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The reactive cholera vaccination campaign in urban Dhaka in 2022: experience, lessons learned and future directions

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ABSTRACT

Introduction: An upsurge of diarrheal cases occurred in Dhaka, Bangladesh, with approximately 30% of the cases being identified as cholera in 2022. To combat this situation, a reactive Oral Cholera Vaccination campaign was organized in five highly cholera-affected areas of Dhaka city. The paper is a descriptive tale of experience gathering, organization and implementation of reactive oral cholera vaccination campaign.
Study design: This is a descriptive report of a reactive oral cholera vaccination campaign.
Methods: Population density maps were generated using GIS technology before launching the campaign. The target population comprised individuals aged over one year, excluding pregnant women, totaling 2,374,976 people residing in above mentioned areas. The campaign utilized Euvichol-Plus, an OCV with adherence to the necessary cold chain requirements. Total 700 teams, each consisting of six members, were deployed across the five zones. The campaign was conducted in two rounds, where first round took place in June–July 2022, followed by second round in August 2022. During the campaign, data on adverse events following immunization (AEFI) was collected. Expert teams from various government and non-government organizations monitored regularly and ensured the campaign's success.
Results: The first round achieved a coverage rate of 99%, whereas in the second round, 86.3% of individuals among the first dose recipients. During the campaigns, a total of 57 AEFIs were reported.
Conclusions: This campaign serves as a model for a multispectral approach in combating cholera epidemics, highlighting the collaborative efforts of policymakers, health authorities, local communities, and health partners.

1. Introduction

Cholera become a public health threat across the globe, especially in low and middle-income countries in Asia and Africa. The World Health Organization (WHO) estimated that there are 1.3–4.0 million cholera cases annually and 21,000 to 143,000 of them results in death [1]. In Bangladesh, an estimated 109,052 cholera cases are seen with an annual incidence rate of 1.64/1000 [2]. COVID-19 has spread to 210 countries around the world, including Bangladesh after the detection of the first case in the province of Wuhan in China in December 2019 [3,4]. In Bangladesh, first case of COVID-19 was detected on March 8, 2020 [4]. Hospitalization rates for diarrhea-related illnesses dropped in Bangladesh during the peak of the pandemic in 2020. However, in 2021, there were widespread epidemics in the regions of Barishal, Gopalganj, Noakhali, Bandarban, Chattogram and Brahmanbaria. Also, the nationwide cholera surveillance recorded an increased number of cholera case in several districts including Narayanganj, Narshingdi, Borguna, Bhola, Brahmanbaria, and Chandpur. This indicates the likelihood of an increase in the cholera outbreak in different parts of the country in the near future [5–10]. Cholera is known to have a biannual seasonal peak, one between April to May and the second peak from August to September [11]. The highest peak is seen in April each year, but unprecedentedly in 2022 the major cholera surge started in early March. The hospitalization rate due to cholera has been observed to be

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very high in Dhaka city in 2022 especially from 8th March 2022 at the icddr,b diarrhea hospital and about 1300 new patients were admitted and treated per day [12,13]. Among the admitted patients over 50% of patients are coming from Jatrabari, Dakshinkhan, Sabujbagh, Mohammadpur and Mirpur area of Dhaka city. Earlier icddr,b data showed that in general 20% of diarrhoeal patients with AWD admitted to icddr,b hospitals are infected with *Vibrio cholerae* [13]. [12]. Along with icddr,b hospital, diarrhoeal patients were also rising in other major government hospitals in the city [12,14].

Therefore, for accelerating the improvements of cholera situation, much attention was given for the deployment of the cholera vaccines as it was recognized as a complementary prevention and control measure along with the primary preventive measure such as water, sanitation and hygiene behavior improvement [15]. The Communicable Disease Control (CDC) of the Directorate General of Health Services (DGHS) has planned for the reactive OCV campaign and applied to the International Coordinating Group (ICG) which is comprised with United Nations International Children's Emergency Fund (UNICEF), The International Federation of Red Cross and Red Crescent Societies (IFRC), Médecins Sans Frontières (MSF) and World Health Organization (WHO) for the vaccine to use during this outbreak situation [16]. The CDC, Bangladesh also nominated the icddr,b as implementing partner along with the Expanded Programme on Immunization (EPI), DGHS, Bangladesh Red Crescent Society (BDRCS) and WHO [15,17]. The ICG approved 4.75 million vaccines for the two-dose campaign on April 11, 2022. The objective of this campaign was to control the outbreak of cholera and reduce hospitalization due to cholera in the high-risk areas of urban Dhaka. This paper is a descriptive report of experience gathering, organization and implementation of reactive oral cholera vaccination campaign in a high-risk endemic urban population in Dhaka, Bangladesh.

