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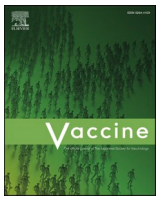

Community willingness to participate in a Nipah vaccine trial in Bangladesh

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ABSTRACT

Introduction: Nipah virus (NiV) is a deadly zoonotic disease with pandemic potential, prioritized by the World Health Organization for research and vaccine development. Since Bangladesh has faced annual NiV outbreaks and repeated spillovers since 2001, it is likely to be the site of a Phase II vaccine trial. This study explored people's knowledge about NiV and their willingness to participate in a NiV vaccine trial in Bangladesh.
Methods: We conducted a mixed methods study, collecting qualitative and quantitative data from Mirpur township, Dhaka, and NiV-affected Faridpur District. From December 2021 to November 2022, the team interviewed adult male and female respondents responsible for household treatment and vaccination decisions.
Results: The team conducted 66 in-depth interviews and 978 survey interviews.
Many in-depth interviewees were aware of NiV and, when asked if they would participate in a NiV vaccine trial, responded with one of three options: willing, unwilling, or would decide later. They were concerned about vaccine safety and side effects when making a decision about participation. In the survey, more respondents from Mirpur township, Dhaka, had heard about a disease transmitted from bats to people (57 %, 272/478 vs. 52 %, 262/500) and were willing to participate in a vaccine trial (45 %, 217/478 vs. 22 %, 111/500) than those from Faridpur. A high number expressed willingness to take an investigational NiV vaccine during an outbreak (Dhaka 75 %, 205/272 vs. Faridpur 81 %, 398/491 Faridpur). We did not find any association between knowledge about NiV and willingness to participate in a NiV vaccine trial.
Conclusion: Many respondents expressed willingness to participate in a NiV vaccine trial, especially during an outbreak, suggesting that such a trial may be feasible in Bangladesh. Given concerns about safety and side effects, clear communication on these issues may support informed participation.

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1. Introduction

Nipah virus (NiV) infection, an often fatal emerging zoonotic disease transmitted from infected *Pteropus* bats to humans, frequently causes neurological sequelae among survivors [1–4]. The first human NiV infection was identified in Malaysia in 1998, with subsequent outbreaks in Singapore, Bangladesh, India, and the Philippines, including person-to-person transmission in Bangladesh, India and the Philippines [1,4–11]. Due to person-to-person transmission, the widespread distribution of the reservoir host, and the lack of specific treatment beyond supportive care, NiV presents broader public health implications, including the risk of a pandemic [6]. Considering the potential of epidemic spread the World Health Organization (WHO) prioritized NiV as a disease for research and vaccine development [12,13].

Several vaccine candidates for NiV are currently under development [14]. Phase II trials of these vaccines are likely to occur in Bangladesh, where a total 322 NiV cases were identified between 2001 and 2021 [15]. Bangladesh is the country most affected by NiV, with cases reported nearly every year [15]. Our previous intervention study findings suggest that, before the intervention, respondents from NiV-affected regions in Bangladesh lacked information about NiV, a disease transmitted through date palm sap or bats, with only a small percentage having heard the name 'Nipah' [16]. This knowledge gap may reduce the perceived risk of NiV, potentially influencing their decisions regarding vaccination.

Although in Bangladesh most people consider vaccines safe and important [17] and vaccine coverage among children is high [18], there is little literature on people's knowledge and understanding of vaccine trials. In addition, a vaccine trial, aimed at a potential pandemic pathogen, may face difficulties in enrolling subjects due to the low probability of pandemics. Understanding people's knowledge and willingness to participate in a NiV vaccine trial can assist in identifying the information necessary for individuals to make an informed decision. The objective of this manuscript is to explore people's knowledge about NiV, and their willingness to participate in a NiV vaccine trial in Bangladesh.

2. Methods

2.1. Study design

We conducted a mixed methods study with qualitative and quantitative components. Our.

qualitative exploration aimed at understanding community perspectives which helped us develop and revise the survey questionnaire and provided context for the quantitative findings. Here, we first describe the qualitative and then the quantitative methods.

2.2. Qualitative methods

2.2.1. Study sites

We selected NiV-affected Faridpur District and non-affected Mirpur township from the capital city Dhaka to collect data because a future NiV vaccine Phase II trial and emergency NiV vaccine intervention could be deployed in Dhaka and Faridpur. In Mirpur township is an area with people from mixed socio-economic backgrounds and icddr,b has a field office there conducting several studies. The data collection team collected data from five NiV-affected villages from Faridpur.

2.2.2. Study population

The team conducted in-depth interviews with adult male and female who were household decision makers, preferably parents who make medical care and vaccination decisions for children under 18 years of age [18]. They also selected respondents from NiV-affected villages who met similar criteria, including both households where at least one member had experienced NiV infection and households without any case. They continued interviews until data saturation [19] meaning they received similar information repeatedly.

2.2.3. Data collection process

Five anthropologists trained in qualitative research collected data from December 13, 2021, to November 6, 2022. They explored knowledge about NiV, willingness to receive an NiV vaccine, and willingness to participate in a NiV vaccine trial. The interview duration averaged 75 min.

2.2.4. Data analysis qualitative

The team used digital voice recorders during the interviews to later transcribe verbatim in the native language Bengali. We drew on thematic analysis approaches alongside framework methods to analyze qualitative data [20]. The data collection team and qualitative investigators collaboratively developed a set of codes, organizing them into categories based on the study objective, interview guidelines and emerging themes. They developed and applied an analytical framework, using a spreadsheet to generate a matrix where applicable. They regularly summarized the findings in the templates and checked accuracy against audio recordings or transcriptions. Once all the interviews had gone through this process the team wrote final summaries by grouping the findings into different themes based on similarities, patterns, and connections to interpret data.

