



# COVID-19 vaccine acceptance and its determinants: A cross-sectional study among the socioeconomically disadvantaged communities living in Delhi, India



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## ABSTRACT

**Background:** Vaccination against severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is the most desired solution to combat COVID-19. We examined the willingness to accept the vaccine and reasons for vaccine hesitancy, and identified some factors associated with the vaccine hesitancy among the socio-economically disadvantaged urban population from Delhi, India.

**Methods:** We conducted a cross-sectional survey of a randomly selected sample of 1539 households from 31 urban clusters. Data on socio-demographics, health beliefs, and willingness to accept the SARS-CoV-2 vaccine were collected through a face-to-face interviewer-administered, pre-tested questionnaire from an adult member. Vaccine acceptance/hesitancy was analysed by various socio-demographic and health belief variables. Multinomial regressions were carried out to identify the factors associated with the vaccine hesitancy.

**Results:** Overall, 64.9% (95% CI: 62.5 to 67.3) of the respondents would accept the vaccine, 17.4% (95% CI: 15.6 to 19.4) were undecided, and 17.7% (95% CI: 15.8 to 19.7) would not accept the vaccine. The reasons for not accepting the vaccine were: belief that they had immunity (12.9%), the corona was a hoax (11.8%), the vaccine was not necessary (7.4%), and did not want to disturb the natural bodily systems by the vaccine (5.6%). The undecided group mainly would like to wait and see (37.7%), decide when the vaccine become available (11.6%), will take if everyone in their community takes (10.4%). Multinomial logistic regression identified older age, low perceived susceptibility of contracting COVID-19, low perceived severity of COVID-19, low self-efficacy to protect against COVID-19, and unawareness and non-use of Aarogya Setu App as significant predictors of vaccine hesitancy.

**Conclusions:** Two-thirds of Delhi's low-income groups would accept the vaccine against SARS-CoV-2. Vaccine hesitancy was associated with older age, low perceived susceptibility, low perceived severity, and low self-efficacy to protect themselves from COVID-19. Hence, efforts are needed to address these issues and vaccine concerns to increase the vaccine uptake.

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## 1. Introduction

COVID-19 has posed unprecedented challenges worldwide. Many countries resorted to national or regional lockdown to slow down the transmission of the novel coronavirus (SARS-CoV-2), and various behavioural interventions were advocated. Simultaneously, countries accelerated developing and testing newer drugs and vaccines while trying to repurpose the existing medical interventions for the COVID-19 treatment. Developing vaccines to combat the novel coronavirus is designed to protect people from the

COVID-19, and is a preferred solution to decrease the COVID-19 transmission. However, vaccine hesitancy surfaced as a major problem globally [1,2]. "Vaccine hesitancy refers to the delay in acceptance, or refusal of vaccination despite the availability of the vaccination services" [3]. Della-Polla et al. reported that one third of the parents were hesitant to vaccinate their children against HPV and they further reported that those parents who knew about HPV vaccine had positive attitude towards HPV vaccination [4]. Bianco et al. evaluated the attitudes of the Italian parents about the childhood vaccine refusal or delay [5]. They reported that parental attitudes, communication and media environment as important determinants of vaccine hesitancy. Dube et al., based on their review, concluded that individual decision

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making for vaccination involves emotional, cultural, social, spiritual and political factors as much as the cognitive factors and emphasized the need for more research to understand vaccine hesitancy among various groups including health professionals [6]. The success of any vaccination programme depends on vaccination coverage, which again depends on peoples' willingness to get vaccinated. Despite vaccines being a solution for many diseases, vaccine hesitancy is rising globally. The World Health Organization identified vaccine hesitancy as one of the top 10 health risks [7]. Human behaviour has been established as an important determinant of prevention, control and management of illnesses including accepting the healthcare interventions. Individual perceptions/beliefs are known to influence health behaviours. Various individual level factors including health beliefs, would influence the COVID-19 related behaviours including vaccine acceptance and these are embedded in a broader social context of the factors at various levels would influence the willingness to accept or not to accept the vaccines against COVID-19. It is conceptualized that access to COVID-19 related information, various health beliefs (perceived susceptibility, perceived severity, perceived risk/perceived benefits, attitudes and subjective norms), socioeconomic status, and other cultural factors, would influence vaccine decisions. Since the determinants of COVID-19 vaccine uptake are not widely known, identifying a range of explanatory factors associated with vaccine decisions would be useful.