2. Methods

2.1. Vaccination areas and target population

The areas of vaccination campaigns were Jatrabari (Area 1), Sabujbagh (Area 2), Mohammadpur and Adabar (Area 3), Mirpur (Area 4) and Dhakshinkhan (Area 5). The total population of Jatrabari and Sabujbagh areas of Dhaka South City Corporation (DSCC) were estimated to be 934,312 and Dakshinkhan, Mohammadpur and Mirpur of Dhaka North City Corporation (DNCC) were 1,489,135 (based on extrapolated census of Bangladesh, 2011). The targeted population of OCV vaccination for DSCC areas were estimated as 915,625 and DNCC were 1,459,351 (assuming 2% of children in the < one-year age group). The estimated total population from the selected areas were about 2,423,447 and target population for the OCV campaign were 2,374,976 residents (Fig. 1).

2.2. Vaccination sites

Updated maps from both the city corporations (North and South) was used for demarcation of the ward and thana boundaries. Satellite image and World Pop digital map was used for determining the population density through the geographical information system (GIS) software. This has been also verified by field verification. We prepared online ArcGIS web map which facilitated the major access routes in the vaccination areas, target structures/households, and vaccination sites. The total areas were subdivided into 700 possible vaccine delivery points considering approximately 800–900 families (3200–3600 population) per site. Five vaccine coordination points were selected for five areas and they were used as vaccination site office and temporary vaccine storage.

2.3. Vaccine storage and transport

The vaccine used in this campaign was Euvichol-Plus, which was formulated in plastic ampoules. Vaccines were transported from the airport to the cold storage facility of the Bangladesh Agriculture Development Corporation (BADC), where detailed inventories, including temperature of storage at 2 °C–8 °C was recorded. Later OCVs were transferred to the Expanded Program on Immunization (EPI) headquarter, Mohakhali, Dhaka and District EPI store, Tejgaon, Dhaka. This was because of lack of space at the EPI cold room at the time. Every morning vaccine was sent through vaccine carriers by 70 pick-up vans from the EPI cold room by 6 a.m. each morning and returned in the evening by 7 p.m. A previously planned route and vaccine receiver team number were assigned to each vehicle. An accountability log was maintained both in the point of distribution and point of delivery. Team leader of the vaccination team received the vaccine from the pickup van. Initially every team received 300 doses of vaccine (150 doses each in two separate vaccine carrier). There was at least one cold box contained about 1500 vaccines for 2/3 teams and kept nearby for their easy access. Moreover, reserved vaccines (15000 for Jatrabari area, 15000 for Mirpur and Mohammadpur area and 7500 each for Sabujbagh and Dakshinkhan) were kept in cold boxes in aforementioned coordination points to manage the immediate vaccine demand. In addition, two freezer vans roamed around the high demand vaccination areas to meet the immediate shortage of vaccine at any site.

2.4. Vaccination teams

A total of 700 vaccination teams were deployed to conduct this campaign in five vaccination areas. Each team consisted of six members-two vaccinators, two volunteers (mobilizer and vaccine card writer), one record keeper and one team leader. The team leader was responsible for the overall management of team and site activities and vaccine accountability. Vaccinators were in charge of checking vaccine vial monitors (VVM) and administering vaccine to people. Record keeper's task was to document vaccination on tally sheet for maintaining vaccination status and also mark the finger nail bed (little finger of the left hand) with indelible marker right after vaccination. Volunteers were engaged in eligibility checking prior to vaccine administration and providing a vaccine card. The vaccination team members (~4200 manpower) were selected from the government and non-government organizations, local youth club and educational institutions from the respective campaign areas who had completed at least a secondary school certificate examination. A total of 175 first-line supervisors was engaged for monitoring purpose, each supervisor supervised four vaccination teams. A total of 58 s-line supervisors was involved in monitoring vaccination teams and they supervised 12 teams including three first first-line supervisors.

