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Public opinion on COVID-19 vaccine prioritization in Bangladesh: Who gets the vaccine and whom do you leave out?

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ABSTRACT

One of the most challenging aspects of the COVID-19 pandemic is the inability to ensure equitable distribution of vaccines to fight the pandemic. Many governments around the globe had to prioritize and perform a triage in distributing the vaccines due to the limited supply as well as a lack of financial strength to acquire a sufficient number of vaccines in time. The present study assessed the public opinion in Bangladesh regarding vaccination prioritization strategy and its associated aspects. Due to the infectious nature of the viral transmission, the study used an online survey and collected a sample of 2291 respondents, distributed proportionally across sex, and income groups. Descriptive statistics and multinomial logistic regression modelling were utilized to conduct the analyses. The results emphasized unanimous preference of prioritized vaccination leaning towards the frontline workers, the severely sick and the elderly. However, the segregation across ethnicity was noted with no major preference among sexes or religion. The results reinforce the Bangladesh government's undertaken strategy of prioritization. However, the preference rankings varied across sociodemographic factors including self-assessed COVID-19 knowledge and income tiers, among others. The findings underline the necessity of improved risk communication strategies to ensure public confidence and conformity to vaccination efforts and their effective deployment across the country.

1. Introduction

The COVID-19 pandemic has emerged as the biggest challenge of the 21st century thus far. The need for a unified global front to deal with an unprecedented level of uncertainty has been felt in all sectors. Originating in Wuhan, China, SARS-CoV-2 has spread across the world and halted regular activities, and impacted the whole world socially, economically, and politically [1–4]. To reflect the appropriate context of Bangladesh during the survey collection period, information in the Introduction and Discussion sections of the paper is focused on the similar timeline of the survey. As of mid-June 2021, the pandemic has reportedly claimed 3.8 million lives [5]. Bangladesh has had its fair share of pandemic catastrophes, as death count has reached 13,282 as of 16 June 2021. A longer duration of lockdown due to multiple waves of COVID-19 has disrupted the socio-economic environment owing to financial losses incurred during this period. Educational institutions and students have borne the brunt of a clear lack of exit strategy due to the lack of previous expertise to conduct mass vaccination involving the adult population [6,7]. However, the GDP growth on-paper due to a probable surge in industrial activities on healthcare protective equipment like masks, personal protective equipment (PPE), sanitizers etc. keeps shooting up despite reports on increased poverty countrywide due to prolonged economic disruptions [8,9] with no clear and inclusive national plan of tackling and subsequent recovery from the pandemic ([6]). Previously published evidence expressing the attitude of willingness to receive

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vaccination has been concentrated on the domain of existing socio-cultural beliefs, erosion of trust in the authorities and the availability of information on the safety, efficacy of the vaccines under development [10–14]. The erosion of trust associated with authorities stems from previous experiences on the capabilities of delivering preventive interventions. On the contrary, the earlier rollout strategies focused on the vulnerable groups associated with COVID-19 mortality and morbidity including elderly population over 55 years [15], which has expressed a greater reluctance in receiving vaccines. These challenges posit Bangladesh in a unique state to understand the public opinion on vaccination and its prioritization across different cohorts and adaptation of relevant strategies associated with addressing these prioritizations in distributing the upcoming COVID-19 vaccination in an equitable manner.

Vaccination is considered the best way out of viral pandemics through establishing community (herd) immunity. The 2020 COVID-19 pandemic has led to the rapid development of multiple vaccines across the globe [16,17]. As of December 2020, over 200 vaccines are under development, with only five of them receiving emergency approval to be administered at the country level [18,19]. Some details are yet to be worked out, such as efficacy against emerging strains, vaccination of children and adolescents, requirement of booster shots or duration of antibody/vaccine induced protection, and long term unintended side-effects [20–22]. While the rich countries have had a good start to the vaccination campaigns and adequate stockpiling of vaccines for future coverage, low- and middle-income countries (LMICs) were slow to begin immunizing their citizens [23,24] largely due to a lack of preparation, purchasing and negotiation capacity with manufacturers, and shortage of supply [25–27]. However, the World Health Organization's (WHO) COVID-19 Vaccines Global Access (COVAX) agenda intends to contribute to bridging this gap by purchasing vaccines in bulk amounts and then distributing them to resource-limited nations [23].

According to the World Bank, Bangladesh falls in the group of LMICs. The vaccination campaign in Bangladesh started in late January 2021, but faced irregularities due to supply shortages from the purchased vendor (Serum Institute of India) due to delta wave COVID-19 surges in India, leading to a suspension by May 2021 after delivering around 10 million doses, covering around 3.9 million people receiving both doses of COVID-19 vaccine with another additional 1.9 million partially vaccinated with the first dose of the supplied vaccine (COVIDSheild) [28]. The vaccination was resumed on June 2021 after receiving stocks of 600,000 Sinopharm vaccines from the Chinese government, and another 106,00 doses of Pfizer-BioNTech and 1.8 million AstraZeneca vaccines from COVAX Initiatives during the timeline of late May and early June 2021. As of June 2021, Bangladesh has a stockpile of around one million doses of AstraZeneca's Covishield vaccines and Chinese Sinopharm jabs with an additional 100,000 Pfizer jabs to come as part of the COVAX alliance [28–31]. Decidedly, these numbers are severely inadequate in a country of 160 million with 80 % adult population. However, Bangladesh is pursuing other channels from the United States, Russia and United Kingdom to secure more vaccines [32–34]. While willingness to take vaccines is generally high in LMICs [35], the lack of access to it clearly puts Bangladesh in a position to decide who to vaccinate first. The present study thus aimed to assess the public opinion regarding the inevitable choice of prioritizing different cohorts for vaccine distribution.

