Chapter 11
COVID-19 Vaccination Status and Hesitancy: Survey Evidence from Rural India

Sneha Shashidhara, Sharon Barnhardt, and Shagata Mukherjee

Abstract While vaccine hesitancy has been a large part of the COVID-19 vaccination discourse in India, there is a significant lack of empirical evidence about hesitancy in rural India. To bridge this gap, we conducted a quasi-representative, in-person survey spanning 32 districts across rural Uttar Pradesh and Bihar in India to comprehensively characterize the barriers to vaccination and understand the attitudes towards the COVID-19 vaccine. We surveyed 6319 adults during April and May of 2022, of which 36% were unvaccinated, 33% were partially vaccinated, and 31% were fully vaccinated. Overall, there was a high intention to get vaccinated among the unvaccinated, with only 20% saying they would never get a vaccine for COVID. We use probit models to estimate the relationships between demographic variables and being vaccinated and the associations between stated barriers and vaccination status. The primary barriers were pregnancy and breastfeeding, and pre-existing medical conditions. The unvaccinated had lower vaccine-related knowledge, more misinformation, and less vaccine-related trust in medical professionals but assigned similar importance to COVID-appropriate behaviors. We also establish a high intention to vaccinate children against COVID, although it varies among adult vaccination statuses, with unvaccinated parents being the least willing to vaccinate their children.

Keyword Vaccine hesitancy · Rural India · COVID · Maternal health · Behavior science

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11.1 Introduction

A fair amount of anecdotal evidence suggests that hesitancy to take a COVID-19 vaccine has been a problem in India (Mashal & Kumar, 2021; Mishra, 2021; Singh, 2021; Sinha, 2021). However, there is surprisingly little quantitative evidence on the level of hesitancy and, more importantly, the beliefs and barriers behind the hesitancy, especially in rural areas. Large online surveys sampling from multiple states in India (IANS, 2021; Jain, 2021; Local Circles, 2021; Mukherjee et al., 2022; Tagat et al., 2022) have focused on getting rapid measurements of hesitancy levels. They ask respondents to select from non-exhaustive lists of possible reasons for vaccine hesitancy (barriers) and do not solicit or report adequate demographic information about respondents. Facebook has been deploying surveys in association with the University of Maryland and Carnegie Mellon University since December 2020, measuring various COVID-19-related outcomes, including symptoms, behavior, vaccine attitudes and uptake. Analysis of the urban samples from India finds seven types of hesitant individuals, or "personas," ranging from "Afraid (but willing)," those who are more concerned with side effects to "Anti-vaxxers" who do not believe the vaccine works (Daral & Shashidhara, 2022).

While the Facebook data collection exercise is relatively concise in investigating barriers and attitudes, its sampling frame consists exclusively of its users. UNDP (2019) finds that Facebook is primarily an urban-male-youth phenomenon in India, casting doubt over how well such surveys could represent attitudes of marginalized persons (e.g., women, low-income groups, senior citizens) in rural India, who have had historically lower rates of access to the internet and technology. As online studies do not represent individuals without access to smartphones or the internet, they are less than ideal for making policy recommendations that affect the broader population. A study comparing COVID-19 vaccine attitudes of rural and urban communities in Tamil Nadu found much higher mistrust in health systems and COVID vaccines in rural populations than in urban populations (Danabal et al., 2021). They conducted in-person interviews, used a random sampling method and highlighted the need for such studies in rural India.

This paper presents results from a large-scale in-person survey in rural Uttar Pradesh and Bihar in India conducted in early 2022. We measured both demand and supply-side barriers critical to vaccination, knowledge, and attitudes about COVID-19 and its vaccination. We also investigated problems faced by partially vaccinated people preventing them from getting the second dose of the vaccine and attitudes towards vaccinating children against COVID-19 of both vaccinated and unvaccinated parents.

11.1.1 What is Vaccine Hesitancy

At the peak of the recent COVID-19 pandemic, it became clear that vaccines would be one of the most efficient ways to limit the spread of the disease. The government, pharmaceutical companies, and academic experts from several countries came together to develop efficacious and clinically safe vaccines against COVID-19. However, their efforts were met with a resistant faction of people who stood against the vaccine and hindered the vaccine rollout's efficient attainment (Nath et al., 2021). An increasing number of people have begun to question vaccines in general, seeking alternative vaccination schedules and sometimes delaying or outright refusing vaccination owing to the rapid global sharing of public concerns and uncertainty around vaccines (Larson et al., 2014).

These tendencies have been grouped together in recent years under the umbrella term of *vaccine hesitancy,* which refers to delayed acceptance or refusal of vaccines despite the availability of vaccination services (Dubé et al., 2014). Vaccine-hesitant individuals have been defined as a heterogeneous group in the middle of a continuum ranging from *total acceptors* to *complete refusers*. *Hesitant* individuals may refuse some vaccines but agree to others, delay vaccines, or accept vaccines but are unsure about doing so (Larson et al., 2014). However, vaccine hesitancy has not been consistently defined and thus can be subjectively interpreted based on context, time, place, and other factors.

11.1.2 Determinants of Vaccine Hesitancy and Vaccine Uptake Intention

The *5C Model* of psychological antecedents to measure vaccine hesitancy comprises confidence, complacency, constraints, calculation, and collective responsibility (Betsch et al., 2018). Confidence in a vaccine's safety and a sense of collective responsibility positively impact COVID vaccination intentions, but calculating the costs and benefits regarding vaccines and the constraints faced both reduce uptake (Nath et al., 2021). Complacency does not seem to have an effect. Hossain et al., 2021 showed that the theory of planned behavior model better explained norms and attitudes towards the COVID vaccine than the 5C model. We include elements of both frameworks as questions in our survey.