2.5. Mobilizing the population

Advocacy and social mobilization were conducted before and during campaign. Advocacy meetings were held at Regional Executive officer's office from DSCC and DNCC at different ward commissioners and councilor's offices. Communication materials poster/banner/leaflet/miking were carried out throughout the vaccination campaign period in the vaccination areas to describe the vaccination plan. Meetings were held as needed with the government, the CDC, the DGHS, as well as city corporations and other stakeholders. To highlight media interest, a press conference and press release were organized prior to the campaign commencement.

2.6. Training

One-day training was conducted for all the members of the vaccination team and supervisors. Around 300 participants per session and

Fig. 1. Reactive OCV campaign vaccination areas.

three sessions per day were conducted for the training. Prior to the staff training, training of the trainers (ToT) was conducted to ensure that a sufficient number of facilitators were trained to conduct the series of training.

2.7. Vaccine delivery

The OCV campaign was carried out for six days in each dose. The First dose was conducted between 26th June 2022 and 2nd July 2022 with a one-day break (Friday, 1st July 2022) and the second dose campaign was conducted between 3rd August 2022 and10th August 2022 (except Friday, 5th August 2022 and a govt. holiday, 9th August 2022). A total of ~600 was the target of administration for each of the vaccination team at each site. Necessary logistics like vaccine carriers with required ice packs, vaccine cards, tally sheets, indelible markers and pens, accountability log for team leader, supervisor checklists, safety equipment (hand sanitizer, face mask), banner, leaflet and others were previously gathered in the vaccination sites. Vaccination cards which wrapped with poly cover were provided to all vaccinees after completing the vaccination to identify vaccinees during 2nd dose. The Record keeper confirmed the vaccination status by checking the cards and completed the tally and finger marking. Each day ~400,000 doses of OCVs were targeted to be administered cumulatively by all the teams. Vaccine recipients were instructed to keep their OCV card safe and bring back during 2nd dose administration. The main strategy was to ensure that first-dose recipients received the second dose of OCV. Volunteers cautiously checked their vaccination cards prior to administering the second dose. Only on the last day of the 2nd dose vaccination campaign, the first dose recipients who lost their cards given the OCV.

2.8. Adverse event following immunization (AEFI) reporting and management

An adverse event following immunization (AEFI) committee consisting of 13 members was formed by the personnel from CDC, EPI of the DGHS, Directorate General of Drug Administration (DGDA), Dhaka city corporations (DNCC, DSCC), the icddr,b, other members of the DGHS, WHO and UNICEF. All the AEFI cases were evaluated and reported by the assigned physicians for each day from icddr,b for the respective five areas. AEFI was monitored for 24 h following vaccination and recorded in the AEFI form. Five AEFI kit boxes were provided to five vaccine coordination points. Two emergency phone numbers were provided in the vaccination card and on call physicians were available 24/7 to respond for the AEFI. When any event happened within 24 h of vaccine receipt, physicians evaluated the patient's clinical history over phone or in person if the participant visited any of the vaccination sites, provided advice, prescribed medication, and referred patient (s) when necessary to a hospital and finally recorded as an AEFI [18,19].

2.9. Waste management plan

The waste materials were collected in different waste disposal bags at each vaccination site. Biohazard bags were provided to dispose of empty tubes and caps and black poly bags for other waste materials. At the end of the vaccination of each day, the waste disposal bags were sent back to five vaccine coordination points. The PRISM Bangladesh Foundation, a reputed organization in Bangladesh responsible for waste management systems, collected these wastes on a daily basis.

2.10. WASH component

All vaccinees were given information of safe drinking water, sanitation, and hygiene (WASH) at vaccination sites and also handed over a pictorial leaflet of behavior change process (Fig. 3). This leaflet contained information, health education, promoting behavior change and ensuring sustained recall.