Socio-economically disadvantaged people mostly live in environmentally degraded conditions e.g. urban slums. They usually have small dwellings, most without a sanitary latrine. People living in such area are unable to comply with the COVID appropriate behaviour. Hence, it is not surprising that a more intense COVID-19 transmission has been observed in such communities. Socio-economically disadvantaged people, in general, face health inequity. If they were to also suffer from vaccine hesitancy, then the consequences could be truly tragic. Therefore, we aimed to measure the magnitude of the vaccine hesitancy, and the factors associated with it. The overall objective being to suggest a package that would increase the acceptance of COVID-19 vaccine.

## 2. Methods

### 2.1. Study area

This study was carried out in the National Capital Territory of Delhi (NCT of Delhi), the national capital of India. Delhi emerged as the second largest urban agglomeration in the world [8]. Delhi is one of the cities with the highest population density, with 29,259 persons per square mile [9]. Due to its developmental potential, Delhi attracts large numbers of poor migrants, which in turn has resulted in the rising numbers of slums and unauthorised colonies. The poor live mainly in three types of habitats viz., resettlement colonies, unauthorized slum colonies/slums, and slums without basic amenities, including those dwellings along the railway tracks, under the bridges, and open spaces, etc. The resettlement colonies were constructed by the government and sold at a subsidized price. The slums, and slums without basic amenities are characterised by open drainage, unsanitary condition, squatter/dilapidated house, usually with a single room, without a sanitary latrine, not aligned in proper streets and constructed haphazardly.

### 2.2. Study design and participants

This was a cross-sectional study. For the present study, we have selected three types of habitats, viz., resettlement colonies, unauthorised colonies/slums and slums without basic amenities, where

the socio-economically disadvantaged communities usually live. According to Delhi Urban Shelter Improvement Board, there were 82 resettlement colonies, 1797 unauthorised colonies and 755 *juggi-jhompri* (*jj bastis*- these are the slums encroached on public land in Delhi) [10]. From these, we have randomly selected 31 clusters (5 resettlement colonies, 13 unauthorised slum colonies, and 13 slums without basic amenities). From each resettlement colony, four to six blocks were selected randomly. From each block, alternative streets were selected, and from each street, 2 to 3 households were selected randomly. In slums without basic amenities, each roughly aligned street was selected and 2 households were randomly selected from each street. An adult member (the head of the household was requested to participate in the survey; in the absence of head of the household, other adult member-usually the spouse, son or daughter participated) provided the data.

We could not find any study that reported rate of COVID-19 vaccine hesitancy. Hence we relied on WHO European Region suggestion of a minimum sample of 1,000 to understand the risk perceptions and engaged behaviours [11]. We decided to include a minimum of 1,500 households (approximately 500 from each type of habitat). The sample size is found justified by considering that at least 50% of the population would be willing to accept the vaccine, with 95% confidence interval and 10% relative precision, taking design effect and non-response rate of 2% [12]. We approached 1559 households, and data were collected from an adult member of the household. The purpose of the study was explained in the local language and the data were collected after obtaining the written consent from the participant. It was also ensured that their personal details and information they provide will be kept confidential and the information they provide will only be used confidentially and will not be disclosed to anyone; and this information will only be used for research purposes. Their name, address, and other personal information will be removed from the questionnaire, and a code will be used to connect the answers. Thus, the anonymity of the participants was maintained. It was also informed that their participation is completely voluntary, they can also stop the interview any time if they wish, or skip any questions that they do not want to answer. The participants did not receive any gift or money for their participation. A trained interviewer conducted face-to-face interviews with the help of a pre-tested questionnaire during September 2020 to January 2021. During the study period no COVID-19 vaccine was licensed in India. Questionnaire contained questions on socio-demographic information and various COVID-19 related behaviours, including vaccine acceptance and health beliefs. The Institute Ethics Committee of the All India Institute of Medical Sciences, New Delhi approved the study protocol (Reference Number: IEC-268/17.04.2020, RP 15/2020).