Several studies postulated vaccine resistance or hesitancy (complacency, lack of convenience and confidence issues) for COVID-19 and its causes [36,37]. Based on previous literature and recent data, some have reported reasons for such hesitancy, including mistrust of health authorities and previous experience with vaccination services [38,39], the rush of vaccine production and abundance of misinformation in electronic media [40], disregarding the dangers of COVID-19 [36,41], doubting vaccine efficacy [42,43] and a lack of information [44]. Few studies assessed the public opinion on who to vaccinate first. In the Belgian population, [45] observed that essential workers and chronically ill were highly supported to be immunized early whereas those over 60 years of age were not. From a sample in the US, [46] reported that people prioritized health care workers, adults with comorbid conditions, communities affected heavily by COVID-19 and frontline workers for earlier vaccination. Some concluded that the general mass' opinion is not very different from experts [47], while others found conflicting results [48]. No such studies were conducted in Southeast Asia during this timeline, that could have been a baseline for the current study.

Given the higher demand for vaccination and the limited supply, there is an urgent need to prioritize who would be getting the jab earlier during the pandemic and decide who would need to wait. While the public supports the notion that experts should be the ones to decide vaccine prioritization [45], evaluation of public opinion helps determine their level of future compliance and develop mass communication strategies. The public's confidence on health measures relies on risk communication and community engagement programs [49]. Thus, it is important that the general public understand who the frontliners and the most vulnerable are during a pandemic and why they should be given the initial allocation of the vaccine over everyone else.

Public opinion, of course, changes over time [50]. Keeping track of such dynamism and restructuring risk communications accordingly are fundamental to the whole process of prioritized distribution of limited-available vaccines and the focus of this present study would be to contribute to that end. To the best of the authors' knowledge, this is the first study that has evaluated such a paradigm in Bangladesh. Addressing this lacuna, this study identified different groups of people based on their sociodemographic factors who ranked their preferred cohort for early immunization.

2. Methodology

2.1. Data overview

An online survey was conducted between 6 December 2020 and 17 January 2021 to collect data for this project. Following ethical clearance guidelines, the online survey platform provided by the University of Southern Queensland based on LimeSurvey was utilized to create and operationalize the survey. Data were stored in the university's secured database. The questionnaire was designed to be completed in 10 min. Eight data collectors were recruited to collect data virtually due to pandemic restrictions in Bangladesh, who primarily used social media contacts to circulate the questionnaire. To include a larger variation of participants without limiting the contract of the data collectors, the survey was circulated via Facebook ads as well, which obtained 90,079 impressions. The ad targeted Facebook users in the geographical border region of Bangladesh of all ages and sexes who speak Bangla. No additional filter was given. As Facebook is widely popular in Bangladesh with around a quarter (44.7 million) users and top three sources of growth in daily active users worldwide in 2022 compared to the previous year [51], this platform was considered the best possible alternative to face-to-face data collection. Additionally, the majority of the individuals not using Facebook are residents of remote areas with limited internet connectivity where any face-to-face data collection activities will be cost and resource intensive to maintain the quality of the collected data without any pandemic enforced lockdown situation. The survey gathered public opinion on which specific groups should be prioritized over others to be vaccinated. These ranking groups were based on age, sex, ethnicity,

religion, health and profession. The questionnaire included inquiries about demographic information as well. No incentives were given to survey participants and the participation was kept voluntary.

The survey was conducted in the native Bangla language targeting residents of Bangladesh who were currently living in Bangladesh. Non-Bangladeshi residents were not included in the survey. This is because local residents are in the best position to provide an opinion based on their experience with the vaccination campaign, which will not be possible for expatriates. The survey was completed by 2309 willing participants with an age range of 13–71 years and was proportionally distributed (female: male = 46.5 %: 53.5 %) across the sexes. The study employed a complete records analysis (CRA) approach that resulted in a final sample of size 2291.

2.2. Ethical statement

The survey questionnaire was formally reviewed and approved by the ethical review committee at the University of Southern Queensland (H20REA274). The participants were asked to provide their informed consent before participating in the survey and were duly notified of the research purpose, type of questions, and confidentiality of individual information before being provided with the opportunity to respond to the survey questionnaire. The respondents were also provided with contact details of multiple independent support organizations, had they felt distressed and decided to seek help while responding to questions regarding their personal experience with COVID-19.

2.3. Independent variables

Sociodemographic factors were mostly considered independent variables, namely respondents' age (continuous), sex (female, male); geographic area of residence (urban, suburban, rural);; monthly family income range (below, 20,000 Bangladesh Taka (BDT), 20,000–35,000 BDT, 35,000–50,000 BDT, and 50,000 BDT or above); level of education (higher, up to secondary); religion (Muslim, others). The highly educated were those who have completed/on-going graduation and secondary educated cohort included those who completed high school (surpassed the higher secondary certificate examination representing receiving an education worth 12 years in Bangladesh). Furthermore, based on respondents' participation in economic activities, a binary variable 'economic contributor' was generated with the two categories: non-earner and earner. Here, respondents with a perceptible earning source were considered earners, while people belonging to occupations without a fixed paycheck such as students, retired employees, and homemakers were considered in the non-earner category.

The level of self-assessed knowledge regarding COVID-19 and hygiene guidelines of the respondents was considered by the variable "self-reported COVID-19 knowledge score" (below median, above median). This was generated from three questions: (a) "How would you grade your general knowledge on COVID-19?" (b) "How closely are you following the news of COVID-19 in print or digital media?" and (c) "How closely are you adhering to the COVID-19 precautions?" Respondents reporting no or very little knowledge, and not following either the news or the health guidelines were given a score of 0 (zero) in each case. Those who responded with having some or moderate knowledge and maintaining adherence to news and health guidelines were assigned a score of 1 (one) in this case. Finally, those who claimed to have good knowledge, regularly followed the news and sincerely maintained health guidelines were assigned a score of 2 (two) in each case. Then all the assigned scores were summed for each respondent and the total scores were categorized into the categories 'below median' and 'above median'. Here the median score obtained by respondents was 4 (four), on a scale from 0 (zero) to 6 (six).