2.11. Monitoring and evaluation (M&E)

Overall monitoring of the campaign was carried out by experts from different stakeholders (CDC, DGHS, icddr,b and WHO). Monitoring tools such as activity logs, vaccine registers, supervisor check lists and vaccine accountability logs were closely reviewed and reported periodically. Experts from the CDC, DGHS, and WHO also visited and monitored the vaccination areas on a regular basis throughout the campaigns.

2.12. Measurements and assessments

A vaccination coverage assessment was done after the completion of the campaign to assess the coverage and identify reasons for non-vaccination. Moreover, continuous monitoring of the number of individuals vaccinated during the campaign ensured timely adjustments to the campaign strategy, ensuring that the targeted population received adequate coverage. On-the-field physician's advice on reported AEFI and 24-h physician's on-call support to monitor AEFI ensured the safety of the vaccine and allowed for prompt responses to any unexpected reactions. Tracking and limiting vaccine waste by optimizing logistics distribution is ensured by strong monitoring and evaluation by the stakeholders. A pre-post evaluation has been going on to see the impact of the OCV campaign by analyzing data from the 2% of surveillance patients coming from the vaccination areas that have been carried out since 1996 at icddr,b. Disease trends will be monitored to assess the long-term impact of the vaccination campaign. This helps in understanding the sustainability of the vaccination efforts.

3. Results

The six -day campaign in the first round was smoothly conducted with an administrative coverage of over 99% along with minimum wastage (<1%). The first dose was administered to approximately 17% of the population (95% CI: 16.9, 17.1), while the second dose saw a slightly lower coverage of around 16% (95% CI: 15.9, 16.1). In terms of gender distribution among recipients under 5 years old, there was a relatively balanced representation. Around 51.5% were male (95% CI: 51.4, 51.6), and approximately 48.5% were female (95% CI: 48.4, 48.6) for the first dose. For the second dose, the gender distribution remained comparable, with approximately 51.2% male (95% CI: 51.1, 51.3) and 48.7% female (95% CI: 48.6, 48.8). This indicates a relatively equitable distribution across genders for both doses of the vaccine among the targeted age group, demonstrating a balanced coverage within the specified areas (Table 1). Highest coverage was recorded from Jatrabari (~93%) area, followed by Mirpur, Mohammadpur-Adabar (85%), Dakshinkhan (83%), and Sabujbag (82%). Area wise vaccination coverage is shown in Fig. 2. Moreover, the high coverage rate observed (99% in the first round and 86.3% among the second dose recipients) reflects the campaign's success in reaching a significant proportion of the target population. Here the coverage was restricted to the administrative coverage. Nevertheless, we recognize that a more extensive assessment, specifically tailored to evaluate the practicality, reception, and extent of implementation (such as surveys conducted after the campaign, qualitative evaluations, or mechanisms for gathering community feedback), would have yielded more nuanced observations and enhanced the credibility of these findings.

During the campaigns, a total of 57 AEFIs were reported. In the first round, 39 adverse events were reported, distributed almost evenly between genders, with 20 cases in males and 19 in females. Notably, a higher number of cases [21] occurred in individuals over 18 years old compared to those under 18 [18]. Among these cases, 20 required hospitalization. The confidence intervals for the male were 51.3% (95% CI: 35.6, 67.0), and for those above 18 years were 53.8% (95% CI: 38.2, 69.4) (Table 2).

In the subsequent second round, 18 adverse events were reported, with a gender distribution of 12 cases in males and 6 in females. Similar

Table 1
Distribution of OCVs in five different areas along with their coverage and age and gender distribution of the recipients.