More specific to low and middle-income countries, *vaccine uptake intention* (VUI) has always been a challenge due to supply-side determinants such as financial and technical constraints and accessibility issues (Moola et al., 2021). These are aggravated by demand-side barriers such as individual risk perceptions and motivation plus demographic characteristics (Bono et al., 2021).

Associations between COVID-19 vaccine hesitancy, gender, socioeconomic status, and level of education have been found across multiple studies in India, Bangladesh, and Nigeria (Bono et al., 2021, Lazarus et al., 2021, Lim et al., 2021,

Moola et al., 2021). Recent findings from India suggest that hesitancy is high among the younger cohort, female respondents, those with lower educational levels, and those from low-income families (Umakanthan et al., 2021; Mukherjee et al., 2022). Some of the concerns surrounding women's vaccination could be regarding vaccine safety and infection risk, especially for pregnant and lactating women (Kumari et al., 2022).

Many of these anticipated risks have been brought about through suboptimal science communication, lack of public engagement, and inadequate trust that governments will act in the best interests of public health and safety based on sound scientific evidence (Bhopal & Nielsen, 2020). Vaccine Uptake Intention has been positively associated with trust in government-sourced information (Nath et al., 2021). A multi-nation study across six Asian and African countries, including India showed a strong correlation between conspiracy beliefs and hesitancy (Salman et al., 2022). Mukherjee et al. (2022) find lower vaccination among people with lower perceptions of COVID vaccine effectiveness in India.

Therefore, one way to gain confidence for improved VUI could be to maintain transparent communication on how vaccines are developed, how they work, their effectiveness, and safety. However, with open internet and social media access, it can be difficult to moderate the inflow of misinformation, incomplete information, and even conspiracy theories that abound in people's conversations about vaccines. Additionally, receiving information from relatives or any other informal or unverified sources has also led to significant misconceptions and fears about vaccination safety (Moola et al., 2021). This finding makes vaccine misinformation an important line of inquiry in India and elsewhere.

11.2 Methods

11.2.1 Survey Instrument Design

In our survey, unvaccinated respondents were asked questions about their vaccination intention and anticipated and experienced barriers to vaccination.[1] We included two open-ended questions for the unvaccinated. First was the reason for not taking the vaccine, and second was what would convince them to take it. The surveyor read the question and requested the respondent to speak on the smartphone to record their response.

We also gave respondents a list of nine common barriers to COVID vaccination, drawn from the Facebook instrument, and asked respondents which barriers, if any, they faced. This list was presented to all respondents, including the fully vaccinated.

[1] Our project was pre-approved by the Institutional Review Board at Ashoka University.

Additionally, the instrument covered knowledge about the COVID vaccine, COVID-19-appropriate behavior, trust in various information sources, risk perceptions around the vaccine (specifically in the context of vulnerable populations), and demographics.

The survey was conducted in Hindi, and it lasted around 30 min. Participants were not incentivized in any manner.

11.2.2 Sampling and Data Collection

Our sample consisted of rural populations in Uttar Pradesh and Bihar. We selected the 50% of districts in each state with the highest rural population according to the 2011 Census, yielding 36 states in Uttar Pradesh and 19 in Bihar). From these, we selected the top ~ 60% of districts in Uttar Pradesh and Bihar, based on having the lowest percentage of the population that had at least one dose of the COVID-19 vaccine from the Co-WIN dashboard (Ministry of Health & Family Welfare, 2021). This process ensured we maximized the possibility of identifying rural unvaccinated people in large districts. The final list of 20 UP districts and 12 Bihar districts surveyed is shown in the appendix (Table A1).

Within each sampled district, we randomly selected eight villages for data collection and an additional five villages as a buffer. We ensured that a nearly equal number of unvaccinated, partially vaccinated (people with one dose of the vaccine), and fully vaccinated adults were selected for the survey in each village by setting a target of approximately four men and four women from each vaccination status category in each village. Given that the survey topic was the reasons behind vaccine hesitancy, we intentionally oversampled the unvaccinated. They already accounted for less than one-third of the population at the time of the survey.

Enumerators started at one end of the village and visited every alternate house. They requested to speak to the male head of the household in one house and the female head in the next and continue alternatively to maintain gender balance in the sample. Only participants above the age of 18 years were surveyed. They continued until reaching their target for the village.

Enumerators from the NYAS research agency were hired to administer in-person surveys on the licensed Survey CTO offline app. Surveys were conducted door-to-door by these trained enumerators and collected digitally on a mobile phone application. All enumerators tested the full instrument by collecting complete pilot surveys. This was to ensure the survey was programmed without error, enumerators were well-trained, and to surface any concerns in the field before starting the proper survey.

To ensure the quality of the data, we conducted backcheck interviews. Ten percent of participants across enumerators were chosen for an additional short survey. A separate enumerator conducted these surveys via a phone call one to three weeks after the primary survey. It included questions about vaccination status, intention,

knowledge, and demographics. All analysis, including data checks, were conducted using custom-made MATLAB (The MathWorks, Inc) and R (R Core Team, 2014) scripts.

11.3 Sample Demographics

In this COVID vaccination hesitancy study in rural UP and Bihar, we conducted a total of 6319 surveys, of which 2288 people were unvaccinated (36%), 2042 were vaccinated once (33%), and 1989 were vaccinated twice (31%).[2] These do not reflect population percentages as we oversampled unvaccinated individuals. Only completed surveys were used for analysis, and no participants with partial surveys were re-contacted to resume the survey.

Our sampling strategy successfully reached a new demographic not often covered in COVID vaccination hesitancy surveys. Over half are women, and roughly 30% belong to scheduled castes. Twenty percent have not completed education beyond primary school, and only 26% are Facebook users.