2.4. Outcome variables

Respondents were asked to give their opinion on who should be vaccinated first. There are six groups (Age, Sex, Ethnicity, Religion, Health Condition, and Profession) and each respondent ranked their vaccination preference with an option "no preference" in each group. For the purpose of analysis, the first preference of each respondent in each group was considered. For example, in the Age group, the option was 'no-preference', 'children (<18 years), adults (19–50 years), elderly (>50 years)'. If a particular respondent responded that the elderly should be vaccinated first in the Age group, only this response is considered in this group. Similarly, in the Sex group, the options were 'no-preference', 'male', 'female' and so on. The groups and possible options in each group are given in Table 1.

2.5. Statistical analyses

Bivariate analysis was conducted first, with descriptive statistics assessed along with estimating the primary associations of the sociodemographic factors with the preference of who should be vaccinated first in each group using chi-square tests of associations [52]. For the continuous variable age, F-tests were conducted to compare the equality of option-wise means for each of the six groups. To assess the effect size and significance of regressors over the outcome variable of preferential ranking, multinomial logistic models were fitted to each of the six groups with all the independent variables. These provided odds ratios (OR), confidence intervals and p-values [53]. A conventional 5 % level of significance, consistent with 95 % CI, was considered as the threshold for identification of associations. For each group, 'no preference' was considered the reference category in the multinomial regression models. As sensitivity analysis, a logistic regression model with "No Rank" as the reference category compared to any preference for the outcomes was fitted for all outcomes. Furthermore, a stratified analysis was conducted where those who had a preference were compared with those with other preferences (who did not have a preference were excluded). Results of these analyses are included in the Supplementary file (Table 7–18). All analyses were conducted in R (version 4.1).

3. Results

The sample of 2291 respondents were proportionally distributed across sex, and income groups. However, non-married,

Table 1
Outcome variables and their categories.

Outcome variable	Categories
Preference in age groups	No preference, children (<18 years), adult (19–50 years), elderly (>50 years)
Preference in sex groups	no preference, female, male
Preference based on ethnicity	No preference, Bengali, 'others' which include native aboriginals (e.g., Chakma in Chittagong hill tracks) and Rohingyas defected from Myanmar
Preference based on religion	No preference, Muslim, others which include Hindu, Buddhist, Christian, Atheists, Agnostics
Preference based on health condition	no preference, healthy, moderately sick, severely sick (multiple comorbidities)
Preference based on	No preference, 'frontliners' which include health workers, police, first responders, emergency workers, 'non-frontliners' such as government employees, parliamentarians, students, or teachers

urban residents, highly educated (graduate or more), Muslim and non-earning members of the family were overrepresented (Table 2). When compared to national figures (last column of Table 2), education and marital status were in contrast in the survey sample. However, survey showed congruence with age, sex ratio, religion, and earning member of the family. The survey also had a higher representation of the urban population when compared with national estimates of 2022 population census.

3.1. Age-wise preference

Over half of the respondents preferred to have the elderly (>50 years) be vaccinated first. The chi-square test showed that the first preference to be vaccinated in the age group was associated with respondent's sex, area of residence, income, education, and level of knowledge (Supplementary Table 1). A higher proportion of females (22.8 %) preferred children compared to males (19.4 %) although both groups prioritized (over 50 %) the elderly. Substantial variation was demonstrated with respect to the area of residence, with the urban population advocating for children (19.7 %), and the elderly (57.4 %) than rural counterpart (27 % and 41.8 %). The richest income group in the sample (>50,000 BDT/month) mostly preferred the elderly (60.1 %) with 14 % choosing adults for vaccination at first, 47.4 % of lowest income group (<20,000 BDT/month) chose the elderly with 20.8 % preferring adults. In the education category, 10.8 % of those who completed secondary education had no preference compared to 6.8 % of the highly educated with most of the highly educated (57.1 %) preferred the elderly. Among those with below median self-reported knowledge on COVID-19, 49.8 % and 23.9 % preferred the elderly and children, respectively, whereas the percentages were 57 % and 19.4 %, respectively, for above-median-knowledge respondents.

The multinomial logistic model showed that age, sex, area of residence, education level and self-assessed COVID-19 knowledge were associated with preference of age groups (Table 3). Males showed 90 % higher odds, and those with over median COVID-19 knowledge showed 40 % higher odds of preferring children for early vaccination compared to those with no preference. Rural residence was associated with 50 % lower odds of preferring children than having no preference for vaccine prioritization. Compared to the highly educated, high school educated respondents had 46 % lower odds of prioritizing children for vaccination over having no preference. Older respondents were more likely to give no preference for vaccination over younger respondents.

Table 2
Distribution of the survey participants across demographics compared to total population of Bangladesh.

Variable	Survey sampleN (%)	National population %
Total population/sample size	2291	167,184,465
Age*	22	27.9
Sex		
Female	1066 (46.5)	48.98
Male	1225 (53.5)	51.02
Marital Status		
Not married	1952 (85.2)	28.65
Married	339 (14.8)	71.35
Area of residence		
Urban	1758 (76.7)	31.5
Rural	244 (10.7)	
Suburban	289 (12.6)	68.5
Education level		
Higher	1755 (76.6)	~25 %
Up to Secondary	536 (23.4)	~75 %
Religion		
Others	346 (15.1)	11.6
Muslim	1945 (84.9)	88.4
Financial contribution to family		
Non-earner	1739 (75.9)	~70 %
Earner	552 (24.1)	~30 %

*Median value. Sources: [54–57].