### 2.3. Study tool

A draft questionnaire consisted of socio-demographic details, COVID-19 behaviours (perceptions/health beliefs, awareness and compliance), COVID-19 vaccine related (awareness on the vaccine, willingness to accept the vaccine and reasons for acceptance or hesitancy). Questions pertaining to the vaccine were developed based on the previous studies on vaccine hesitancy. The questionnaire's face validity was checked through the following steps. This draft questionnaire was discussed amongst ourselves, checked for sequence and easy flow of questions. We carefully checked whether questions are addressing the objectives of the study. The questionnaire was carefully checked for duplicatability. This questionnaire developed in English was translated to Hindi, local language of Delhi by a research assistant. Again, this questionnaire was discussed to ensure whether the translated version is conveying the question without altering its meaning. Care was taken to

**Table 1**  
Background characteristics of the respondents and their health beliefs about COVID-19.

Variable	Number (%) (n = 1539)
<b>Type of habitation</b>	
Resettlement colonies	448 (29.1)
Unauthorised slum colonies	574 (37.3)
Slums without basic amenities	517 (33.6)
<b>Gender of the respondent</b>	
Men	784 (50.9)
Women	755 (49.1)
<b>Age group of the respondents</b>	
18–29 years	405 (26.3)
30–39 years	449 (29.2)
40–49 years	342 (22.2)
50–59 years	204 (13.3)
60 years and above	139 (9.0)
<b>Educational attainment</b>	
No formal schooling	440 (28.6)
1–5 years of education	162 (10.5)
6–8 years of education	265 (17.2)
9–11 years of education	260 (16.9)
12–14 years of education	242 (15.7)
15 or more years of education	170 (11.0)
<b>Type of house<sup>1</sup></b>	
Katcha	99 (6.4)
Semi-pucca	333 (21.6)
Pucca	1107 (72.0)
<b>Ownership of the house/dwelling<sup>2</sup></b>	
Own	1166 (75.8)
Rented	373 (24.2)
<b>Number of rooms</b>	
One room	608 (39.5)
Two rooms	582 (37.8)
Three rooms	228 (14.8)
Four or more rooms	121 (7.9)
<b>Source of drinking water</b>	
Piped water supply into the house	1278 (83.0)
Common public tap/ tanker-truck/fetched from neighbourhood	261 (17.0)
<b>Frequency of water supply</b>	
Supplied daily	1394 (90.6)
Supplied one to three times in a week	130 (8.4)
No supply	15 (1.0)
<b>Sanitation facility</b>	
Separate own toilet	1066 (69.3)
Shared toilet with other households	47 (3.1)
Community toilet	423 (27.5)
Open place/drainage	3 (0.2)
<b>Electricity</b>	
Has metered connection	1528 (99.3)
No metered connection / drawn from street lines	11 (0.7)
<b>Ration card</b>	
Do not possess ration card	769 (50.0)
Has non-priority ration card (for above poverty line households)	13 (0.8)
Has priority ration card (for below poverty line households)	676 (43.9)
Has <i>Antyodaya Anna Yojana</i> card (for the poorest of the poor)	58 (3.8)
Temporary (Coupon) for provision of ration (due to COVID situation)	23 (1.5)
<b>Religious affiliation</b>	
Hindu	1337 (86.9)
Islam	166 (10.8)
Others	36 (2.3)
<b>Social class/caste category</b>	
Scheduled tribe/ scheduled caste	567 (36.8)
Other backward castes	152 (9.9)
Others / did not report	820 (53.3)
<b>Number of household members</b>	
Living alone	54 (3.5)
2–5 household members	907 (58.9)
6 or more household members	578 (37.6)
<b>Monthly household income</b>	
Up to INR 9,999	258 (16.8)
INR 10,000–14,999	471 (30.6)
INR 15,000–19,999	311 (20.2)

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**Table 1** (continued)

Variable	Number (%) (n = 1539)
INR 20,000–29,999	293 (19.0)
INR 30,000 or more	206 (13.4)
Mean $\pm$ SD (in INR)	INR 17047 $\pm$ 11476
5% trimmed mean (in INR)	INR 15,825
Median (in INR)	INR 15,000

<sup>1</sup> Type of house: Squatter hut – a temporary dwelling made up of used and cheap material like plastic sheets, corrugated metal sheets, plywood, card boards, etc. for the purpose of making roof and walls.; katcha house – with walls and roof are made of material such as unburnt bricks, mud, thatch, loosely packed stones, etc.; pucca house – with cemented floor and walls; and the roof is of concrete slab or tiled; semi-pucca house – with fixed walls made up of pucca material but roof is made up of the material other than those used for pucca house.