2.3. Quantitative methods

2.3.1. Study sites and population

The survey team collected data from NiV-affected Faridpur Sadar Upazila and non-affected Mirpur township in Dhaka city.

2.3.2. Sample size assumptions and calculation

The primary hypothesis was that people who know about NiV would be more likely to take part in a NiV vaccine trial. From previous surveys – we estimated that approximately 20 % of people from Faridpur [16] and 15 % from Dhaka would have heard about a disease that is transmitted from bats to humans. To detect a difference of 5 % (20 % in Faridpur vs 15 % in Dhaka) of household heads reporting that they know about Nipah disease (80 % power, alpha 0.05) would require enrolling 452 randomly selected households in each study site. We planned to approach 500 households in each group, expected to yield at least 452 participants.

2.3.3. Sampling methods/ Household selection

Using digital map files for Mirpur township, and Faridpur Sadar, we randomly generated and selected 500 GPS coordinates within the boundaries of those geographic areas. The team then located the nearest residence to each selected GPS coordinate point and approached that household to participate in the survey, meaning each respondent had an associated GPS point. When a GPS point was closest to a multi-story building, the interviewer counted the total number of households or flats and randomly selected one. If a GPS point was positioned on a river, waterbody, tree, or forest, the interviewer identified the closest household followed a clockwise (right to left) direction from the given GPS point to identify alternative households. If an interviewer attempted to reach a household three times without success, the household was marked as missing, and the next household was identified following the clockwise method.

Inclusion and exclusion criteria: The team selected adult male or female household heads who made healthcare and vaccination decisions within their households. When the head of household was the primary healthcare decision-maker, the team selected him or her as the respondent. If the household reported shared decision-making, the team interviewed an available decision-maker, such as the wife, father, or mother of the household head, ensuring that only one respondent per household was interviewed. Households were excluded if they could not be reached at the GPS location after three attempts or if they refused to participate in the study.

2.3.4. Data collection process

Six experienced interviewers in quantitative data collection received training to identify and select households using a GPS coordinator. They pre-tested the questionnaire, and collected data from September 20 to November 17, 2022, using electronic tablets. They collected demographic information and knowledge about NiV, adapted from a previous survey [16], and willingness to participate in a vaccine trial. We modified the WHO's 10-item vaccine hesitancy scale and adapted three items to measure the respondents' concerns and beliefs about vaccines (Annexure 1), as previously used in Bangladesh [21].

2.3.5. Data analysis quantitative

Once an interviewer completed an interview, the data was automatically saved on a server and then exported into STATA. For the household survey, we calculated the percentage of peoples' knowledge of NiV and willingness to participate in a vaccine trial. We compared responses between Dhaka and Faridpur using independent *t*-tests for normally distributed data, Wilcoxon rank-sum tests for non-normally distributed data, and chi-square tests for categorical variables, reporting *p*-values for statistical significance. We assessed the associations between willingness to take a NiV vaccine with knowledge about NiV as well as demographic characteristics including age, gender, education, and calculated odds ratios, 95 % confidence limits, and *p* values.

2.4. Ethical consideration

The team obtained written consent before conducting the interviews. The study protocol received approval from the Institutional Review Boards (IRBs) of icddr,b (protocol number PR-20112) and Stanford University (protocol number 60075).

3. Results

3.1. Qualitative in-depth interviews

3.1.1. Demography and knowledge about NiV

The team conducted 66 in-depth interviews in Dhaka and Faridpur. Average age of the respondents was 41 years, with more than half being female and homemakers (Table 1). Over half reported hearing about NiV (Table 1, Box 1). Respondents from Faridpur mainly learnt about NiV from previous outbreaks and word of mouth, while respondents from Dhaka learnt from television and newspapers. Many mentioned that people could contract NiV by drinking raw date palm sap and that NiV could be transmitted from one person to another. Although they described NiV as contagious, many from NiV affected Faridpur later expressed confusion, suggesting that it might be caused by a curse, punishment from Allah or the actions of supernatural forces.

3.1.2. Knowledge and willingness to participate in a vaccine trial

Only a few respondents had heard of vaccine trials (Table 1 and Box 2), mostly during the COVID-19 pandemic, through television, radio, newspapers, and word of mouth. To continue the interview, for participants who were unfamiliar with NiV, the team explained that NiV is a fatal infectious disease transmitted through consumption of bat-contaminated date palm sap. They added that a NiV vaccine was in development and undergoing rigorous safety and efficacy testing, a process known as a vaccine trial and asked whether respondents would have participated if a NiV vaccine trial had taken place in Bangladesh. Respondents answered in one of three categories: willing, not willing, or will decide later (Table 1, Boxes 3 and 4).

3.1.3. Willing to participate

Many respondents were willing to take a NiV vaccine themselves and for their families to also be vaccinated. When the team asked about a vaccine trial offering an investigational vaccine, fewer were willing to accept it (Table 1 and Box 3). Those who were willing mentioned preventing NiV, limiting its spread like COVID-19, their personal experiences with deadly NiV outbreaks, their trust in biomedicine, and their satisfaction that they would have taken a NiV vaccine. They expressed willingness to accept an investigational vaccine during a NiV outbreak, comparing it with the COVID-19 situation and explaining the importance of utilizing every preventive measure during emergencies.

Table 1
Demographic information of qualitative study respondents from Dhaka and Faridpur field sites, Bangladesh, 2021 and 2022.