3.2. Sex-wise preference

Over half of the respondents (51.6 %) had no preference among which gender to be vaccinated first, followed by 30.4 % and 18 % had first preference of male and female. The chi-square test showed that preference ranking by sex was associated with respondent's sex, marital status, area of residence, income, religion, financial contribution to family and level of knowledge (Supplementary Table 2). Males were given first preference by a much higher percentage of males (39.5 %) than females (19.9 %). The proportion of no preference was higher in non-married respondents (52.9 %) than married (44 %). Rural residents least preferred females as first preference (15.6 %) and respondents with lowest income ($<20,000$ BDT) preferred males (35.9 %). Higher proportion of respondents from other religions apart from Muslims voted no preference (59.8 %). Earning member of the families preferred males (36.4 %) over females (21.2 %) as did those with above median COVID-19 knowledge.

The multinomial logistic model showed that sex, monthly income, religion, financial contribution, and self-assessed COVID-19 knowledge were associated with preference of sex groups (Table 4). Males strongly preferred (OR = 2.4) males to be vaccinated first compared to the no preference group as did those with self-assessed above median COVID-19 knowledge. The higher the income, the odds of choosing males or females as first vaccination preference group decreased compared to those with no preference. Muslims preferred males (OR = 1.5) and females (OR = 1.8) over no preference option. Those who were involved in earning professions showed 1.5- and 2.0-times the odds of preferring males and females than did the non-earners for early vaccination, respectively.

3.3. Ethnicity-wise preference

Nearly similar proportion of respondents had no preference (48 %) and chose Bengali group (48.3 %) to be vaccinated first, with only 3.7 % preferring aboriginals or Rohingyas. The chi-square test showed that preference ranking by ethnicity was associated with respondent's sex, marital status, living arrangement, area of residence, income, religion, and financial contribution to family (Supplementary Table 3). Over half of the males (55.5 %) preferred Bengalis and females (56.3 %) had no preference. Over 50 % of the respondents living in group housing or single preferred Bengalis, and so did rural residents. Those with income below 35,000 BDT preferred Bengalis more ($> 50\%$) and $> 50\%$ of those with above that income threshold had no preference; and 55.6 % Respondents in earning profession preferred Bengalis. Preference of aboriginals or Rohingyas were below 5 % in all groups.

The multinomial logistic model showed that sex, marital status, monthly income, religion, and self-assessed COVID-19 knowledge were associated with preference of sex groups between no preference and Bengalis (Table 5). Compared to females, males were more likely (72 % higher odds) to choose Bengalis than voting for no preference. Similarly, respondents who are married or Muslim nominated Bengalis to be vaccinated first. Higher income groups significantly opted for no preference than choosing Bengalis. Above median self-assessed knowledge led to 23 % increased odds of preferring Bengalis compared to respondents with no preference.

Table 3
Multinomial logistic regression fitted to preference of age groups for vaccination (reference: no preference) over sociodemographic factors.

Factor	Children		Adult		Elderly	
	OR (95 % CI)	P-value	OR (95 % CI)	P-value	OR (95 % CI)	P-value
Age	1.00 (0.96, 1.03)	0.883	0.94 (0.9, 0.98)	0.003	0.98 (0.94, 1.02)	0.306
Sex						
Female	1.00		1.00		1.00	
Male	1.89 (1.35, 2.64)	<0.001	1.37 (0.95, 1.98)	0.088	1.41 (0.97, 2.05)	0.074
Marital Status						
Not married	1.00		1.00		1.00	
Married	1.10 (0.57, 2.14)	0.771	1.61 (0.78, 3.31)	0.196	1.46 (0.70, 3.04)	0.308
Type of living arrangement						
Family residence	1.00		1.00		1.00	
Group-housing	0.57 (0.32, 1.01)	0.052	0.68 (0.37, 1.28)	0.233	0.92 (0.50, 1.72)	0.804
Single resident	1.36 (0.51, 3.61)	0.539	1.06 (0.36, 3.16)	0.911	0.79 (0.25, 2.48)	0.683
Area of residence						
Urban	1.00		1.00		1.00	
Rural	0.50 (0.30, 0.84)	0.009	0.90 (0.52, 1.56)	0.697	0.84 (0.48, 1.5)	0.565
Suburban	0.81 (0.49, 1.33)	0.407	1.14 (0.67, 1.94)	0.627	1.29 (0.75, 2.22)	0.351
Monthly family income						
Below 20,000 BDT	1.00		1.00		1.00	
20,000–35,000 BDT	1.46 (0.89, 2.39)	0.137	1.4 (0.82, 2.39)	0.213	1.14 (0.66, 1.97)	0.650
35,000–50,000 BDT	0.90 (0.55, 1.46)	0.661	0.74 (0.43, 1.27)	0.274	0.89 (0.52, 1.53)	0.664
Above 50,000 BDT	1.67 (1.00, 2.80)	0.051	1.40 (0.80, 2.44)	0.236	1.12 (0.63, 1.99)	0.699
Education level						
Higher	1.00		1.00		1.00	
Up to Secondary	0.54 (0.38, 0.77)	0.001	0.74 (0.51, 1.09)	0.127	0.72 (0.48, 1.07)	0.104
Religion						
Others	1.00		1.00		1.00	
Muslim	1.13 (0.74, 1.74)	0.575	1.28 (0.79, 2.06)	0.315	1.36 (0.83, 2.23)	0.224
Financial contribution to family						
Non-earner	1.00		1.00		1.00	
Earner	1.04 (0.61, 1.77)	0.888	1.43 (0.80, 2.55)	0.226	1.25 (0.70, 2.26)	0.451
Self-reported COVID-19 knowledge score						
Below median	1.00		1.00		1.00	
Above median	1.44 (1.04, 1.99)	0.030	1.11 (0.78, 1.58)	0.566	1.35 (0.93, 1.95)	0.113

Table 4
Multinomial logistic regression fitted to preference of groups by sex for vaccination (reference: no preference) over sociodemographic factors.