<sup>2</sup> 'Own' need not imply legal ownership. These are constructed by the households themselves in the in the vacant areas, usually government owned land, and emerged as big colonies/slums. These houses are again rented or even sold to others implying a semi-legal ownership. Governments started the process of authorising these houses, mainly in the older slums, where people have invested their earning in constructing these houses; INR = Indian Rupee, 1INR = US\$ 0.013.

use the words which are commonly used by the people. This questionnaire was pre-tested among 15 respondents in a community, which was not included in the main survey. These pre-tested questionnaires were reviewed to see whether the questions were understood in the same way by all the participants, whether the words are easily understood to the participants, and for flow and sequence of questions; some questions were made open-ended after pre-testing. The questionnaire was again pre-tested among 10 other respondents and then finalised. The questionnaire consisted of sociodemographic details, perceptions about COVID-19 and COVID-19 vaccines. The intention to accept the COVID-19 vaccine was ascertained (categories: accept the vaccine, not yet decided, do not accept the vaccine). The information on perceived susceptibility was collected by asking the following question: "Considering various factors around you, what are your chances of getting infected with the novel coronavirus (1 = extremely unlikely, 2 = unlikely, 3 = somewhat likely, 4 = likely, 5 = extremely likely, which were re-categorized as 1 = unlikely, 2 = somewhat likely and 3 = likely, during the analysis). Perceived severity of the disease was assessed by asking, "What do you think about how serious would contracting the novel coronavirus be for you?" Also, the participants were asked, "Do you know how to protect yourself from coronavirus?" (1 = do not know, 2 = know a little, 3 = know well/mostly). The concerns of the respondent regarding the vaccine were collected in an open-ended manner, and the responses were categorized later. The variables were categorised as reported in [Table 1](#) and [2](#).

#### 2.4: Statistical analysis

Descriptive analysis was carried out for various socio-demographic variables ([Table 1](#)); and also by the various categories of vaccine acceptance ([table 2](#)). To identify the independent variables for the multinomial regression analyses, each independent variable was initially regressed against the dependent variable (accept vaccine Vs hesitant to vaccinate). Those variables with a minimum p-value of 0.25 were included for final analyses following Mickey and Greenland [13]. The model selected for carrying out the multinomial logistic regression analysis was the main effects model, and model fitting was based on log-likelihood ratios. A p-value of <0.05 was considered as statically significant, and the tests were two-sided. All analyses were carried out using SPSS 23.0 (IBM Corp., Armonk, NY, USA).

### 3. Results

None of the participants refused to participate, however, twenty out of 1,559 questionnaires were incomplete, hence were excluded from the analysis. The background characteristics of 1539 respon-

dents are given in [table 1](#). While 448 respondents were from resettlement colonies, 574 were from unauthorised slums, and 517 were inhabiting slums without basic amenities. Almost half (50.9%) of the respondents were men. Nearly 29% of the participants did not have formal schooling. Three-fourths (75%) of the respondents lived in their own house. Nearly 72% of the houses had cemented floors with a concrete slab. About 40% respondents had single-room dwelling, and 83% of the households had access to a piped water supply ([Table 1](#)).

A majority were Hindu (86.7%). Nearly 47% reported that they belonged to backward caste groups (scheduled tribes, scheduled castes and other backward castes). The government of India had recognized these groups for affirmative action in education, employment and other developmental opportunities.

Only 26% of the respondents rated that their chances of getting infected with COVID-19 as "likely", nearly one fifth (21.2%) as "somewhat likely", while 52% as "unlikely". Approximately 37% felt that COVID-19 was a severe disease, while 24% thought it was not severe. When asked if they knew how to protect themselves from the coronavirus, 47% said that they knew well/mostly, (45.7%) knew a little, and 7% did not know at all.

Using a questionnaire, we ascertained the intention to accept the COVID-19 vaccine. While 64.9% of the respondents said that they would accept the vaccine, 17.4% said they were undecided, and 17.7% said they would not accept the vaccine ([Table 2](#)).

