Threats J 2009;2:7088. https://doi.org/10.3402/ehtj.v2i0.7088.
- [33] Haridi HK, Salman KA, Basaif EA, Al-Skaibi DK. Influenza vaccine uptake, determinants, motivators, and barriers of the vaccine receipt among healthcare workers in a tertiary care hospital in Saudi Arabia. J Hosp Infect 2017;96:268–75. https://doi.org/10.1016/j.jhin.2017.02.005.

- [34] 4,296,344 people registered to receive Covid-19 vaccines. Dhaka Trib 2021. https://www.dhakatribune.com/bangladesh/2021/02/28/42-96-344-people-registered-to-receive-covid-19-vaccines (accessed March 24, 2021).
- [35] Holder J. Tracking Coronavirus Vaccinations Around the World. N Y Times n.d.
- [36] Al-Mohaithef M, Padhi BK. Determinants of COVID-19 Vaccine Acceptance in Saudi Arabia: A Web-Based National Survey. J Multidiscip Healthc 2020;13:1657–63. https://doi.org/10.2147/JMDH.S276771.
- [37] Schwarzinger M, Flicoteaux R, Cortarenoda S, Obadia Y, Moatti J-P. Low Acceptability of A/H1N1 Pandemic Vaccination in French Adult Population: Did Public Health Policy Fuel Public Dissonance? PLOS ONE 2010;5:e10199. https://doi.org/10.1371/journal.pone.0010199.
- [38] Nguyen T, Henningsen KH, Brehaut JC, Hoe E, Wilson K. Acceptance of a pandemic influenza vaccine: a systematic review of surveys of the general public. Infect Drug Resist 2011;4:197– 207. https://doi.org/10.2147/IDR.S23174.
- [39] Machida M, Nakamura I, Kojima T, Saito R, Nakaya T, Hanibuchi T, et al. Acceptance of a COVID-19 Vaccine in Japan during the COVID-19 Pandemic. Vaccines 2021;9:210. https://doi.org/10.3390/vaccines9030210.
- [40] Domnich A, Cambiaggi M, Vasco A, Maraniello L, Ansaldi F, Baldo V, et al. Attitudes and Beliefs on Influenza Vaccination during the COVID-19 Pandemic: Results from a Representative Italian Survey. Vaccines 2020;8:711. https://doi.org/10.3390/vaccines8040711.
- [41] Kourlaba G, Kourkouni E, Maistreli S, Tsopela C-G, Molocha N-M, Triantafyllou C, et al. Willingness of Greek general population to get a COVID-19 vaccine. Glob Health Res Policy 2021;6. https://doi.org/10.1186/s41256-021-00188-1.
- [42] Zijtregtop EAM, Wilschut J, Koelma N, Van Delden JJM, Stolk RP, Van Steenbergen J, et al. Which factors are important in adults' uptake of a (pre)pandemic influenza vaccine? Vaccine 2009;28:207–27. https://doi.org/10.1016/j.vaccine.2009.099.
- [43] Lau JTF, Yeung NCY, Choi KC, Cheng MYM, Tsui HY, Griffiths S. Factors in association with acceptability of A/H1N1 vaccination during the influenza A/H1N1 pandemic phase in the Hong Kong general population. Vaccine 2010;28:4632–7. https://doi.org/10.1016/j.vaccine.2010.04.076.
- [44] Dror AA, Eisenbach N, Taiber S, Morozov NG, Mizrachi M, Zigron A, et al. Vaccine hesitancy: the next challenge in the fight against COVID-19. Eur J Epidemiol 2020;35:775–9. https://doi.org/10.1007/s10654-020-00671-y.
- [45] 99d53e21771b4754028f720769f25b1e0be2.pdf n.d.
- [46] Mahmud S, Hossain S, Muyeed A, Islam MM, Mohsin M. The Global Prevalence of Depression, Anxiety, Stress, and, Insomnia and Its Changes Among Health Professionals During Covid-19 Pandemic: A Rapid Systematic Review and Meta-Analysis. Rochester, NY: Social Science Research Network; 2021. https://doi.org/10.2139/ssrn.3770223.
- [47] Jamieson LM, Harrison JE, Berry JG. Hospitalisation for head injury due to assault among Indigenous and non-Indigenous Australians, July 1999 – June 2005. Med J Aust 2008;188:576– 9. https://doi.org/10.5694/j.1326-5377.2008.tb01793.x.
- [48] COVAX 2021. https://www.who.int/initiatives/act-accelerator/covax (accessed February 20, 2021).
- [49] National Academies of Sciences E, Division H and M, Practice B on PH and PH, Policy B on HS, Coronavirus C on EA of V for the N, Kahn B, et al. Achieving Acceptance of COVID-19 Vaccine. National Academies Press (US); 2020.