Factor	Male		Female	
	OR (95 % CI)	P-value	OR (95 % CI)	P-value
Age	1.00 (0.98, 1.02)	0.872	0.98 (0.95, 1.00)	0.092
Sex				
Female	1.00		1.00	
Male	2.44 (1.98, 2.99)	<0.001	0.99 (0.78, 1.25)	0.909
Marital status				
Not married	1.00		1.00	
Married	1.20 (0.83, 1.74)	0.331	1.26 (0.82, 1.92)	0.288
Type of living arrangement				
Family residence	1.00		1.00	
Group-housing	0.95 (0.67, 1.36)	0.798	0.72 (0.45, 1.16)	0.173
Single resident	0.74 (0.43, 1.28)	0.282	1.02 (0.56, 1.87)	0.946
Area of residence				
Urban	1.00		1.00	
Rural	1.19 (0.85, 1.66)	0.312	0.85 (0.55, 1.30)	0.459
Suburban	1.03 (0.76, 1.40)	0.861	1.17 (0.83, 1.65)	0.364
Monthly family income				
Below 20,000 BDT	1.00		1.00	
20,000–35,000 BDT	0.99 (0.74, 1.34)	0.969	0.83 (0.58, 1.19)	0.313
35,000–50,000 BDT	0.66 (0.48, 0.91)	0.012	0.56 (0.38, 0.82)	0.003
Above 50,000 BDT	0.59 (0.43, 0.81)	0.001	0.62 (0.43, 0.89)	0.009
Education level				
Higher	1.00		1.00	
Up to Secondary	1.11 (0.87, 1.40)	0.404	1.23 (0.94, 1.61)	0.132
Religion				
Others	1.00		1.00	
Muslim	1.54 (1.17, 2.03)	0.002	1.75 (1.24, 2.48)	0.002
Financial contribution to family				
Non-earner	1.00		1.00	
Earner	1.45 (1.07, 1.96)	0.016	1.96 (1.38, 2.78)	<0.001
Self-reported COVID-19 knowledge score				
Below median	1.00		1.00	
Above median	1.33 (1.09, 1.64)	0.006	1.12 (0.88, 1.42)	0.369

Table 5
Multinomial logistic regression fitted to preference of ethnic groups for vaccination (reference: no preference group) over sociodemographic factors.

Factor	Bengali		Others (aboriginals and Rohingyas)	
	OR (95 % CI)	P-value	OR (95 % CI)	P-value
Age	0.99 (0.98, 1.01)	0.485	0.97 (0.91, 1.02)	0.228
Sex				
Female	1.00		1.00	
Male	1.72 (1.44, 2.06)	<0.001	1.35 (0.85, 2.13)	0.204
Marital status				
Not married	1.00		1.00	
Married	1.57 (1.13, 2.18)	0.008	1.01 (0.43, 2.4)	0.981
Type of living arrangement				
Family residence	1.00		1.00	
Group-housing	1.38 (0.99, 1.92)	0.054	0.47 (0.14, 1.57)	0.219
Single resident	1.51 (0.93, 2.47)	0.098	1.45 (0.48, 4.42)	0.515
Area of residence				
Urban	1.00		1.00	
Rural	1.35 (0.99, 1.84)	0.056	1.09 (0.47, 2.54)	0.833
Suburban	1.05 (0.80, 1.37)	0.723	1.12 (0.58, 2.18)	0.737
Monthly family income				
Below 20,000 BDT	1.00		1.00	
20,000–35,000 BDT	0.84 (0.64, 1.11)	0.218	0.71 (0.33, 1.55)	0.389
35,000–50,000 BDT	0.65 (0.49, 0.87)	0.004	1.24 (0.60, 2.56)	0.555
Above 50,000 BDT	0.61 (0.46, 0.81)	0.001	0.85 (0.40, 1.78)	0.667
Education level				
Higher	1.00		1.00	
Up to Secondary	1.01 (0.82, 1.25)	0.905	1.11 (0.65, 1.89)	0.707
Religion				
Others	1.00		1.00	
Muslim	1.31 (1.03, 1.68)	0.028	0.61 (0.36, 1.04)	0.067
Financial contribution to family				
Non-earner	1.00		1.00	
Earner	1.25 (0.96, 1.64)	0.102	1.93 (0.99, 3.74)	0.053
Self-reported COVID-19 knowledge score				
Below median	1.00		1.00	
Above median	1.23 (1.03, 1.48)	0.025	0.87 (0.55, 1.37)	0.543

3.4. Religion-wise preference

Around 85 % of respondents had no preference in terms of which religious groups to be vaccinated first. The chi-square test showed that preference ranking by religion was associated with respondent's sex, marital status, living arrangement, area of residence, income, and religion (Supplementary Table 4). Majority (>80 %) of males and females had no preference on which religious group to get vaccine first. Among the married, 18 % prioritized Muslims. Around 15 % and 16 % of respondents living alone or in group residences supported Muslims to be vaccinated first, compared to 12 % of the respondents living with families, respectively; 21 % of rural residents and 19 % respondents with income below 20,000 BDT preferred Muslims to be vaccinated first. While 14.6 % of the Muslims wanted Muslims to be vaccinated, 6.4 % of respondents from other religious chose to vaccinate other religious groups over Muslims first.