The distribution of vaccine acceptance/hesitancy by various socio-demographic variables and health beliefs revealed that a slightly higher proportion of men (67% of men, and 63% women) would accept the vaccine. Younger age groups were more inclined to accept the vaccine compared to older age group. Better educated were prepared to accept the vaccine. Approximately one-quarters (28%) of the respondents knew of someone who had been infected with COVID 19. Out of the nine respondents, who had already been infected, 8 were willing to accept the vaccine, while one was undecided. Of the 31 respondents whose household member had contracted COVID-19, 25 (80.6%) were willing to accept the vaccine. Perceived susceptibility (i.e. their chances of getting COVID-19 infection) was considerably low. Only 26% of the respondents rated their chances of contracting COVID 19 as "likely", and nearly 30% rated "unlikely". However, once infected, COVID-19 was considered as "severe" (36.7%) or "somewhat severe" (39%). While 47% expressed that they mostly knew how to protect themselves from COVID-19, 46% said they knew a little, and 7% said they do not know at all. Around 65% of the respondents were aware that a vaccine against COVID – 19 was being developed in India. Regarding the awareness and utilization of the Indian government's *Aarogya setu* app, one third said they had never heard of it, 40% had heard of it (but not using it), and only 27% were using the *Aarogya setu* app.

**Table 2**  
Vaccine acceptance and hesitancy by various socio-demographic variables and health beliefs.

Independent variable	Number	Accept vaccine (n = 999)	Undecided (n = 268)	Do not accept (n = 272)
<b>Percentage (95% CI)</b>	<b>1539</b>	<b>64.9 (62.5–67.3)</b>	<b>17.4 (15.6–19.4)</b>	<b>17.7 (15.8–19.7)</b>
<b>Gender</b>				
Men	784	522 (66.6)	128 (16.3)	134 (17.1)
Women	755	477 (63.2)	140 (18.5)	138 (18.3)
<b>Age group</b>				
18–29 years	405	311 (76.8)	52 (12.8)	42 (10.4)
30–39 years	449	286 (63.7)	89 (19.8)	74 (16.5)
40–49 years	342	227 (66.4)	60 (17.5)	55 (16.1)
50–59 years	204	114 (55.9)	33 (16.2)	57 (27.9)
60 yrs & above	139	61 (43.9)	34 (24.5)	44 (31.7)
<b>Residential area</b>				
Resettlement colonies	448	316(70.5)	80 (17.9)	52 (11.6)
Unauthorised slum colonies	574	359 (62.5)	80 (13.9)	135 (23.5)
Slums without basic amenities	517	324 (62.7)	108 (20.9)	85 (16.4)
<b>Education status (in years)</b>				
No formal schooling	440	243 (55.2)	79 (18.0)	118 (26.8)
1–5 years	162	98 (60.5)	31 (19.1)	33 (20.4)
6–8 years	265	156 (58.9)	65 (24.5)	44 (16.6)
9–11 years	260	184 (70.8)	41 (15.8)	35 (13.5)
12–14 years	242	178 (73.6)	33 (13.6)	31 (12.8)
15 years or more	170	140 (82.4)	19 (11.2)	11 (6.5)
<b>Monthly household income</b>				
Up to INR 9,999	258	159 (61.6)	54 (20.9)	45 (17.4)
INR 10,000–14,999	471	291 (61.8)	82 (17.4)	98 (20.8)
INR 15,000–19,999	311	207 (66.6)	54 (17.4)	50 (16.1)
INR 20,000–29,999	293	206 (70.3)	47 (16.0)	40 (13.7)
INR 30,000 & above	206	136 (66.0)	31 (15.0)	39 (18.9)
<b>Size of the household</b>				
Living alone	54	32 (59.3)	11 (20.4)	11 (20.4)
2–5 members	907	625 (68.9)	148 (16.3)	134 (14.8)
6 or more members	578	342 (59.2)	109 (18.9)	127 (22.0)
<b>Religious affiliation</b>				
Hindu	1337	882 (66.0)	237 (17.7)	218 (16.3)
Islam	166	92 (55.4)	26 (15.7)	48 (28.9)
Others	36	25 (69.4)	5 (13.9)	6 (16.7)
<b>Knew at least one person (self/family member or neighbour) who had COVID-19</b>				
Yes	425	317 (74.6)	62 (14.6)	46 (10.8)
Don't Know	1114	682 (61.2)	206 (18.5)	226 (20.3)
<b>Awareness on vaccine development in India</b>				
Aware	1012	711 (70.3)	165 (16.3)	136 (13.4)
Not aware	527	288 (54.6)	103 (19.5)	136 (25.8)
<b>Considering various factors around you, what are your chances of getting infected with novel coronavirus?</b>				
Unlikely	807	456 (56.5)	162 (20.1)	189 (23.4)
Somewhat likely	327	237 (72.5)	51 (15.6)	39 (11.9)
Likely	405	306 (75.6)	55 (13.6)	44 (10.9)
<b>What do you think about how serious would contracting the novel coronavirus be for you?</b>				
Not severe	372	208 (55.9)	78 (21.0)	86 (23.1)
Somewhat severe	602	397 (65.9)	95 (15.8)	110 (18.3)
Severe	565	394 (69.7)	95 (16.8)	76 (13.5)
<b>Do you how to protect yourself from coronavirus?</b>				
Don't know at all	108	33 (30.6)	26 (24.1)	49 (45.4)
Know a little	704	431 (61.2)	134 (19.0)	139 (19.7)
Know well/mostly	727	535 (73.6)	108 (14.9)	84 (11.6)
<b>Awareness and use of Aarogya Setu App</b>				
Never heard	507	251 (49.5)	99 (19.5)	157 (31.0)
Heard of it	616	411 (66.7)	115 (18.7)	90 (14.6)
Using the App	416	337 (81.0)	54 (13.0)	25 (6.0)