Respondents' ages ranged from 18–100 years, with a mean age of 35 (SD = 16.76). Most participants were Hindus, and only 14.7% belonged to the general (upper) caste category. Approximately 36% of respondents were not employed. All demographic characteristics are presented by vaccination status in Table 11.1.

11.4 Results

11.4.1 Associations Between Demographics and Vaccination Status

Our first question of interest is whether demographic factors such as age and wealth are associated with the likelihood of taking a COVID vaccine. Table 11.1 presents the means of these variables by vaccine status.

We use a probit regression to estimate the relationship between demographic (independent) variables and whether or not an individual is vaccinated (at all) as our dependent variable (see Table 11.2 for full results).

We find many significant associations between demographic characteristics and vaccination status. Hindus are 1.25 times ($p < 0.01$) more likely to be vaccinated

[2] We intended to recruit 6,000 participants for the study, allowing us to calculate sample estimates of vaccine hesitancy for the ~ 247 million rural population of UP and Bihar with a 99% confidence interval and margin of error of about 1.7%. While we planned a representative survey of rural UP, due to the incredible success of the Indian vaccination program, by March 2022, a considerable proportion of the population was already vaccinated. Thus, we changed our design to oversample the unvaccinated to understand their reasons for not vaccinating.

Table 11.1 Sample demographics by vaccination status

Number of vaccine doses	0 (Unvaccinated)	1 (Partially)	2 (Fully)
Total completed surveys	2288	2042	1989
% Women	63.2	52.1	43.5
Mean age	36	32	38
% Hindu	82.4	86.5	88.6
% General caste	14.1	13.2	16.8
% OBC	43.3	41.6	43.1
% Scheduled caste	30.9	31.8	28
% Primary education or lower	20.4	19.5	16.9
Monthly HH income INR: Less than 5 k	30.6	27.6	28.5
Household members	6.8	6.48	6.4
% Not working	43.4	38	26.8
% Married	84.3	76	81.8
% Have children between 15–18 years	12.1	14.5	28.7
% Support the central government	81.8	83.1	87.6
% Households with a toilet	61.1	58.7	67.7
% Households with a groundwater source	64.2	65.2	64
% Tobacco, alcohol or paan users	75.7	70.5	68.6
% Hospital access less than 20 min	26.4	29.5	30.2
% Facebook users	19.3	29.4	30.1
% Whatsapp users	33.3	44	44
% With a pre-existing medical condition	34.3	15.6	14.8
% Pregnant or breastfeeding	31.1	18.3	5.8
% Has taken COVID Test	40.6	45.5	51.5

than other religious groups. People with education up to eighth, tenth, and twelfth grade and graduation are all more likely to be vaccinated compared to people with no schooling by a factor of 1.12 ($p < 0.05$), 1.16 ($p < 0.05$), 1.36 ($p < 0.01$), and 1.54 ($p < 0.01$) respectively.

Unemployed people, homemakers, migrant laborers, and those that report employment as "other" are less likely to be vaccinated by a factor of 1.93 ($p < 0.01$), 1.21 ($p < 0.01$), 1.12 ($p < 0.1$), 1.15 ($p < 0.1$) respectively compared to those working in the agricultural sector.

For every increase of one member in the household, vaccination is less likely by a factor of 1.02 ($p < 0.01$). People with a monthly household income of Rs.10,000 to 15,000 are 1.18 times ($p < 0.01$) more likely to be vaccinated, and those that do not report an income are 1.33 times ($p < 0.01$) less likely to be vaccinated compared to those that report having less than Rs.5,000 per month.

Individuals with a previously existing medical condition or those who are pregnant or breastfeeding are less likely to be vaccinated by a factor of 2.39 ($p < 0.01$). Married

Table 11.2 *Regression results: Outcome variable* "is vaccinated" (yes/no)

Factors	Odds ratio	Standard error
UP State	0.919*	–0.049
Hindu	1.246***	–0.055
Female	0.982	–0.054
Highest Education: Primary	1.06	–0.055
Highest Education: 8th Standard	1.123**	–0.059
Highest Education: 10th Standard	1.175**	–0.067
Highest Education: 12th Standard	1.361***	–0.072
Highest Education: Diploma, College or Higher	1.536***	–0.086
Highest Education: Other	0.776	–0.232
Support Central Gov	1.024	–0.05
Age	1	–0.002
HH Members	0.980***	–0.006
Consumes tobacco	0.982	–0.05
Is WhatsApp user	1.05	–0.044
Occupation: Self-Employed	1.021	–0.074
Occupation: Migrant Labor	0.896*	–0.061
Occupation: Service (Private or Gov)	0.935	–0.106
Occupation: Unemployed	0.518***	–0.11
Occupation: Student	1.158	–0.099
Occupation: Homemaker	0.825***	–0.063
Occupation: Other	0.868*	–0.076
HH Income INR: 5-10 k	1.005	–0.049
HH Income INR: 10-15 k	1.177***	–0.061
HH Income INR: > 15 k	1.01	–0.06
HH Income INR: Other	0.750***	–0.072
Have a comorbidity	0.418***	–0.048
Are breastfeeding or pregnant	0.418***	–0.058
Married	1.312***	–0.065
Have children of 15–18 years	1.408***	–0.053
Has taken a COVID test	1.416***	–0.038
Constant	1.481***	–0.143
Observations	5,902	
Log Likelihood	–3,189.09	
Akaike Inf. Crit	6,460.19	

Note * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$ Not reporting these insignificant factors due to space: Reservation category OBC, EC, SC/ST or Other, HH has toilet, HH has piped water, HH has another water source. Hospital access 20–60 min, hospital access > 60 min. The full results are available on request

people are more likely to be vaccinated by a factor of 1.31 ($p < 0.01$) compared to unmarried and people with children between the ages of 15–18 years are 1.41 ($p < 0.01$) times more likely to be vaccinated against COVID.