Area	1st Dose Total Vac Pop Male <5 Years	2nd Dose Total Vac Pop Male <5 Years	1st Dose Total Vac Pop Female <5 Years	2nd Dose Total Vac Pop Female <5 Years	<5 years both male and female (%)	1st Dose both male and female (%)	2ndDose both male and female (%)	1st Dose Total Vac Pop Male≥5 Years	2nd Dose Total Vac Pop Male≥5 Years	1st Dose Total Vac Pop Female≥5 Years	2nd Dose Total Vac Pop Female≥5 Years	1st Dose Total Transgender	2nd Dose Total Transgender	1st Dose Grand Total Vac Pop	2nd Dose Grand Total Vac Pop
Mirpur	102,763	86,165	99,168	80,430	1st Dose 17% (95% CI: 16.9, 17.1) and 2nd Dose 16% (95% CI: 15.9, 16.1)	Male 51.5% (95% CI: 51.4, 51.6) and female 48.5% (95% CI: 48.4, 48.6)	Male 51.2% (95% CI: 51.1, 51.3) and female 48.7% (95% CI: 48.6, 48.8)	502,563	433,963	447,286	385,971	294	41	1,152,074	986,570
Mohammadpur-Adabar															
Dakshinkhan	18,751	15,492	18,979	15,504				128,585	105,553	128,087	108,209	9	5	294,411	244,763
Sabujbag	30,803	27,707	29,962	26,848				181,164	145,531	176,754	145,227	29	0	418,712	345,313
Jatrabari	46,734	40,902	47,551	40,488				206,772	192,121	199,180	193,108	151	10	500,388	466,629
Total	199,051	170,266	195,660	163,270				1,019,084	877,168	951,307	832,515	483	56	2,365,585	2,043,275

to the first round, a higher number of male cases [10] were observed in individuals. Notably, a significantly higher (77.8%) percentage of adverse events (95% CI: 58.6, 97.0) in the second round required hospitalization, in contrast to the first round. The confidence intervals for hospitalization male were 66.7% (95% CI: 44.9, 88.5) and 55.5% (95% CI: 32.5, 78.5) for the below 18 years. Gastrointestinal symptoms such as diarrhea, vomiting, nausea, abdominal pain and fever were the most frequently reported events. Among all the reported cases 34 required hospitalization. Over the follow up period no serious adverse event was reported.

4. Discussion

This is a descriptive report of a reactive oral cholera vaccination campaign. The oral cholera vaccine is one of the key tools and widely used to control cholera epidemics worldwide. In response to the major upsurge of the cholera cases, CDC, DGHS, in collaboration with the icddr,b, BDRCS, MSF, DSCC, DNCC, EPI, UNICEF and WHO, carried out the large OCV (4.75 million doses) campaigns targeting around 2.4 million population. To our knowledge this is one of the largest OCV campaign globally, where we have vaccinated more than 2 million high risk population. The administrative coverage was very high in this campaign for both first and second dose. Also, this is an example of a multisectoral approach to combat cholera epidemics and was streamlined within the National Cholera Control Plan (NCCP) of Bangladesh that was developed in response to the goal of ending cholera by 2030 a global roadmap. The success of the OCV campaigns was carried out due to the strong political commitment from policymakers and good collaboration and coordination between health authorities, local communities, and health and WASH partners.

The reactive vaccination was successful because of the experience earned from the previous vaccination campaigns, which included preventive OCV campaigns in Dhaka in 2020 and also in Rohingya Myanmar nationals in Cox's Bazar [20] from 2017 was used. To cover the maximum target population, different strategies like miking, leaflet distribution, media support was used. The previous experience of conducting vaccines campaigns was helpful in making the reactive vaccination successful; using different strategies such as miking, leaflet distribution, media coverage it was possible to cover the maximum target population [21–23]. The coverage of the vaccination was similar with other campaigns conducted in Bangladesh as well as in other similar settings [24].

The gender distribution of the vaccine recipients and the AEFI was consistent with data from other OCV campaigns [21,25]. However, high vaccination coverage may not always indicate vaccine acceptability. As the campaigns happened in the midst of an ongoing outbreak, the high vaccination rate may have been the result of people taking the vaccine out of fear of possible cholera deaths and dehydrating illness that they witnessed in the community [26]. Limitation of this campaign was the huge space required for vaccine storage and cold chain management needed during vaccination. Due to the sheer volume of doses supplied and the variety of locations where they were stored, this produced a significant logistical difficulty. Maintaining a cold chain at every site, especially with a mobility staff, was difficult to organize in order to meet the required cold chain criteria. Furthermore, we also planned for vaccine storage space, large number of vaccine carriers, as well as a cold box and enough ice packs to ensure vaccine thermostability. These limitations should be considered for the implementation of future large-scale OCV vaccination.