CI = confidence interval.

Among those that were undecided to accept the vaccine, 37.7% reported that they would like to wait and see, 11.6% said they will think about it once the vaccine was made available, followed by 10.4% who said that they would accept the vaccine if everyone else in their community opted for it (Table 3). Various health beliefs were major reasons for those who did not wish to accept the vaccine. These beliefs included, "I do not need vaccine, I have immunity (12.9%), corona is a hoax, there is no corona (11.8%), vaccine is not necessary (7.4%), fear of vaccine (7.0%), I do not want to disturb my natural body system (5.9%), I do not have COVID (5.1%), do not trust vaccine (3.3%), and concerned about side effects (3.3%)".

The results of the multinomial regression are presented in Table 4. The younger age-group respondents were significantly more likely to accept the vaccine ( $p < 0.05$ ). Compared to those living in slums without basic amenities, those living in unauthorised slum colonies were twice as likely not to accept vaccine ( $p < 0.05$ ). Those who perceived their chances of contracting COVID-19 as unlikely ( $p < 0.05$ ), those who perceived COVID-19 as not severe ( $p < 0.05$ ), those who did not know how to protect themselves from coronavirus ( $p < 0.05$ ), and those who had not heard or not using Aarogya Setu app ( $p < 0.05$ ) were at the higher risk of not accepting the vaccine. Thus, the younger age group, those who perceived

**Table 3**  
Reasons/concerns for vaccine hesitancy.

Concerns/reasons for vaccine hesitancy*	Number (%)
<b>Vaccines concerns of those who were not yet decided to accept vaccine (n = 268)</b>	
Wait and see	101 (37.7)
Did not express any specific concern	46 (17.2)
Will decide once vaccine is made available	31 (11.6)
Will take if everyone in their community takes	28 (10.4)
Will take vaccine if infected with COVID	15 (5.6)
Concerned about side effects	12 (4.5)
Will take if government recommends it	11 (4.1)
If family members insist	7 (2.6)
Cost concerns	7 (2.6)
Safety of vaccine	7 (2.6)
Fear of vaccine	3 (1.1)
Religious reasons	2 (0.7)
Vaccine efficacy	2 (0.7)
<b>Vaccines concerns of those who 'Do not accept the vaccine' (n = 272)</b>	
Did not express any specific concern	98 (36.0)
I do not need vaccine, I have immunity	35 (12.9)
No need of vaccine, corona is hoax/there is no corona	33 (11.8)
Vaccine is not necessary	20 (7.4)
Fear of vaccine	19 (7.0)
Do not want to disturb natural body systems	16 (5.9)
I do not have COVID	14 (5.1)
Concerned about side effects	9 (3.3)
Do not trust vaccine	9 (3.3)
Corona is not dangerous	6 (2.2)
I do not want it	4 (1.5)
I have lived my life, so no need	3 (1.1)
Religious reasons	2 (0.7)
Since it is not compulsory	2 (0.7)
Vaccine efficacy	1 (0.4)
I am sick	1 (0.4)
No point in taking, whatever has to happen will happen	1 (0.4)

\*Multiple responses were given.

higher likelihood of contracting novel corona infection, those who perceived COVID-19 as a severe illness, knew how to protect themselves from COVID-19 infection, and those using *Aarogyasetu* app were more likely to accept COVID-19 vaccine. The model explains 12.9% of the variance by the selected variables.