	Dhaka non-case %(n)	Faridpur non-case %(n)	Faridpur case % (n)	Total % (n)
No. of interviews	**29**	**22**	**15**	**66**
Age: mean (range) in years	35 (21–60)	45 (25–68)	46 (23–75)	41 (21–75)
Gender: Female % (n)	72 (21)	64 (14)	40 (60)	62 (41)
Education year % (n)				
0–5	45 (13)	45 (10)	47 (7)	45 (30)
6–12	38 (11)	36 (8)	53 (8)	41 (27)
Above 12	17 (5)	18 (4)	0	14 (9)
Religion % (n): Muslim	100 (29)	95 (21)	93 (14)	97 (64)
Occupation % (n)				
Homemaker	67 (20)	54 (12)	20 (3)	53 (35)
Govt. and/ private services	3 (1)	4 (1)	20 (3)	7 (5)
Business/shopkeeper	10 (3)	9 (2)	26 (4)	13 (9)
Daily laborious work	17 (5)	23 (5)	33 (5)	23 (15)
Unemployed/retired)	–	9 (2)	–	2 (3)
Household members, mean (range):	5 (3–8)	5 (3–10)	5(2–10)	5(2–10)
Children under 18 mean (range)	2 (0–5)	2 (0–3)	1 (0–4)	2 (0–5)
Monthly household income: mean (range) in US$*	213 (41–468)	207 (47–748)	203 (75–375)	209 (41–748)
Monthly household expenditure: Mean (range) in US$*	216 (41–935)	169 (47–468)	185 (75–359)	192 (41–935)
Heard about the Nipah virus infection	27 (8)	63 (14)	100 (15)	56 (37)
Willingness to take a Nipah vaccine				
Willing	65 (19)	68 (15)	40 (6)	61 (40)
Not willing	3 (1)	4 (1)	13 (2)	6 (4)
Will decide later	31 (9)	27 (6)	46 (7)	33 (22)
Willing to let family take a Nipah vaccine	65 (19)	54 (12)	33 (5)	54 (36)
Heard about a vaccine trial	10 (3)	4 (1)	20 (3)	11 (7)
Willingness to take a Nipah trial/ investigational vaccine				
Willing	45 (13)	41 (9)	40 (6)	42 (28)
Not willing	17 (5)	18 (4)	20 (3)	18 (12)
Will decide later	38 (11)	41 (9)	40 (6)	39 (26)
Willingness to let family take a Nipah trial/ investigational vaccine				
Willing	27 (8)	27 (6)	20 (3)	26 (17)
Not willing	21 (6)	18 (4)	40 (6)	24 (16)
Will decide later	52 (15)	54 (12)	40 (6)	50 (33)

* Rate 1 US$ = 107BDT.

3.1.4. Not willing to participate

The main concerns of those not willing to take an investigational vaccine, revolved around effectiveness, side effects, or potential harm to their bodies, leading them to also reject participation for their family as

Box 1
Quotations from qualitative in-depth interviews representing respondents' knowledge about Nipah virus infection from field sites in Dhaka and Faridpur, Bangladesh, in 2021 and 2022.

Knowledge about Nipah virus infection

- *"The Nipah virus spreads from bat's saliva. By consuming contaminated raw date palm sap people can get infected with Nipah"*– Female, 52 years, non-case household, Faridpur
- "*The disease infected my wife immediately after the death of two people (neighbors that the wife came in touch with). Isn't it contagious?"*- Male, 65 years, case household, Faridpur
- *"I have never heard about the Nipah virus from any source or person. I do not know anyone who got Nipah virus infection"* – Male, 39 years, non-case household, Dhaka
- *"I have heard about Nipah, but I don't know any details about it. I only know Nipah virus exists and assumed that it can be caused by cold"* – Female, 21 years, non-case household, Dhaka

Box 2
Quotations from qualitative in-depth interviews representing respondents' knowledge about an investigational vaccine, specifically from those who heard about a vaccine trial, from field sites in Dhaka and Faridpur, Bangladesh, in 2021 and 2022.

Knowledge about an investigational vaccine

- *"Providing a vaccine to the people is a big decision. Before developing the main vaccine, doctors or scientists test vaccines on people to investigate whether it works or not, and after several trials, they get the proper vaccine"* – Female, 25 years, non-case household, Dhaka
- *"I heard from the TV news during the Covid-19 pandemic time, that the vaccine is about to come to the market. Before that, scientists are preparing it and tested it by injecting it into other humans. I studied about a vaccine trial when I studied in school. I read in the book that during the trial period of a vaccine, the vaccine gets tested by trying it on monkeys and then on humans"* – Male, 41 years, non-case household, Dhaka
- *"In terms of a vaccine trial, at first the vaccine is tested on different animals. Then there will be a human trial, and more or less 100-500 people are participating in that human trial. After the trial, they will be observed for one to two months and then, after getting the results, the vaccine will be ready"*- Male, 44 years, non-case household, Dhaka
- "*A vaccine trial happens to see how effective the vaccine is, by vaccinating around 100 people and keep them in observation to see the side effects of it*" - Male, 53 years, non-case household, Faridpur
- "*Corona vaccine was tested on many persons to see if it was effective or not. If people died, or doctors found it less effective, then they took the necessary steps to solve those problems*" – Female, 44 years, case household, Faridpur

well (Box 3). They wanted to have information on vaccine origin, administration, and the experiences of previous recipients - if they were doing well or poorly after receiving the vaccine to assess its potential risks before making a careful decision. A few of them feared severe side effects like high fever, cancer, or death. Most lacked financial means to deal with any medical complications, and questioned who would assume responsibility if such outcomes occurred. Furthermore, two respondents—one who suffered from a chronic condition and another who had experienced trauma from losing multiple family members during a NiV outbreak—refused to accept any vaccine.