The multinomial logistic model showed that sex, marital status, area of residence, monthly income, education, and religion were associated with preference of religious groups for vaccination (Table 6). Compared to females, males were associated with higher odds of preferring Muslims or other religious groups be vaccinated first over no preference. Married respondents had twice the odds of choosing Muslims than those who were unmarried compared to the no preference group. Similarly, rural residents and those who studied only up to high school preferred Muslims to be vaccinated first. However, those in the higher income groups ($\geq 35,000$ BDT) were more likely (50 % increased odds) to have no preference over choosing Muslims to be vaccinated first. Respondents who were Muslim were opined to vaccinate Muslims first and other religious groups later (Table 6).

3.5. Health condition-wise preference

Around two-thirds of respondents suggested the severely sick to be vaccinated first and 10 % had no preference. The chi-sq test showed that the preference ranking by health condition was associated with respondent's level of education, financial contribution to the family and self-reported COVID-19 knowledge (Supplementary Table 5). Slightly higher percentage of highly educated respondents (67.7 %) preferred severely sick to be vaccinated first than those who studied up to the secondary level (64 %). Similar distribution was observed for non-earner (67.6 %) vs earners (64.5 %). Around 68 % of the respondents with self-assessed above median COVID-19 knowledge preferred the severely sick to be vaccinated first compared to 64 % of those below median.

The multinomial logistic model only found monthly income and education to be associated with preference of vaccination based on health condition (Table 7). Respondents in income bracket between 35,000 and 50,000 BDT had 43 % lower odds of prioritizing the moderately sick to be vaccinated first than those with income below 20,000 BDT with reference to no preference. Those with education up to high school were associated with 32 % increased odds of preferring the severely sick compared to the highly educated.

3.6. Profession-wise preference

Most of the respondents (74.9 %) chose the frontliners to be vaccinated first than having no preference (18.6 %) or non-frontliners (6.5 %). The chi-square test showed that preference ranking by profession was associated with respondent's sex, marital status, monthly income, education level, financial contribution to the fam-

Table 6
Multinomial logistic regression fitted to preference of groups based on religion for vaccination (reference: no preference) over sociodemographic factors.

Factor	Muslim		Others	
	OR (95 % CI)	P-value	OR (95 % CI)	P-value
Age	0.99 (0.96, 1.01)	0.284	1.02 (0.97, 1.08)	0.441
Sex				
Female	1.00		1.00	
Male	1.58 (1.21, 2.07)	0.001	2.64 (1.22, 5.74)	0.014
Marital status				
Not married	1.00		1.00	
Married	2.15 (1.38, 3.35)	0.001	1.11 (0.32, 3.91)	0.869
Type of living arrangement				
Family residence	1.00		1.00	
Group-housing	1.24 (0.78, 1.95)	0.362	1.97 (0.8, 4.87)	0.141
Single resident	1.43 (0.75, 2.74)	0.280	1.77 (0.48, 6.44)	0.389
Area of residence				
Urban	1.00		1.00	
Rural	1.59 (1.07, 2.35)	0.020	1.21 (0.46, 3.13)	0.701
Suburban	0.88 (0.58, 1.33)	0.539	0.29 (0.07, 1.26)	0.099
Monthly family income				
Below 20,000 BDT	1.00		1.00	
20,000–35,000 BDT	0.78 (0.54, 1.12)	0.185	0.92 (0.40, 2.12)	0.838
35,000–50,000 BDT	0.51 (0.34, 0.77)	0.001	0.65 (0.24, 1.73)	0.384
Above 50,000 BDT	0.50 (0.34, 0.74)	0.001	0.46 (0.17, 1.28)	0.139
Education level				
Higher	1.00		1.00	
Up to Secondary	1.27 (0.95, 1.71)	0.109	2.08 (1.05, 4.15)	0.037
Religion				
Others	1.00		1.00	
Muslim	8.54 (3.98, 18.33)	<0.001	0.19 (0.10, 0.37)	<0.001
Financial contribution to family				
Non-earner	1.00		1.00	
Earner	1.17 (0.8, 1.71)	0.421	0.94 (0.35, 2.48)	0.895
Self-reported COVID-19 knowledge score				
Below median	1.00		1.00	
Above median	0.97 (0.74, 1.26)	0.820	0.88 (0.46, 1.7)	0.702

Table 7
Multinomial logistic regression fitted to preference of groups based on health condition for vaccination (reference: no preference) over sociodemographic factors.