#### 4. Discussion

We found that nearly two-thirds (64.9%) of the respondents were inclined to accept the vaccine. An additional 17.4% were currently undecided but would likely accept the vaccine if most of their community members were to get vaccinated. Our study results are comparable to several other studies across the world. A web-based survey across India had revealed that 78.6% were willing to accept the vaccination [14]. However, 35% of the respondents in this study were healthcare providers, and the sample represented relatively better educated respondents. A systematic review on COVID-19 vaccine acceptance revealed that willingness to receive the COVID-19 vaccine ranged from 27.7% (in Congo) to 91.3% in China [15]. Wang et al., based on the meta-analysis of 38 studies, estimated that the vaccine acceptance rate was 73% [16]. Napolitalino et al. reported a high prevalence of vaccine hesitancy among Italian parents [17]. Relatively higher rate of willingness to accept COVID-19 vaccines were reported from China [18] and Southern Italy [19]. Only 71.4% of the Mozambicans were willing to accept COVID-19 vaccine [20]. Ragan et al. among the university undergraduates in the US, reported that only human papilloma virus vaccine and that the student's decision making is mainly influenced by the parents [21]. They reported that while

the HPV vaccination among the students was 55.8%; however, a higher proportion of students (95.8%) who received encouragement (95.8%) from their parents received the vaccine [21].

We found that only 17.7% of the respondents were truly disinclined to accept the vaccine. The global data on COVID-19 suggests that vaccine hesitancy behaviour is dynamic and changes according to various factors at given point of time and context [22]. We found older age, low perceived susceptibility to the disease, low perceived severity of the disease, and not knowing protective measures against COVID-19 to be associated with vaccine hesitancy. Abedin et al. [23] reported that nearly three-fourths of the Bangladeshis (74.6%) were ready to accept the vaccine; and the vaccine refusal was significantly high among the elderly, those living in slums and rural areas, those involved in low-income occupations, and those with low educational attainment. This finding was similar to what we had observed. Several other studies found risk perception [24–26], self-efficacy [15], age [25–28], educational status [27,29,30] as enabling factors for vaccine acceptance. A systematic review revealed that self-efficacy and perceived severity as the strong predictors for vaccine acceptance [15]. Our findings are thus in agreement with other published literature.

A narrative review [31] identified being against the vaccines in general, concerns about safety, general lack of trust, doubts about the efficiency of the vaccine, vaccine as useless, vaccine development process in a rush as the main reasons to refuse vaccines. Thus, it is crucial to provide correct information and support to the people in making vaccine decisions. Kadoya et al. [32] suggested that it is vital to target people with specific socioeconomic backgrounds who are less willing and more hesitant to take the vaccine, for a successful vaccination programme. Han et al. [33] highlighted that lack of vaccine information and confidence as major reasons for vaccine hesitancy in China.

We found that the major concern appeared to be rooted in health beliefs and perceptions. If these issues were to be addressed properly, then one may expect a substantial decline in the proportion of respondents that were currently disinclined to accept the vaccine. We, therefore, feel that health education campaigns focussing on various health beliefs to improve the risk perception and self-efficacy to protect oneself, including vaccination as a protective measure, would be helpful. Also, it is vital that genuine factual information reaches people in simple, understandable language to make informed decisions to protect themselves against COVID-19, including the decision to accept the vaccine.

Our study had some limitations. Owing to the cross-sectional design, causality could not be ascertained. The predicted associations based on regression analyses could be a function of other causes. The data were not adjusted for clustering, which might result in spurious associations. However, the independent variables for multinomial regression were selected based on a prior univariate analysis. Also, our study results are in consonance with the other studies focussing on the determinants of vaccine hesitancy. Social desirability bias could be present, however, the data were collected with the help of a pre-tested questionnaire by a trained interviewer and the concerns of the vaccine were asked in an open-ended manner, which minimised the social desirability bias. Our study presented a snapshot of vaccine acceptance/hesitancy at that point in time when the vaccine was not available for public use, and these vaccine acceptance decisions may change with time. Despite these limitations, our study has several strengths. The study was based on a scientifically drawn sample, representing socioeconomically disadvantaged communities inhabiting three different types of residential areas; and collected data using pre-tested questionnaires through face-to-face interviews.