3.1.5. Will decide later

Respondents who reported that they would decide later said that they lacked detailed information about the vaccine's effectiveness, mechanisms, benefits, drawbacks, and side effects and, therefore, could not accept it (Box 4). They preferred to wait, observe, consult, and learn about side effects and safety from others in the community who had already received the investigational vaccine, much as they had done when deciding about the COVID-19 vaccine. Some also reported that they would consult trusted healthcare providers about potential side effects before making a decision. They were concerned about major side effects, such as paralysis, and requested that contact information be included for reporting these side effects. They wanted to have information on dosages, expiration dates, and the vaccine's efficacy in animal testing, if such testing had been conducted. They said that if NiV became widespread and vaccination became obligatory, they and their families might consider participating, like their acceptance of the COVID-19 vaccine. In light of potential side effects, they would make a collective family decision about accepting or rejecting such a vaccine, consulting their spouses to discuss serious risks, including the possibility of severe adverse effects.

3.2. Quantitative household survey

3.2.1. Demography

The survey team conducted a total of 978 interviews, with more female (54 %) than male respondents. More respondents from Dhaka than Faridpur had 10 or more years of formal education (31 %, 148/478 vs. 11 %, 56/500, $p < 0.001$) (Table 2). Respondents' average monthly household income and expenditures were higher in Dhaka than in Faridpur (US$ 280 vs. 149 and US$ 205 vs. 140, $p < 0.001$) (Table 2).

3.2.2. Knowledge about NiV

Over 50 % of respondents from Dhaka and Faridpur reported hearing about diseases transmitted from bats to people (Table 2). More respondents from Faridpur than Dhaka reported hearing about a disease from raw date palm sap consumption (Faridpur 46 %, 228/500 vs. Dhaka 38 %, 181/478, $p < 0.033$).

Box 3
Quotations from qualitative in-depth interviews representing respondents' willingness to take and not take an investigational vaccine from field sites in Dhaka and Faridpur, Bangladesh, in 2021 and 2022.

Willing to take an investigational vaccine

- *"I will take the vaccine, so this kind of disease can't attack me"*- Female, 50 years, non-case household, Dhaka
- *"I will take the test (investigational) vaccine if it helps to boost immune systems. For example, we have taken the corona vaccine because it helped to increase our immune power and protect us from this disease"* Male, 45 years, case household, Faridpur
- *"I will take part in the vaccine trial because my wife died from Nipah virus… People who would not agree to take the vaccine, I want to inspire them…I will feel better if I see that people are following me and taking the vaccine. "It will make me feel better if I see any people are in a good health after taking the vaccine…"* – Male, 65 years, case household, Faridpur
- **"***I will participate in the trial with courage. It might be harmful to me, but I don't care. The work can be successful because of the participation of 2, 4, 5, and 7 people like me. At least the participants would be able to say that they did something for the people"*- Male, 44 years, non-case household Dhaka
- *"I will feel better (to take an investigational vaccine) because people will gradually take it and the virus will go away one day. I would feel good thinking that I've participated in the test when the government approves it, and it will be available in the market of every country"* – Male, 40 years, non-case household, Faridpur

Not willing to take the vaccine

- *"The vaccine is still in the trial phase and the result of the test is unknown. I don't know what the result of this trial will be (to make a decision)"* –Female, 26 years, non-case household, Faridpur
- *"I would never participate in the vaccine trial. According to me, I am unaware of the side effects of the vaccine and its outcomes"* -Female, 40 years, non-case household, Dhaka
- *"I won't take the test (investigational) vaccine. Who will take the risk if I suffer any complications after getting vaccinated? Even they (my family members) don't have any knowledge about it."* -Male, 39 years, non-case household, Dhaka

Box 4
Quotations from qualitative in-depth interviews representing respondents' willingness to decide later about a trial/investigational vaccine, from field sites in Dhaka and Faridpur, Bangladesh, in 2021 and 2022.

Will decide later (including family participation)

- *"Before deciding on accepting the vaccine I would like to know about the effectiveness of the Nipah vaccine trial and what are the side effects of the vaccine"*- Male, 41 years, non-case household, Dhaka.
- *"If ten people take the Nipah test(investigational) vaccine, then I will take it. Otherwise, how can we take it? Without knowing about the Nipah test vaccine and if anyone doesn't take it, then how will I take it with my physical conditions"* – Female, 54 years, non-case household, Dhaka
- "*Because of its seriousness, the decision about accepting the vaccine would be taken later. I don't know what would happen. People will have this type of fear just like the Coronavirus vaccine which came to us after many trials. We observed, and when we found that it was safe then we took it*" – Male, 43 years, non-case household, Dhaka
- *"I'll not include my family in the vaccine trial at first, I'll take it and if it works well, nothing happens to me, then my family members will participate"* – Male, 58 years, non-case household, Faridpur
- *"If we feel assured and secured, I will take the test (investigational) vaccine along with my family members. (Before making a vaccine decision) I have to understand that I will not face any problem, I require a proper document with all the details"*- Male, 45 years, case household, Faridpur
- "*If it is required/mandatory for me to receive the Nipah test (investigational) vaccine then I will receive it, otherwise I will not…If the disease is spread and it is obligatory to take the vaccine like corona, then I, along with my family members, will take the test vaccine provided by the government*" -Female,26 years, non-case household, Dhaka
- *"If such a vaccine test to prevent Nipah takes place in my locality, I may accept the vaccine if my husband suggests receiving the vaccine. I want to receive the vaccine earlier before having any problem (before the Nipah infection spreads) like Covid-19"*- Female 25 years, non-case household, Faridpur

3.2.3. Willingness to participate in a vaccine trial

About twice as many respondents from Dhaka expressed their willingness to participate in a NiV vaccine trial than respondents from Faridpur (45 %, 217/478 vs. 22 %,111/500, $p < 0.001$) (Table 3). Respondents willing to participate in a NiV vaccine trial commonly cited self or family protection and contributing to society as their motivations (Table 3). Those who declined to participate in the vaccine trial cited concerns about its safety, potential side effects, preferring to wait and see others' experiences, or getting NiV infection before taking the vaccine. Fewer respondents were willing to enroll their family members and children under 18 years of age in a vaccine trial, even if they were willing to participate themselves (Table 3).