11.4.2 Demand-Side Barriers to Vaccination Among the Unvaccinated

We now turn to our primary question of vaccination hesitancy. Twenty percent of unvaccinated individuals reported they would never take a COVID vaccine. However, among the unvaccinated, 58.2% said they tried to get the vaccine. Further, 67% said they would *definitely* take the vaccine, and 48% said they would get it *immediately* when asked about the timeframe.

Descriptive evidence from our open-ended question about reasons for not getting vaccinated paints a clear picture of the reasons for not being vaccinated. The two main barriers that came out were 33% saying they did not take the vaccine due to a health issue and 22% saying they were pregnant or breastfeeding (Fig. 11.1). Despite over 50% of the answers mentioning health, only 98 (4.3%) mention a doctor. Thus, many holdouts may be due to misinformation about eligibility rather than genuine medical complications.

ID-related issues are a significant supply-side barrier for 12% of unvaccinated individuals, as a valid government ID is required to get the vaccine across India. Interestingly, vaccine-related reasons, such as disliking the vaccine, not considering it necessary, and being afraid of it, are least reported at 2%. A complete set of the barriers is in the appendix (Table A2).

After answering open-ended questions, unvaccinated respondents indicated if each item from a list of nine common barriers applied to them. This list was taken from the University of Maryland's COVID-19 trends and impact survey in partnership with Facebook (Fan et al., 2020). The most common barriers picked by respondents were side effects, wanting to wait and watch before taking the vaccine, and that others needed it more; the least common one was religious beliefs. These barriers are more common in those who did not try to get the vaccine than those who did, except for cost concerns and religious reasons (Fig. 11.2).

11.4.3 Supply-Side Barriers to Vaccination Among the Unvaccinated

More than half of the unvaccinated reported trying to get the vaccine, indicating the likelihood that supply-side barriers persist despite real efforts to provide access to COVID vaccines in UP and Bihar. These people were asked about the problems they faced while trying to get vaccinated.

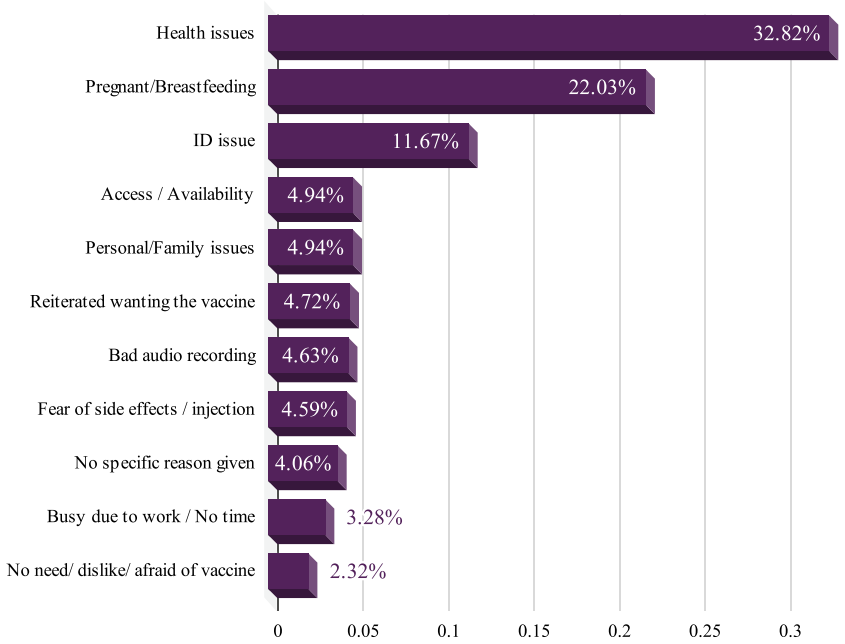

Fig. 11.1 The main reason for not taking the vaccine, reported by participants in an open-ended question (n = 2288 unvaccinated individuals)

While many did not explicitly report a problem, 23% said they were deemed ineligible for pregnancy or breastfeeding. Access and availability issues also surfaced, with 15% saying the vaccination center was far and 14% saying it ran out of vaccines when they went. Another 20% mentioned some administrative issues, be it the portal, ID, or health worker related.

11.4.4 Barriers Among the Partially and Fully Vaccinated

We surveyed 2042 partially vaccinated respondents, having taken only one dose of the COVID-19 vaccine, and 62.4% reported trying to get the second dose. We use this structure to investigate if either the partially or fully vaccinated differed from the unvaccinated in knowledge about the COVID-19 vaccine and attitudes toward it.

There is a gap of 10% points between the fraction eligible to take the second dose (82.9% had completed their waiting period) and the 73% who said they would take the vaccine immediately. Only 2% of these individuals said they would *never take* the next vaccine. Many partially vaccinated people who tried to take the second dose did not report a specific problem in getting a vaccination. Some did mention the vaccination center being far from home, running out of vaccines, and having too