**Table 4**  
Results of multinomial logistic regression for vaccine acceptance by various variables.

Variable	AOR (95% CI) Accept vaccine vs. Undecided	AOR (95% CI) Accept vs. Do not accept
<b>Gender</b>	p = 0.220	
Men	0.86 (0.63–1.18); 0.352	1.23 (0.87–1.72); 0.240
Women	Reference	Reference
<b>Age group</b>	p = 0.000	
18–29 years	0.36 (0.20–0.65)	0.28 (0.15–0.52)
30–39 years	0.62 (0.36–1.06)	0.46 (0.27–0.81)
40–49 years	0.49 (0.28–0.84)	0.33 (0.19–0.59)
50–59 years	0.53 (0.29–0.96)	0.70 (0.40–1.24)
60 years & above	Reference	Reference
<b>Residential area</b>	P = 0.000	
Resettlement colonies	1.06 (0.72–1.57)	0.91 (0.57–1.44)
Unauthorised slum colonies	0.81 (0.57–1.15)	1.98 (1.38–2.89)
Slums without basic amenities	Reference	Reference
<b>Education status (in years)</b>	p = 0.112	
No formal schooling	1.32 (0.70–2.49)	2.131 (0.99–4.59)
1–5 years	1.52 (0.76–3.03)	2.03 (0.89–4.65)
6–8 years	2.17 (1.17–4.02)	1.87 (0.86–4.10)
9–11 years	1.29 (0.69–2.41)	1.36 (0.62–2.10)
12–14 years	1.27 (0.68–2.38)	1.83 (0.84–3.98)
15 years or more	Reference	Reference
<b>Monthly household income</b>	p = 0.296	
Up to Rs. 9,999	1.07 (0.59–1.94)	0.49 (0.27–0.92)
Rs. 10,000–14,999	0.99 (0.58–1.697)	0.67 (0.39–1.15)
Rs. 15,000–19,999	1.03 (0.60–1.76)	0.56 (0.32–0.99)
Rs. 20,000–29,999	0.94 (0.553–1.608)	0.48 (0.27–0.84)
Rs. 30,000 & above	Reference	Reference
<b>Size of the household</b>	p = 0.211	
Living alone	1.34 (0.61–2.93)	1.82 (0.79–4.21)
2–5 members	0.79 (0.59–1.08)	0.85 (0.61–1.18)
6 or more	Reference	Reference
<b>Religious affiliation</b>	p = 0.033	
Hindu	1.23 (0.45–3.37)	0.66 (0.24–1.81)
Islam	1.10 (0.36–3.35)	1.28 (0.43–3.78)
Others	Reference	Reference
<b>Knew at least one person (self/family member or neighbour) who had COVID-19</b>		P = 0.261
Yes	1.26 (0.89–1.78)	1.28 (0.86–1.90)
Don't Know	Reference	Reference
<b>Awareness on vaccine development in India</b>		p = 0.277
Aware	1.09 (0.80–1.48)	1.31 (0.94–1.81)
Not aware	Reference	Reference
<b>Considering various factors around you, what are your chances of getting infected with novel coronavirus?</b>	P = 0.025	
Unlikely	1.50 (0.81–1.10)	1.80 (1.17–2.76)
Somewhat likely	1.27 (0.81–1.98)	1.18 (0.71–1.97)
Likely	Reference	Reference
<b>What do you think about how serious would contracting the novel coronavirus be for you?</b>	p = 0.012	
Not severe	1.35 (0.91–2.00)	1.84 (1.19–2.85)
Somewhat severe	1.058 (0.76–1.50)	1.81 (2.24–2.65)
Severe	Reference	Reference
<b>Do you how to protect yourself from coronavirus?</b>	p = 0.000	
Don't know at all	2.58 (1.43–4.68)	5.09 (2.88–9.00)
Know a little	1.42 (1.05–1.91)	1.93 (1.38–2.70)
Know well/mostly	Reference	Reference
<b>Awareness and use of Aarogya Setu App</b>	p = 0.000	
Never heard	1.69 (1.11–2.57)	4.87 (2.92–8.10)
Heard of it	1.39 (0.95–2.02)	2.08 (1.27–3.42)
Using the App	Reference	Reference

Reference category is "Accept the Vaccine"; Model fitting information:  $\chi^2$  (p) = 352.73 (0.000); PseudoR<sup>2</sup> (McFadden) = 0.129; AOR = adjusted odds ratio, CI = confidence interval.

## 5. Conclusion

A large proportion of respondents were inclined to accept the COVID-19 vaccine. This proportion is likely to increase further if the concerns raised by the undecided; and the currently disinclined respondents were to be addressed in a credible manner.

## 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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