3.2.4. WHO vaccine hesitancy scale adapted to NiV vaccine trial context and willingness to take an investigational vaccine during a NiV outbreak

Over 70 % of respondents agreed that new vaccines carry more risks than older vaccines and were concerned about the serious adverse effects (Table 4). However, slightly more respondents from Faridpur than Dhaka agreed that the information they received about the vaccine was "reliable and trustworthy" (Faridpur 91 %, 456/500 vs. Dhaka 82 %, 395/478, $p < 0.001$). A high number of respondents were willing to take the NiV trial vaccine during an outbreak to protect themselves, with more from Faridpur than Dhaka (Faridpur 89 %, 356/398 vs. Dhaka 82 %, 169/205, $p < 0.001$). Those who disagreed mainly cited concerns about side effects (Table 4).

Table 2
Demographic characteristics and socio-economic status of the quantitative survey household health decision makers (community) and reported community knowledge of Nipah virus infection from Dhaka and Faridpur field sites, Bangladesh, 2022.

Characteristics of respondents	Category	Mirpur township, Dhaka	Faridpur Sadar	p-value
		% (n)	% (n)	
		***N* = 478**	***N* = 500**	
Age of respondents	Age in years (mean (SD))	41 (13.0)	43 (15.6)	0.187[a]
Gender	Female	54 (258)	54 (270)	0.994[b]
Educational Status	0–5 years of schooling	37 (175)	57 (283)	<0.001[b]
	6-10 years of schooling	32 (155)	32 (161)	
	11 years and above	31 (148)	11(56)	
Number of household members	Total household members (Mean (SD)	4.5 (1.9)	4.5 (1.8)	0.761[a]
	Number of children (Mean (SD))	1.5 (1.1)	1.5 (1.2)	0.822 [a]
	Number of adults (Mean (SD))	3.0 (1.4)	3.0 (1.3)	0.772[a]
Monthly household expenditures: median (IQR)	US$1 = 107 taka	US$205.55 (206–327)	US$140 (93–187)	<0.001[c]
Monthly household income: median (IQR)	US$1 = 107 taka	US$280.30 (187–467)	US$149.49 (112–234)	<0.001[c]
Knowledge about Nipah		**N = 478**	***N* = 500 %**	
Heard about a disease that can be transmitted from bats to people	Yes	57 (272)	52 (262)	0.157 [b]
		***N* = 272**	***N* = 262**	
Disease name (Spontaneous) (among those that heard about diseases)	Nipah	41 (112)	28 (73)	<0.001[b]
	COVID	23 (64)	14 (36)	
	Cannot recall	33 (89)	56 (147)	
		N = 478	**N = 500**	
Heard about a disease that people can get from drinking raw date palm sap	Yes	38 (181)	46 (228)	0.033 [b]
		***N* = 181**	***N* = 228**	
Name of that disease (Spontaneous) (among those that heard about diseases)	Nipah	60 (109)	35 (81)	<0.001[b]
	COVID	3 (5)	1 (2)	
	Cannot recall	31 (57)	59 (134)	
	Other	5 (10)	5 (11)	
When (how many years ago) did you first hear about Nipah disease	In years (mean (SD)	5.08 (4.20)	5.52 (4.29)	0.525 [a]

[a] Independent *t*-test statistics (considering that data is normally distributed).
[b] Chi-square test statistics, [c]Wilcoxon rank-sum test statistics (considering that data is not normally distributed).

3.2.5. Association of demographic characteristics and knowledge with willingness to participate in a NiV vaccine trial

Respondents from Faridpur over 45 years old were more likely to be willing to participate in a vaccine trial than those under 31 (28 % vs. 14 %, OR 2.30, 95 % CI 1.30–4.07, $p = 0.004$) (Table 5). In Faridpur, females were less likely than males to say that they would participate in a vaccine trial (17 % vs. 29 %, OR 0.49, CI 0.32–0.76, $p = 0.001$) and during an outbreak (77 % vs. 86 %, OR 0.55, CI 0.34–0.89, $p = 0.015$). In Dhaka, respondents who had 11 or more years of schooling were less

Table 3
Reported willingness of the quantitative survey community respondents to participate in a Nipah vaccine trial from Dhaka and Faridpur field sites, Bangladesh, 2022.

Willingness to participate in a vaccine trial	Category	Mirpur township, Dhaka	Faridpur Sadar	p-value
		% (n)	% (n)	
		N = 478	**N = 500**	
Would you consider participating in a Nipah vaccine trial?	Yes	45 (217)	22 (111)	
	No	49 (234)	76 (378)	<0.001[b]
	Will decide later	6 (27)	2 (11)	
Would consider participating		***N* = 217**	***N* = 111**	
Why would you consider participating (among those willing to participate): multiple responses are possible	I want to be protected from Nipah	99 (214)	98 (109)	
	I want to protect my family member	59 (128)	47 (52)	
	This work can benefit society	29 (62)	12 (13)	0.003 [b]
	Other	0.5 (1)	1 (1)	
Would not consider participating in a Nipah vaccine trial		***N* = 234**	***N* = 378**	
Why would you not consider participating? Among those not willing to participate. Multiple responses possible	Trial (investigational) vaccines can be risky	54 (127)	29 (111)	
	I am worried about the side effects	35 (83)	32 (120)	
	I would be scared to receive a trial vaccine	39 (91)	31 (119)	
	I do not want to be the first to take a vaccine (want to see others taking the vaccine)	12 (28)	51 (194)	
	I will not be vaccinated without getting infected or seeing others infected with NiV disease	11 (26)	19 (71)	<0.001[b]
	Due to my physical problems	12 (27)	6 (21)	
	I do not enjoy participating in research	9 (20)	2 (9)	
	Other	3 (8)	1 (2)	
Will decide later about participating in a Nipah vaccine trial		**N = 27**	**N = 11**	
Why would you consider participating later (among those who will decide to participate later): multiple responses are possible	Trial (investigational) vaccines can be risky	19 (5)	46 (5)	
	Do not know much about this vaccine to make a decision	22 (6)	18 (2)	
	I would be scared to receive a trial (investigational) vaccine	7 (2)	36 (4)	<0.001[b]
	Want to observe others before making a vaccine decision	63 (17)	73 (8)	
	Other	7 (2)	0	
Willing to support family/household members to participate in a Nipah vaccine trial		**N = 478**	**N = 500**	
*Willing to support a member of the household participating in a Nipah vaccine trial	Yes	36 (172)	14 (72)	
	No	53 (252)	80 (400)	
	Will decide later	11 (54)	6 (28)	<0.001[b]
		N = 378	***N* = 394**	