Considering the coverage and vaccine demand, we deduce that the vaccine was well accepted and also feasible to use in large campaign in highly densely populated urban area. The feasibility was assumed from the effective implementation of 700 vaccination teams, mobilization endeavors, and proficient management of vaccine logistics, resulting in the administration of a significant number of doses within a specified period. Though the campaign was largest in comparison to any other

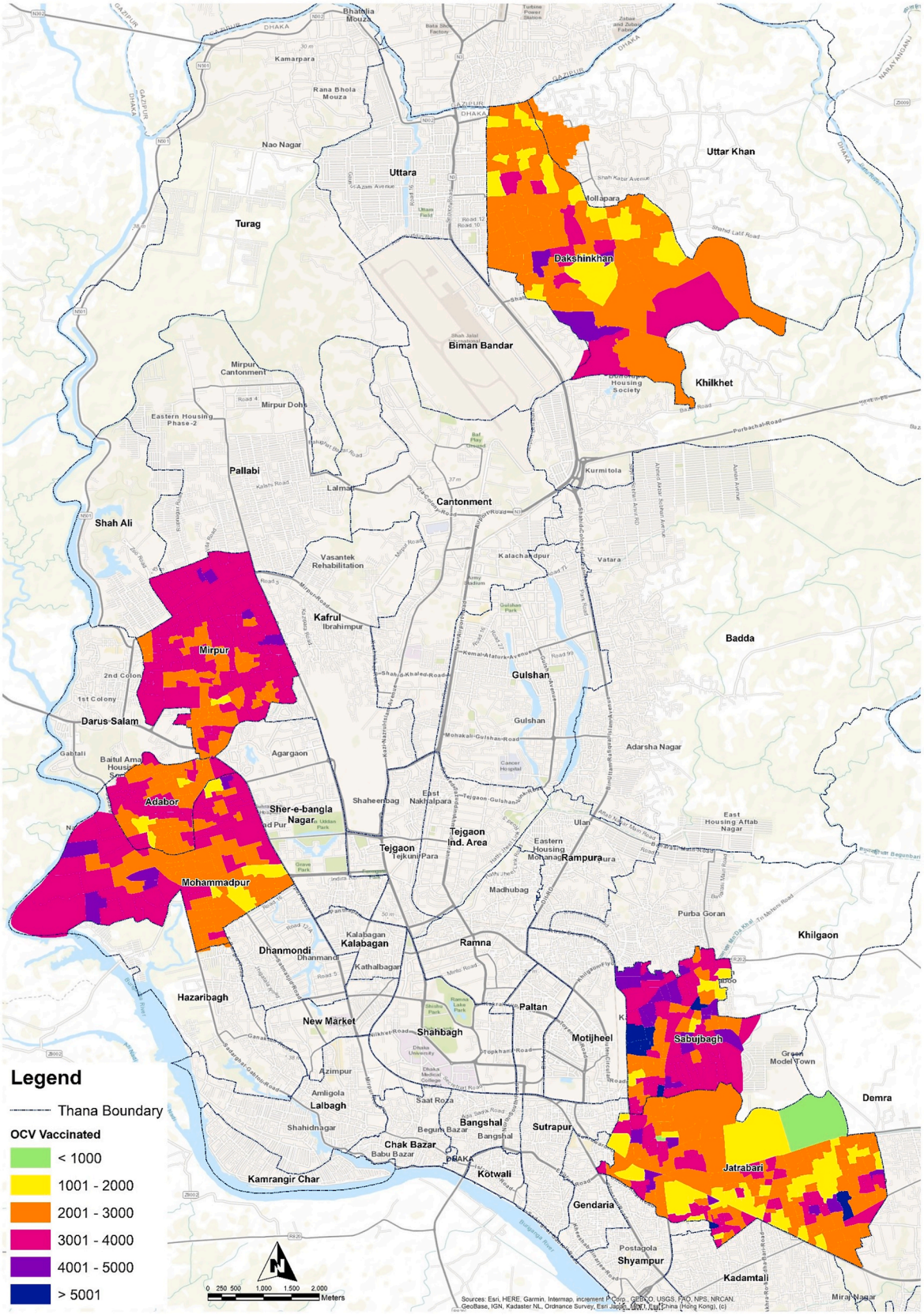

Fig. 2. Reactive OCV vaccination coverage in the five campaign areas.