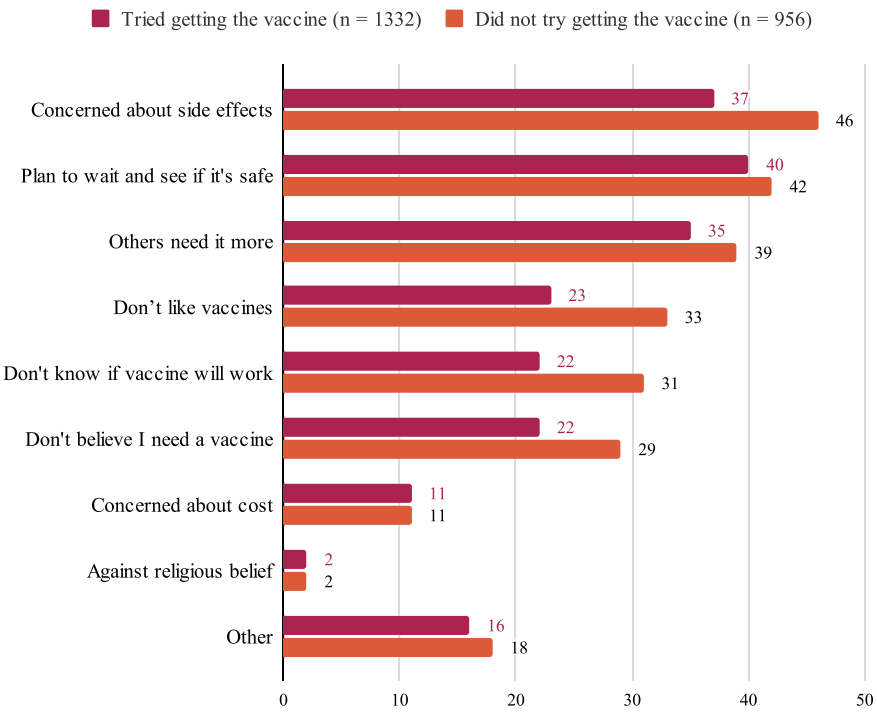

Fig. 11.2 Percentage of respondents who indicated a reason as contributing to their decision not to take the vaccine (n = 2288 unvaccinated individuals)

much work as potential issues. Generally, each possible issue was reported more by partially vaccinated than fully vaccinated (Figs. 11.3 and 11.4).

11.4.5 Drivers for Vaccination

We asked all partially and fully vaccinated respondents whether each of the 16 common reasons contributed to their decision to vaccinate (Fig. 11.4). There were several common answers: 91.5% said they were vaccinated to protect from COVID infection, 60.5% said because many people are taking the vaccine, 58.1% said due to societal responsibility, and 54.2% said there is no harm in taking the vaccine. The reason chosen by the least number of people was recommended by a national political leader (9%).

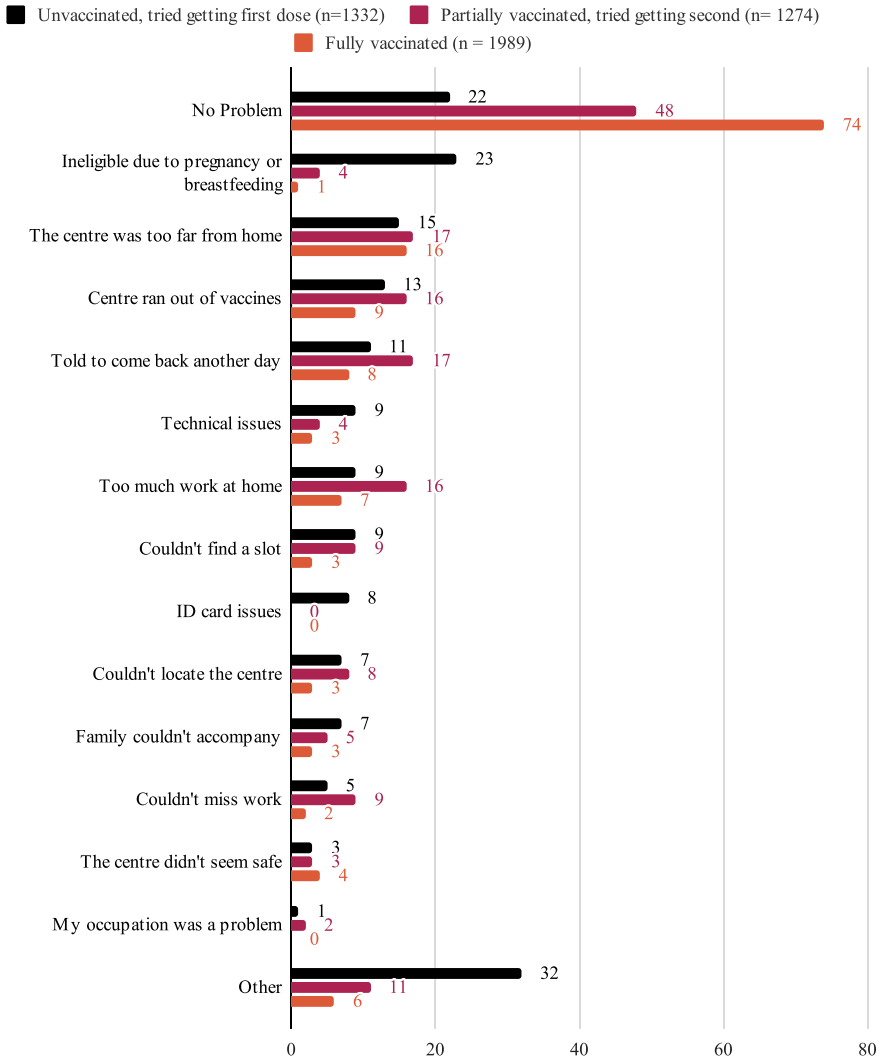

Fig. 11.3 Fraction reporting specific problem in the way of vaccination. Other includes: Doctor said no, health worker/administrative issues, the centre was too crowded

11.4.6 Knowledge and Attitudes Towards the COVID-19 Vaccine

We now address knowledge and attitudes and their relationships with vaccine status. Table 11.3 shows the raw proportions of individuals who reported the statement shown by vaccination status. Most people strongly agree with a national mandate for the COVID-19 vaccine (94.3% overall).