(*continued on next page*)

Table 3 (*continued*)

Willingness to participate in a vaccine trial	Category	Mirpur township, Dhaka	Faridpur Sadar	p-value
		% (n)	% (n)	
** Willing to support a family member under the age of 18 participating in a Nipah vaccine trial	Yes	25 (96)	8 (31)	<0.001[b]
	No	61 (231)	85 (337)	
	Will decide later	13 (51)	7 (26)	

*Asked all respondents, **Only asked respondents with children under 18 years of age.
[b] Chi-square test statistics.

likely to say that they would take a NiV investigational vaccine during an outbreak situation than those who had 0 to 5 years of formal education (84 % vs. 60 %, OR 0.28, CI0.14–0.57, p < 0.001). We did not find any association between people's knowledge about NiV and their willingness to take a NiV investigational vaccine, or during a NiV outbreak (Table 5).

4. Discussion

While not a majority, many respondents reported being willing to participate in a NiV vaccine trial, suggesting that it may be feasible to recruit sufficient study participants to carry out such a trial in Bangladesh. The willingness to participate increased, especially in the context of an outbreak, indicating the perceived risk and salience of protective measures in emergencies. Respondents' primary concerns with an investigational vaccine were its safety related to the risk of severe side effects, including death. Clear communication on risks and benefits can help people to decide whether or not to participate in a vaccine trial.

Several studies and systematic reviews identified factors that motivate people to participate in or avoid a vaccine and/or a clinical trial [22–28]. These motivating factors include altruism, personal and health benefits, access to health care, health-seeking behavior, financial incentives, doctors' recommendations, perceived risk, curiosity, and hope. Reasons to avoid participation include dis/mistrust, social networks, stigma, fear of side effects, trial procedures, lack of financial support, knowledge about the trial and the disease (including perceived seriousness), language and cultural barriers, distance to the health center, and not sharing the trial results [22–28]. Although we asked our respondents about a vaccine against a rare disease, their concerns were similar to those reported in previous studies. Our respondents' reported main motivations were to prevent NiV and acquire immunity, protect their families, and contribute to society. Their primary concerns about an investigational vaccine were safety and side effects, which may explain why they wanted to know about the experiences of previous vaccine recipients (Phase I participants), including information about their health status following vaccination. This concern might be why fewer were willing to have their family participate than themselves. Since NiV is rare, respondents might not perceive an immediate risk, but many expressed willingness to accept a vaccine after observing others, aligning with COVID-19 vaccine decision-making in Bangladesh [29]. The broader post-pandemic context might also have played a role in framing attitudes toward emerging infection vaccine trials.

Many respondents (over 75 %) were willing to take the vaccine during an outbreak situation, similar to how people in past outbreaks and emergencies have also been willing to get vaccinated. Although hesitancy existed, willingness varied 8 %–67 % among countries to take a vaccine during the H1N1 pandemic in 2009 [30] and 60 % [31] to 66 % [32] for COVID-19. For H1N1, peoples' perceived susceptibility and the severity of disease were related to protective behavior including

Table 4
WHO vaccine hesitancy scale adapted to the Nipah vaccine trial context and tested with the quantitative survey community respondents and willingness to receive an investigational vaccine during a Nipah outbreak situation from Dhaka and Faridpur field sites, Bangladesh, 2022.

Modified WHO vaccine hesitancy scale	Category	Mirpur township, Dhaka	Faridpur Sadar	p-value
		% (n)	% (n)	
		N = 478	**N = 500**	
Modified WHO vaccine hesitancy scale				
New vaccines carry more risks than older vaccines	Agree	74 (354)	77 (388)	0.378[b]
	Neutral	19 (93)	16 (80)	
	Disagree	6 (31)	6 (32)	
The information I receive about vaccines is reliable and trustworthy	Agree	82 (395)	91 (456)	<0.001[b]
	Neutral	12 (57)	5 (27)	
	Disagree	5 (26)	3 (17)	
I am concerned about the serious adverse effects of vaccines	Agree	75 (358)	67 (335)	0.022[b]
	Neutral	8 (38)	11 (57)	
	Disagree	17 (82)	22 (108)	
		N = 272*	***N* = 491***	
Willingness to receive a Nipah trial/investigational vaccine during a Nipah outbreak situation				
During a Nipah outbreak, would you like to get this vaccine?*	Yes	75 (205)	81 (398)	<0.001[b]
	No	15 (43)	10 (50)	
	Not sure	7 (20)	8 (41)	
	Don't know	1 (4)	0.4 (2)	
Would like to get this vaccine during a Nipah outbreak		***N* = 205**	***N* = 398**	
Why would you consider getting the vaccine? (multiple responses)	I want to be protected from Nipah (full protection)	82 (169)	89 (356)	<0.001[b]
	To minimize the risk of getting this disease	45 (93)	25 (99)	
	Cannot answer	0	1 (3)	
	Other	0	0. 2 (1)	
Do not like to get this vaccine during the Nipah outbreak		***N* = 43**	**N = 50**	
Among those who would not like to get this vaccine: Why would you not consider getting the vaccine? (multiple responses)	Trial(investigational) vaccines can be risky even during an outbreak	65 (28)	54 (27)	0.05 [b]
	I am worried/not sure about the effectiveness of this trial	23 (10)	8 (4)	
	Due to my current health condition	9 (4)	8 (4)	
	I am worried about the side effects	42 (18)	54 (27)	
	Other	2 (1)	0	