Factor	Moderately sick		Severely sick		Healthy	
	OR (95 % CI)	P-value	OR (95 % CI)	P-value	OR (95 % CI)	P-value
Age	1.03 (0.99,1.07)	0.122	1.01 (0.97, 1.04)	0.769	1.03 (0.99, 1.08)	0.136
Sex						
Female	1.00		1.00		1.00	
Male	1.06 (0.75, 1.48)	0.758	1.27 (0.95, 1.69)	0.112	1.52 (0.96, 2.39)	0.072
Marital status						
Not married	1.00		1.00		1.00	
Married	0.87 (0.45, 1.68)	0.672	1.13 (0.64, 2.01)	0.673	1.06 (0.46, 2.43)	0.887
Type of living arrangement						
Family residence	1.00		1.00		1.00	
Group-housing	1.17 (0.63, 2.19)	0.616	0.96 (0.55, 1.66)	0.883	0.99 (0.43, 2.26)	0.980
Single resident	1.46 (0.51, 4.18)	0.478	1.61 (0.62, 4.18)	0.324	1.04 (0.26, 4.10)	0.953
Area of residence						
Urban	1.00		1.00		1.00	
Rural	0.61 (0.35, 1.06)	0.078	0.64 (0.41, 1.01)	0.054	0.66 (0.32, 1.38)	0.272
Suburban	1.03 (0.63, 1.69)	0.911	0.87 (0.57, 1.34)	0.528	1.10 (0.57, 2.10)	0.779
Monthly family income						
Below 20,000 BDT	1.00		1.00		1.00	
20,000–35,000 BDT	1.20 (0.72, 2.02)	0.480	1.16 (0.74, 1.81)	0.525	0.96 (0.49, 1.87)	0.900
35,000–50,000 BDT	0.57 (0.34, 0.97)	0.040	0.75 (0.48, 1.17)	0.208	0.49 (0.24, 1.00)	0.051
Above 50,000 BDT	0.93 (0.55, 1.59)	0.798	1.10 (0.70, 1.74)	0.681	0.89 (0.45, 1.76)	0.735
Education level						
Higher	1.00		1.00		1.00	
Up to Secondary	0.75 (0.52, 1.10)	0.138	0.68 (0.49, 0.93)	0.015	0.68 (0.41, 1.14)	0.145
Religion						
Others	1.00		1.00		1.00	
Muslim	1.17 (0.75, 1.82)	0.487	1.29 (0.89, 1.88)	0.180	1.48 (0.80, 2.72)	0.211
Financial contribution to family						
Non-earner	1.00		1.00		1.00	
Earner	1.21 (0.72, 2.05)	0.477	0.96 (0.60, 1.52)	0.858	1.06 (0.54, 2.09)	0.860
Self-reported COVID-19 knowledge score						
Below median	1.00		1.00		1.00	
Above median	1.30 (0.92, 1.81)	0.132	1.4 (1.06, 1.87)	0.019	1.24 (0.79, 1.94)	0.348

Table 8
Multinomial logistic regression fitted to preference of groups based on profession for vaccination (reference: no preference) over sociodemographic factors.

Factor	Frontline		Non-Frontline	
	OR (95 % CI)	P-value	OR (95 % CI)	P-value
Age	1.02 (0.99, 1.05)	0.264	1 (0.96, 1.05)	0.957
Sex				
Female	1.00		1.00	
Male	1.87 (1.49, 2.35)	<0.001	2.06 (1.38, 3.06)	<0.001
Marital status				
Not married	1.00		1.00	
Married	1.39 (0.88, 2.21)	0.158	2.45 (1.20, 5.03)	0.014
Type of living arrangement				
Family residence	1.00		1.00	
Group-housing	1.33 (0.84, 2.10)	0.221	1.70 (0.85, 3.39)	0.131
Single resident	0.93 (0.49, 1.75)	0.814	1.34 (0.50, 3.58)	0.555
Area of residence				
Urban	1.00		1.00	
Rural	1.48 (0.98, 2.24)	0.064	1.99 (1.07, 3.68)	0.029
Suburban	1.21 (0.86, 1.70)	0.277	1.37 (0.78, 2.41)	0.280
Monthly family income				
Below 20,000 BDT	1.00		1.00	
20,000–35,000 BDT	1.53 (1.08, 2.17)	0.018	1.26 (0.73, 2.18)	0.416
35,000–50,000 BDT	1.03 (0.73, 1.46)	0.865	0.82 (0.46, 1.46)	0.497
Above 50,000 BDT	1.51 (1.07, 2.13)	0.020	0.67 (0.36, 1.23)	0.199
Education level				
Higher	1.00		1.00	
Up to Secondary	0.78 (0.61, 1.00)	0.047	0.88 (0.57, 1.37)	0.575
Religion				
Others	1.00		1.00	
Muslim	0.88 (0.64, 1.21)	0.419	1.04 (0.60, 1.81)	0.880
Financial contribution to family				
Non-earner	1.00		1.00	
Earner	1.09 (0.76, 1.57)	0.634	1.00 (0.54, 1.83)	0.994
Self-reported COVID-19 knowledge score				
Below median	1.00		1.00	
Above median	1.28 (1.02, 1.60)	0.030	1.08 (0.73, 1.60)	0.693

ily and self-reported COVID-19 knowledge (Supplementary Table 6). More females (24.3 %) had no preference than did the males (13.6 %) on this choice. Over 80 % married respondents preferred frontliners to be vaccinated first. The higher the income group, the higher was the proportion of respondents choosing no preference on which professional category to get vaccinated earlier. Majority of highly educated individuals (76.5 %) preferred frontliners and so did those up to secondary level of education (69.8 %). Around 20 % of the non-earners and below median COVID-19 knowledge had no preference.

The multinomial logistic model showed that sex, marital status, area of residence, monthly income, and COVID-19 knowledge were associated with vaccine preference on professional groups (Table 8). Males showed higher odds of choosing either the frontliners or non-frontliners than their female counterparts compared to having no choice. Married respondents and rural residents had 2.5- and 2.0- times the odds of preferring non-frontliners than having no choice. Higher income group were more likely to prefer frontliners than having no preference. Those with self-claimed above median knowledge on COVID-19 had 30 % higher odds of prioritizing the frontliners to be vaccinated first than those with below median knowledge.

4. Discussion

The primary objective of this study was to assess the opinion of Bangladeshi people regarding the prioritization of different cohorts for vaccination considering the limited available vaccine supply. A strong preference for early vaccination was shown towards frontline workers, the severely sick, and the elderly. However, segregation across ethnicity was noted without any major preference among sexes or religion. This supports the Bangladesh government's strategy of vaccination priority list [58]. However, this preference ranking varied across sociodemographic factors including self-assessed COVID-19 knowledge and income, which varied with different effect sizes and significance. Despite the skewness in the collected sample, it seems that primary understanding of vaccine needs, such as immunizing the frontliners or the severely sick, was common across the population, which could be used to argue that public health communication is likely to work if delivered efficiently.

While early vaccination of the essential workers and the most vulnerable is expected [45,46,59–61], this discussion would focus on the cohort who went beyond the typical norm and opined otherwise. The probable rationale for the cohort that did not have any preference would be elucidated as well.