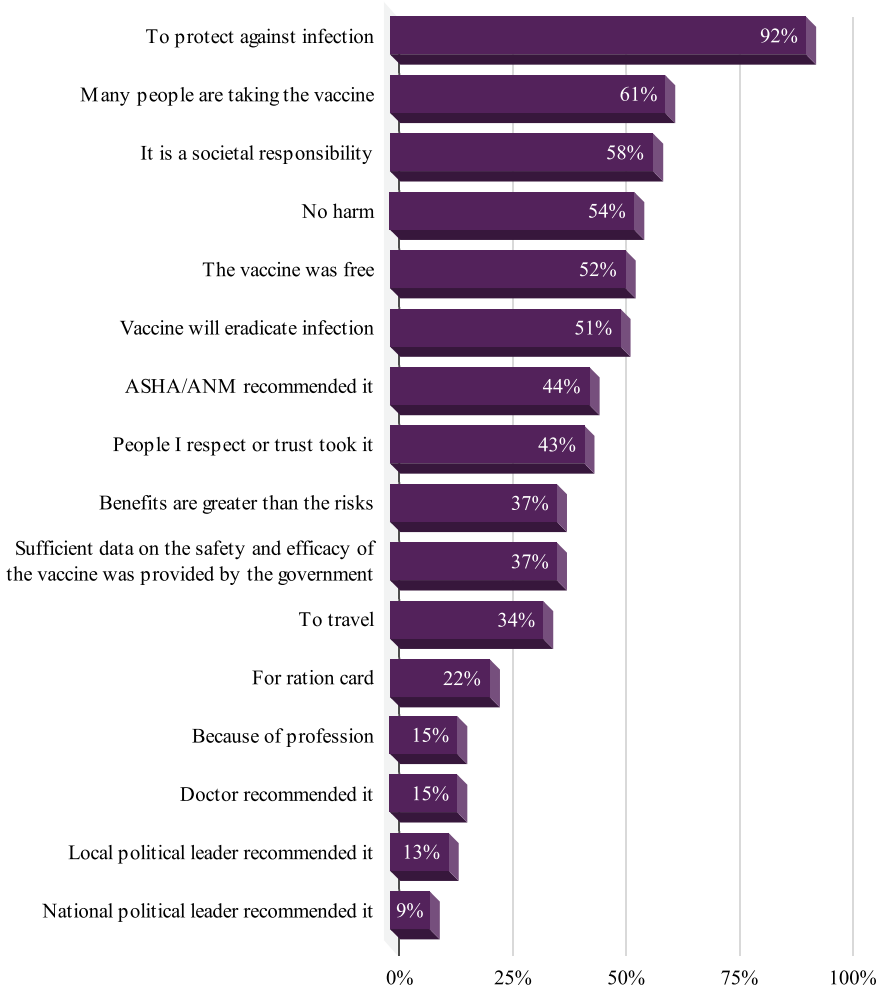

Fig. 11.4 Fraction reporting reasons for taking a COVID vaccine (all vaccinated, n = 4031)

We investigate if knowledge and attitudes are associated with vaccination status (unvaccinated, partially, or fully) controlling for demographic variables. In the probit regressions reported in Table 11.4, vaccination status is a categorical outcome.

The partially and fully vaccinated are 1.56 ($p < 0.01$) and 1.28 ($p < 0.01$) times more likely to agree strongly with a national mandate than the unvaccinated. The vaccinated are more likely to believe the vaccine prevents infection (1.21 ($p < 0.01$) and 1.20 ($p < 0.01$) for partially and fully vaccinated, respectively), and 1.11 ($p < 0.05$) and 1.15 ($p < 0.05$) times more likely to believe the vaccine prevents death. All groups are equally likely to think the vaccine prevents hospitalization.

Table 11.3 Knowledge and attitudes around COVID and the vaccine (proportions)

	Unvaccinated (%)	Partially (%)	Fully (%)
Strongly agree with a national mandate for COVID-19 vaccine	93	95	95
Vaccine protects from infection	91	94	94
Vaccine protects from hospitalization	86	87	86
Vaccine protects from death	82	85	86
Consider taking second dose on time absolutely essential	88	92	96
Definitely agree should wear masks even after getting the vaccine	64	70	74
Definitely agree children can get COVID-19	64	71	75
Recommend the vaccine to Pregnant women	60	66	67
Recommend the vaccine to Breastfeeding women	65	69	72
Recommend the vaccine to Diabetics	54	54	60
Recommend the vaccine to TB Patients	52	54	58
Recommend the vaccine to Cancer Patients	48	49	53
Avoid people all the time during the peak of the second wave	30	28	28
Social distancing is very effective in preventing infection	83	82	83
Wearing masks is very effective in preventing infection	91	91	91
Completely likely to vaccinate children	86	90	93
Strongly agree with a COVID-19 vaccine mandate for schools	93	95	95
Trust frontline health workers as a COVID-19 information source	93	94	95
Trust Indian scientists as a COVID-19 information source	91	94	95
Trust WHO as a COVID-19 information source	89	91	93
Trust government officials as a COVID-19 information source	93	95	96
Trust politicians as a COVID-19 information source	74	73	67
Trust journalists as a COVID-19 information source	84	85	83
Trust friends and family as a COVID-19 information source	94	94	94
Trust religious leaders as a COVID-19 information source	76	75	70

Table 11.4 Regression results: Knowledge and attitudes around COVID and the vaccine