[*] This question was included later, and data was not collected from 165 respondents from Dhaka and 9 from Faridpur.
[b] Chi-square test statistics (large sample size).

willingness to take a vaccine [33]. When we asked questions within the context of a deadly NiV outbreak, respondents might have felt susceptible to this deadly disease and many of them reported willingness to accept an investigational vaccine. This may also reflect their experience with COVID-19, which shaped their perception of similar situations. Studies on COVID-19 vaccine hesitancy in Bangladesh reported concerns about safety, side effects, effectiveness, trust issues, and disbelief in the disease [29,34–36]. However, an increase in the perceived benefits of the COVID-19 vaccine, perceived severity of and perceived susceptibility to COVID-19, was associated with reduced vaccine hesitancy in Bangladesh [37,38]. Overall Bangladeshi citizens were likely to accept the COVID-19 vaccine if they believed it reduced the risk of infectious disease and had no associated health risks after receiving it [29].

Table 5
Association between 'Nipah knowledge' and 'Willingness to take a Nipah trial vaccine' based on community reporting in Dhaka and Faridpur field sites, Bangladesh, 2022.

Characteristics		Mirpur township, Dhaka				Faridpur Sadar		
	Willingness to take a vaccine % (n)	Odds Ratio (OR)	95 % CI	p-value	Willingness to take a vaccine % (n)	Odds Ratio (OR)	95 % CI	p-value
Age in year								
≤30	45 (50/110)				14 (20/139)			
31–45	44 (89/202)	0.94	0.59–1.50	0.81	22 (38/171)	1.7	0.93–3.0	0.80
>45	47 (78/166)	1.00	0.65–1.72	0.80	28 (53/190)	2.3	0.28–0.84	0.004
Gender								
Male	45 (98/220)				29 (66/230)			
Female	46 (119/258)	1.06	0.74–1.52	0.73	17 (45/270)	0.49	0.32–0.76	0.001
Educational status								
0–5 years of schooling	45 (50/110)				14 (29/139)			
6–10 years of schooling	44 (89/202)	0.66	0.42–1.02	0.06	22 (38/171)	0.62	0.38–1.02	0.06
11 years and above	47 (78/166)	0.7	0.45–1.08	0.11	28 (53/190)	1.13	0.59–2.17	0.70
Knowledge								
A disease transmitted from bats to people	45 (122/272)	0.95	0.66–1.37	0.78	25 (66/262)	1.44	0.94–2.22	0.09
Heard about a disease that people can get from drinking raw date palm	48 (87/181)	1.19	0.82–1.72	0.36	24 (54/228)	1.17	0.76–1.79	0.46
Outbreak situation								
Age in Year								
≤30	84 (56/67)				82 (122/137)			
31–45	75 (82/109)	0.60	0.27–1.30	0.194	81 (136/168)	0.94	0.53–1.69	0.85
>45	70 (67/96)	0.45	0.20–0.098	0.047	81 (150/186)	0.93	0.52–1.63	0.80
Gender								
Male	75 (91/122)	Ref			86 (193/225)	Ref		
Female	76 (144/150)	1.07	0.62–1.87	0.78	77 (205/266)	0.55	0.34–0.89	0.015
Educational status								
0–5 years of schooling	84 (83/99)	Ref			80 (221/275)	Ref		
6–10 years of schooling	80 (73/91)	0.78	0.37–1.64	0.76	82 (132/160)	1.1	0.69–1.9	0.58
11 years and above	60 (49/82)	0.28	0.14–0.57	<0.001	80 (45/56)	0.99	0.48–2.06	0.99
Knowledge								
A disease transmitted from bats to people	71 (106/149)	0.59	0.33–1.05	0.07	81 (211/259)	1.05	0.67–1.66	0.80
Heard about a disease that people can get from drinking raw date palm sap	69 (65/94)	0.60	034–1.02	0.08	78 (176/227)	0.65	0.41–1.02	0.06

Additionally, our experience with NiV outbreak investigations indicated that people explore multiple healthcare options during an outbreak [39]. If an investigational vaccine could offer protection, most would be willing to accept it.

Respondents' knowledge about NiV transmission, a disease from bats to people was relatively common. Respondents from Dhaka were more familiar with the name Nipah as a bat-related disease than Faridpur which might because of media exposure. However, more respondents from Faridpur than Dhaka knew of the disease from raw date palm sap, probably because Faridpur experienced repeated NiV outbreaks and received health messages during outbreaks. In general, there was a slight increase in reporting knowledge than in a previous study, which was conducted approximately nine years prior to current one [16]. Continuous circulation and improvement of knowledge about NiV can help people recognize the associated risks. However, we did not find any noticeable association between respondents' willingness to take a vaccine with demographic characteristics and knowledge about NiV except age and education. Factors such as being students, graduates, aged 50 and over, having family members who had COVID-19, and having taken a vaccine in the last few years were associated with taking a COVID-19 vaccine in Bangladesh [38]. Age has also been found to be associated with other studies [40,41]. In our study respondents over 45 years old from Faridpur were more likely to say that they would participate in a vaccine trial than those ≤30 years old. However, we did not find any such age-related association with the willingness to take a vaccine during an NiV outbreak.