Fig. 3. Reactive OCV campaign pictorial leaflet of behavior change process.

Table 2
Adverse events following immunization (AEFI) following 1st and 2nd round of OCV campaign.

1st Round						2nd Round					
AEFIs reported	Sex		Age		Required hospitalization	AEFIs reported	Sex		Age		Required hospitalization
39	Male 20 (51.3%) (95% CI: 35.6, 67.0)	Female 19 (48.7%) (95% CI: 33.0, 64.4)	<18 years 18 (46.1%) (95% CI: 30.4, 61.7)	>18 years 21 (53.8%) (95% CI: 38.2, 69.4)	20 (51.3%) (95% CI: 35.6, 67.0)	18	Male 12 (66.7%) (95% CI: 44.9, 88.5)	Female 6 (33.3%) (95% CI: 11.5, 55.1)	<18 years 10 (55.5%) (95% CI: 32.5, 78.5)	>18 years 8 (44.5%) (95% CI: 21.5, 67.5)	14 (77.8%) (95% CI: 58.6, 97.0)

OCV campaign carried out in Bangladesh, we have successfully implemented the vaccination with our experiences and collaboration with the government and non-government organization which denotes the feasibility of mass campaign in endemic settings. Acceptability was gauged through pre-campaign advocacy meetings, community engagement initiatives, and minimal vaccine hesitancy observed during the vaccination period. During the campaign all the vaccines were delivered beyond the timeline and a large group of people demanded the vaccine who come from different areas adjacent to the campaign regions. The cholera vaccination program in high-risk urban population and densely populated area can be successfully implemented with the existing system in Bangladesh considering the feasibility and acceptability. However, for long term prevention of the cholera outbreak, a multisectoral approach consisting of different partners needs to be involved with proper planning. Comprehensive surveillance is required throughout the country in order to issue early warnings and develop an alert response system. The study employed a descriptive report format to outline the experience, organization, and execution of the reactive oral cholera immunization program. Data collection methods were ensured to be of high quality by several steps and collected digitally with the help of a digital platform (Arc GIS Survey 123; Mobile app). Data quality was ensured by different training sessions for the vaccination teams, supervising their work by specialists from different stakeholders, maintaining vaccination records, and monitoring the process in real-time.

5. Conclusion

Despite the context of great vaccine hesitancy globally, this OCV campaign was an example for policymakers in all the cholera-endemic countries where minimum reluctance was observed in vaccination. The OCV campaign of a large population in the selected urban areas of Dhaka city proved feasible and acceptable and achieved high coverage. This is encouraging and is a way forward for reducing cholera related morbidity and mortality among vulnerable populations based on the National Cholera Control Plan of Bangladesh to achieve the global roadmap to end cholera by 2030. The experience in this campaign will also serve to inform and encourage cholera high-risk countries to use OCV along with other preventive measures to end the epidemics and outbreaks of cholera. This successful campaign can serve as a blueprint for implementing similar vaccination drives in other high-risk cholera epidemic regions of Bangladesh and in comparable settings worldwide.

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Authors contribution statement

Concept and design, ZHK, MTI, AIK, and FQ.; drafting of the manuscript, ZHK, MTI, AIK, and FQ; and critical revision of the manuscript for important intellectual content, ZHK, MTI, MAA NAT, FC, FK, TRB, TIB, AR, MNI, AIK, and FQ. All authors reviewed and approved the final version of the manuscript.

Ethical approval

The reactive oral cholera vaccination campaign was a national vaccination program which was led by the Communicable Disease Control (CDC) of the Directorate General of Health Services (DGHS), Bangladesh. The icddr,b conducted the OCV campaign as an implementing partner. Therefore, Ethics Committee's ethical approval was not required.

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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