Dependent variables Independent variables →	Partially	Fully
National mandate for COVID-19 vaccine	1.56*** (0.15)	1.28*** (0.16)
Vaccine protects from infection	1.22*** (0.07)	1.21*** (0.07)
Vaccine protects from hospitalization	$1.07^{n.s}$ (0.05)	$1.07^{n.s}$ (0.06)
Vaccine protects from death	1.11** (0.05)	1.15** (0.06)
Importance of taking second dose on time	0.94 (0.14)	1.83*** (0.17)
People should wear masks even after getting the vaccine	$1.09^{n.s}$ (0.07)	1.14* (0.08)
Children can get COVID-19	$1.09^{n.s}$ (0.08)	1.16* (0.08)
Recommend the vaccine to pregnant women	1.16*** (0.04)	1.11** (0.05)
Recommend the vaccine to breastfeeding women	1.12** (0.04)	1.12** (0.05)
Recommend the vaccine to diabetics	$1.01^{n.s}$ (0.04)	$1.05^{n.s}$ (0.05)
Recommend the vaccine to TB patients	$1.05^{n.s}$ (0.04)	1.11** (0.05)
Recommend the vaccine to cancer patients	$1.05^{n.s}$ (0.04)	$1.07^{n.s}$ (0.05)
Avoid people during the peak of the second wave	$0.96^{n.s}$ (0.06)	$0.89^{n.s}$ (0.07)
Social distancing is effective in preventing infection	$0.87^{n.s}$ (0.09)	$0.87^{n.s}$ (0.10)
Wearing masks is effective in preventing infection	$0.87^{n.s}$ (0.13)	$0.86^{n.s}$ (0.13)
Likely to vaccinate children	1.27** (0.11)	1.55*** (0.13)
Strongly agree with a COVID-19 vaccine mandate for schools	$1.17^{n.s}$ (0.15)	$1.15^{n.s}$ (0.17)
Trust frontline health workers as a COVID-19 information source	$1.08^{n.s}$ (0.07)	1.26*** (0.07)
Trust Indian scientists as a COVID-19 information source	$1.06^{n.s}$ (0.07)	1.25*** (0.08)
Trust WHO as a COVID-19 information source	$0.99^{n.s}$ (0.06)	$1.07^{n.s}$ (0.07)
Trust government officials as a COVID-19 information source	1.13* (0.07)	1.16* (0.08)

(continued)

Table 11.4 (continued)

Dependent variables Independent variables →	Partially	Fully
Trust politicians as a COVID-19 information source	1.00$^{n.s}$ (0.05)	0.91* (0.05)
Trust journalists as a COVID-19 information source	1.01$^{n.s}$ (0.05)	0.10$^{n.s}$ (0.06)
Trust friends and family as a COVID-19 information source	1.10$^{n.s}$ (0.07)	1.04$^{n.s}$ (0.07)
Trust religious leaders as a COVID-19 information source	0.99$^{n.s}$ (0.05)	0.92* (0.05)

$p < 0.1 = *$, $p < 0.05 = **$, $p < 0.01 = ***$

Figures reported are odds ratios from probit regressions. Controls include: age, gender, highest level of education, occupation, household income per month, number of members in the household, state, religion, reservation category, distance to the nearest medical center, whether the house has a toilet, the type of water source used by the household, whether the participant consumes paan, alcohol or tobacco, whether the participant is a WhatsApp user, whether they support the current central government, whether they have a pre-existing medical condition, whether they are married, whether they are currently pregnant or breastfeeding, whether they have children between the age of 15–18 years, and whether they have ever taken a COVID test

Fully vaccinated people are 1.79 times ($p < 0.01$) more likely than unvaccinated people to think taking a second dose on time is essential. Perhaps expectedly, partially vaccinated and unvaccinated people have similar importance ratings for taking the second dose on time. Fully vaccinated show less misinformation as they are 1.16 times ($p < 0.1$) more likely to know children can get COVID-19 and 1.15 times ($p < 0.1$) more likely to think people should wear masks after vaccination. There is no difference between the partially vaccinated and the unvaccinated.

Another measure of misinformation is to check if people would recommend the vaccine to pregnant women and people with comorbidities. The vaccinated are more likely to recommend the vaccine to pregnant women (Partially: 1.15 times ($p < 0.01$), Fully: 1.12 times ($p < 0.01$)) and breastfeeding women (Partially: 1.10 times ($p < 0.01$), Fully: 1.13 times ($p < 0.01$)). Fully vaccinated are 1.12 times ($p < 0.05$) more likely to recommend the vaccine to TB patients (no difference between partially vaccinated and unvaccinated). All groups were equally likely to recommend the vaccine to diabetics and cancer patients. None of the groups showed a difference in COVID-19 protective behavior regarding avoiding contact, wearing masks, and social distancing to prevent infection.

Vaccinated people are more likely to say they would vaccinate their children if a vaccine were available and approved than unvaccinated (Partially: 1.27 times ($p < 0.05$), Fully: 1.55 times ($p < 0.01$)). All groups are equally likely to support a vaccine mandate for schools.

Frontline health workers and Indian scientists are more trusted as COVID-19 sources by the completely vaccinated (1.25 ($p < 0.01$), and 1.23 ($p < 0.01$) times) than the unvaccinated. On the other hand, politicians and religious leaders were less likely to be trusted by completely vaccinated participants by a factor of 1.11 ($p < 0.05$) and 1.10 ($p < 0.1$), respectively. There is no difference between the partially vaccinated and the unvaccinated. Government officials were more trusted by the vaccinated (Partially: 1.14 ($p < 0.1$), Fully: 1.15 ($p < 0.1$)). All groups equally trust the WHO, journalists, and friends and family.

11.5 Discussion

Vaccine uptake is one of the most important frontiers of our efforts against the COVID-19 pandemic. Through our large-scale in-person survey around vaccine hesitancy in rural India, we probe the reasons for hesitancy and attitudes around adult and child vaccination. The survey was conducted in person to target the digitally marginalized populations not represented by online surveys. We succeeded in that, as only 19% of our unvaccinated users were Facebook users, and 33% were WhatsApp users.