Respondents from Dhaka with more education were less willing to take the investigational vaccine during an outbreak situation than those with 0 to 5 years of schooling. A study from Jordan reported that higher education was associated with unwillingness to take part in a COVID-19 vaccine trial [42]. The authors of the Jordan study explained that higher-educated people are more aware of clinical trial procedures and the time required, which makes them less willing to participate than those with less education (below university level). Thirteen percent of Jordan's study sample consisted of people with biomedical degrees that might have been the source of this reported hesitancy. We cannot confirm that our respondents with over 11 years of education knew more about clinical trials than those with 0–5 years of education. However, they might have associated the term "vaccine trial" with the risks of "side effects" because they might have more media access to information about COVID-19 vaccine trials than those with minimal formal education. This also suggest that individuals with less formal education might not fully understand the vaccine trial process or anticipate any potential risk. The influence of education on vaccination decisions is complex. A systematic review [43] reported that people with a bachelor's degree are likely to be vaccinated, as they take time to understand the disease severity and benefits of vaccination. However, the same review noted that higher education, such as university and college degrees, can also be linked to vaccine hesitancy, potentially due to external influences like social groups, government, and health authorities.

Female respondents from Faridpur were less likely to participate in a vaccine trial, even during an outbreak, than male respondents. This may be due to gender dynamics in rural Bangladesh. Although women reported making many vaccination and treatment decisions at home, women in our qualitative study reported that it may be difficult for them to decide whether or not to take a new vaccine without input from other family members due to concerns about the perceived potential of deadly side effects of a new vaccine.

According to the modified WHO vaccine hesitancy scale that we used in our study, respondents believed that new vaccines carry more risk than those already in use: providing information can help people make informed decisions. However, our respondents considered the vaccine information they received to be "reliable and trustworthy", indicating trust in the health system. People may not want to take vaccines when they do not trust the health system as seen in studies from other settings [44]. Mass implementation of the Expanded Program of Immunization (EPI) since 1974 [45], which noticeably reduced childhood mortality in Bangladesh [46,47] likely contributed to a vaccination coverage rate of 83 % among children [48] as parents considered vaccines safe and effective [49] and established vaccine-related trust among general people.

Our study has limitations. While many respondents expressed concerns about side effects, many also agreed to take the investigational vaccine. Some of the stated agreements to participate could be due to social desirability bias, where respondents answered in a way, they thought the interviewers wanted to hear. The timing of the data collection may have also influenced their responses, as the COVID-19 vaccination experience was still fresh, potentially leading respondents to favor the NiV vaccine, believing that NiV might spread as widely as COVID-19. Additionally, their responses were more hypothetical than based on real experiences, as most respondents lacked detailed information about NiV, the investigational vaccine, and the vaccine trial process. Since we conducted a mixed-methods study, the qualitative findings helped us understand the reasons behind their willingness or reluctance to participate in the trial. These issues are important to consider when planning the next vaccine trial, especially when developing communication materials for potential participants.

Our findings suggest that it is feasible to conduct a NiV vaccine trial in Bangladesh. While concerns about safety and side effects persist, overall trust in vaccines and the health system remains high, likely influenced by long-standing national immunization programs, which may contribute to willingness to participate. To strengthen recruitment and ensure ethical trial implementation, communication strategies can explain the risks and benefits of participation that may improve health literacy and trust, which can be achieved through community engagement [50]. Additionally, future efforts can focus on sharing data from early-phase trial participants to improve transparency and support informed decision-making. Together, these steps may help establish an effective and context-appropriate approach for NiV vaccine trials in Bangladesh.

CRediT authorship contribution statement

Nazmun Nahar: Writing – original draft, Visualization, Resources, Project administration, Methodology, Formal analysis, Data curation. **Shahana Parveen:** Writing – review & editing, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Emily S. Gurley:** Writing – review & editing, Methodology. **Probir Kumar Ghosh:** Writing – review & editing, Software, Resources, Formal analysis, Data curation. **Ishrat Jabeen:** Writing – review & editing, Investigation, Formal analysis. **Md. Rifat Haidar:** Writing – review & editing, Investigation, Formal analysis. **Farhat Jahan:** Writing – review & editing, Investigation, Formal analysis. **Mohammad Saeed Munim:** Writing – review & editing, Investigation, Formal analysis. **Kanij Fatema Chanda:** Writing – review & editing, Investigation, Formal analysis. **Md. Wazed Ali:** Writing – review & editing, Investigation. **Zubair Akhtar:** Writing – review & editing, Methodology. **Tahmina Shirin:** Writing – review & editing. **Sayera Banu:** Writing – review & editing. **Atique Iqbal Chowdhury:** Writing – review & editing, Software. **Asraful Alam:** Writing – review & editing, Software. **Brian E. Dawes:** Writing – review & editing, Resources. **Joan Fusco:** Writing – review & editing. **Thomas P. Monath:** Writing – review & editing. **Gray Heppner:** Writing – review & editing. **Stephen P. Luby:** Writing – review & editing, Visualization, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of generative AI and AI-assisted technologies in the writing process

Authors did not use AI assisted technologies in the writing process.

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Annexure 1: Modified WHO's vaccine hesitancy assessment questions. We excluded seven items related to children and kept three general items, and modified the five point Likert scale to three points scale.

Q. No.	Questions & response
1	New vaccines carry more risks than older vaccines which people usually have been taking for a long time SELECT ONE o 1 = Agree o 2 = Neutral o 3 = Disagree
2	The information I receive about vaccines is reliable and trustworthy SELECT ONE o 1 = Agree o 2 = Neutral o 3 = Disagree
3	I am concerned about serious adverse effects of vaccines SELECT ONE o 1 = Agree o 2 = Neutral o 3 = Disagree

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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Data availability

Data will be made available on request.

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