Males had vaccination preference for children, males, Bengalis and any religious group rather than having no preference compared to females. Similarly, married respondents preferred Bengalis and Muslims to be vaccinated compared to the unmarried. The preference for Bengalis and Muslims could be due to nativism. Some respondents may feel more related to their sect than others. In the conservative society of Bangladesh, males are typically more outgoing [62] and might form an opinion on choosing themselves [63] or preferring their cohorts to be vaccinated first, as they would see themselves as the breadwinners of the family who must go out regularly. Patriarchal societies typically prioritize males and income earners more than other members of the family [64], which could have reflected participants' opinions in the survey. Married respondents might be more protective of their families and own society. This certainly does not mean they would not have preferred frontliners or the most vulnerable; however, given the strict choice between their native groups and others, they chose their own.

Rural residents, interestingly, preferred Muslims and non-frontliners. They are the only group that preferred non-

frontliners over showing no preference. Those with income below 20,000 BDT had a higher preference for males, Muslins and Bengalis. Rural residents are the further detached from the true scenario of the pandemic compared to urban residents, as health measures were less strictly followed in peripheral districts during the pandemic in Bangladesh [6]. The public health messages often are not clearly portrayed in rural areas keeping them unaware of the vaccine reception hierarchy. And rural occupations might not be regarded as essential, which may have made some respondents choose to vaccinate non-frontliners. Similarly, the lower income group (who might overlap with rural residents) might have resorted to nativism by supporting the Muslims and Bengalis. This is true for Muslims supporting Muslims, Bengalis, and males.

Those with self-assessed above median COVID-19 knowledge preferred children, males and Bengalis. Earning members of the family chose either sex over having no preference. Interestingly, the ones with high school-level or below education preferred less to vaccinate the severely sick than those who were highly educated. Preference heterogeneity among individuals without qualitative information or some form of justification from them is hard to assume and would be unwise as well. However, it is imperative that risk communication in peripheral districts of Bangladesh be enhanced, as the viral infection is spreading rapidly in borders adjacent to India [65–67].

Highly educated respondents, especially those living in urban areas and in higher income groups, did not show major preferences over age, sex, ethnicity, or religion. This was expected, as informed members of the public would be aware of the need for frontline workers and the most vulnerable and would differentiate them by other demographic characteristics. Public strategies shall be required to be formulated to achieve the desired status by meeting the stated preferences of the study respondents and promoting rational allocation of resources, as the elderly population is met with reluctance in receiving COVID-19 vaccination [14].

Some caution is required while interpreting the results, as this study used snowball sampling and was not completely randomized. The study was skewed towards the urban privileged class, particularly those with access to the internet. The predominance of the higher educated respondents (over 76 %) also echoed the skewness towards people with access to the internet. Due to public health constraints, face-to-face data collection was abandoned and thus limiting the sampling frame. The contrasts in Table 2 show that the sample cannot be strictly nationally representative, however, this is a limitation based on social media users and who are willing to engage in online opinion surveys. Second, due to online data collection, no verification of the information provided by the respondents could be conducted. Furthermore, the study is cross-sectional, and so there is no baseline to compare life disruptions from the pre-pandemic period. While the survey was analyzed using a multinomial model due to multiple categories in outcome variables, there are some caveats: the model assumes a linear relationship between the predictors and the outcome; such models require a higher sample size compared to logistic regression models (sensitivity analysis) and too many categorizations of outcomes can lead to overfitting. Additionally, remote collection of data employing social media platforms also limits the external validity of the inferences, as many hard-to-reach communities in remote areas with limited internet connectivity alongside feature phone users could not be reached using the stated methodologies.

5. Conclusion

In order to fight the pandemic, equitable distribution of vaccines is essential. However, the limited availability of vaccines and the ever-changing dynamics of the pandemic have put stern restrictions on the ability of governments to vaccinate their people as early as possible, effectively forcing them to perform a triage and thus prioritizing certain cohorts over the others. Such selective distribution of vaccines requires the people to be on board with the necessity of such policies, which is largely dependent on effective risk communication and trust in the government's capability to successfully reach herd immunity.

The findings of this study propound these very ideas in the context of Bangladesh and shed light on the fact that most people do concur with the WHO and the Bangladesh government. The individual- or group-specific heterogeneity in opinions could be due to the lack of appropriate risk communication and the deficiency in understanding the overall depth of the pandemic. As of early 2023, vaccination has been successfully administered to a large section of the globe and Bangladesh was able to vaccinate 17 million people [68]. Although 60 % of those aged 60 or older are yet to be vaccinated in Bangladesh, it has done well to recover from the initial mismanagement of the pandemic. This paper provides some of the lessons to take on board for future health crises. It is fundamental that the government ensure the people's confidence in the effective deployment of any measures during the pandemic and thus take the necessary initiatives to that end.

Data availability

Data will be made available on request.

Declaration of Competing 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.

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Ethical clearance

All procedures performed in studies involving human participants were in accordance with international ethical standards. Ethical approval was taken from The University of Southern Queensland Human Research Ethics Committee (H17REA157). The participation to the study was voluntary and informed consent was obtained from all patients for being included in the study.

Contributor statement

RK Biswas conceptualized the study, designed the survey questionnaire, compiled the data, synthesized the analysis plan, and drafted the manuscript. A Afiaz designed the survey questionnaire, synthesized the analysis plan, conducted formal analysis, and critically revised the manuscript. S Huq conducted literature review, designed the survey questionnaire, and critically revised the manuscript. M Farzana conducted data collection, and critically revised

the manuscript. E Kabir designed the survey questionnaire, managed ethics, and critically revised the manuscript. The final manuscript was read and approved by all the authors.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2023.06.050.

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