Vaccine equity is an essential part of the COVID-19 discourse. In rural UP and Bihar, there are disparities between those who took the vaccine and those who did not, with employment, higher education, higher income, and the majority religion all predicting vaccination. Interestingly, caste is not a significant factor. Gender is also not significant but breastfeeding or being pregnant reduces the probability of vaccination. We see that vaccinated people have higher knowledge of the vaccine and are more likely to support a national or a school mandate. They also have higher intentions to vaccinate their children. While we see differences in knowledge, misinformation, the importance of the second dose, and child vaccination, COVID-19 protective behaviors of avoiding contact, social distancing, and mask-wearing are not different.

We also find that pre-existing medical conditions decrease the probability of vaccination. While some ($n = 54$) explicitly indicated not taking the vaccine due to the doctor's recommendation, most did not. This is in line with the literature citing previous health conditions as a barrier to vaccine uptake (Bono et al., 2021). Similarly, Abedin et al., 2021 found that people with chronic conditions, including diabetes, hypertension, and cancer were less likely to vaccinate than those without (difference in the mean acceptance rate of 8.7%). It is especially concerning that only 52–60% are willing to recommend the vaccine to people with diabetes and TB patients, both dangerous comorbidities for the infection (Tadolini et al., 2020; Lin et al., 2021). Low recommendations of the vaccine to vulnerable groups have been previously established in a large Indian web-based survey (Kumari et al., 2021). This has important policy implications for adult vaccination and child immunization. It could be perilous if people decide not to take the vaccine due to medical conditions without consulting a doctor, as many common illnesses are known to worsen the disease prognosis (CDC,

2022). Similarly, if a pre-existing health condition becomes a barrier to vaccination among children, then it will have serious repercussions as India is yet to reach complete coverage on even routine child immunization. Therefore, the government should proactively launch IEC (Information Education Communication) campaigns in local languages to nudge parents of children with pre-conditions not only for the COVID vaccine for children but also for routine immunization.

Another much-discussed topic is that of the information source or the messenger of COVID-19-related information. Interestingly we see that politicians and religious leaders are less trusted by the completely vaccinated, while health workers, scientists, and government officials are more trusted. National political leaders recommending the vaccine is also the least cited reason for the vaccinated to decide to take the vaccine. Thus, based on this finding, the policy recommendation will be to do vaccine uptake messaging through frontline health workers who are more trusted by the community than through local or national politicians.

Finally, our results suggest that the last few holdouts of the COVID-19 vaccine are better explained by mistakenly waiting to take the vaccine due to various health conditions fuelled by misinformation rather than disbelief in the COVID pandemic or the efficacy of the vaccine. In particular, misinformation about the vaccine's safety with pregnancy and breastfeeding and any pre-existing conditions are critical factors that systematically delay vaccinations and deny them to those that may need them the most. A large-scale survey of pregnant women in 16 countries, including India, as early as November 2020 found 52% of pregnant women indicated intent to vaccinate as opposed to 73% of non-pregnant women (Skjefte et al., 2021). In our survey, also only 60–70% of the respondents were willing to recommend the vaccine to pregnant women. It is also one of the most cited reasons in our open-ended audio questions, which we then classify as misinformation, as very few (4.3%) mention a doctor's recommendation or even consulting with one. This misinformation is also seen in frontline health workers and those administering vaccines as among unvaccinated people who tried getting vaccinated, 23% reported being deemed ineligible due to their pregnancy or breastfeeding. Therefore, the policy recommendation will be to do targeted messaging to pregnant women as The Ministry of Health in India discusses the possibility of premature birth due to COVID-19 infections (MoHFW, 2022). Thus, timely counseling and assuring pregnant and lactating women about the vaccine's safety will lead to closing the last-mile gap of complete COVID vaccination among the rural population of India.

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Appendix

See Tables A1 and A2

Table A1 Districts covered by survey

State	District
Bihar 12 districts	Araria
	Begusarai
	Bhojpur
	Jamui
	Khagaria
	Madhepura
	Madhubani
	Muzaffarpur
	Samastipur
	Sitamarhi
	Vaishali
	West Champaran
Uttar Pradesh 20 districts	Aligarh
	Badaun
	Bahraich
	Barabanki
	Bijnour
	Bulandshahr
	Deoria
	Fatehpur
	Gonda
	Hardoi
	Kushinagar
	Lakhimpur Kheri
	Maharajganj
	Moradabad
	Muzaffarnagar
	Raebareli
	Saharanpur
	Siddharthnagar
	Sitapur
	Sultanpur

Table A2 Barriers mentioned by unvaccinated in open-ended question recordings

Barrier	Number who mentioned
Pregnant/Breastfeeding	504
Long term health condition	330
Unwell (Temporary illness/fever/allergy)	269
ID issue	267
I want to get vaccine	108
Bad audio recording	106
Poor health (General/Old age/Weakness/no info)	102
Infant/Small child at home	100
No specific reason given	93
Fear of fever/side effects	89
Vaccine wasn't available	41
No time	40
I wasn't here when vaccination was happening	39
Busy with work	35
Afraid to vaccinate	32
Recent surgery/Major health episode/taking medication	31
Fear of injection	16
Disability/Immobile	10
Injury	9
No health worker visited the house to vaccinate	8
Center was crowded	7
Mentally disturbed/facing personal problems	7
No need: no benefit to vaccination	7
No need: Not interested	5
Problem getting to the center	4
Unaware that the vaccine was available	4
Child was unwell	3
Didn't find slots	3
Live alone	3
Refused to vaccinate at the center	3
Vaccine is harmful	3
Friend died from vaccine	2
My family/friends did not take the vaccine	2
Death in the family	1
Don't like the vaccine	1
Don't want the vaccine	1
Misinformation: mobile number is required for vaccination	1

(continued)

Table A2 (continued)

Barrier	Number who mentioned
No need: No COVID now	1
Vaccine causes COVID	1

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