COUNTRY LEARNING HUB FOR IMMUNISATION EQUITY IN BANGLADESH

Findings From Rapid Assessment

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Johns Hopkins University Affiliate

redorange communications
STRATEGY IMPLEMENTATION CREATION

ISBN: 978-984-551-392-0

Working Paper No. 181

Published in Bangladesh by icddr,b
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SUGGESTED CITATION
Chowdhury ME, Alam N, Sarker BK, Das H, Shiblee SI, Jannat Z, Rahman M, Ali MW, Rahman MM, Rahim MA, Oliveras E, Mahmood SS, Morgan C, Wahed T, Uddin MJ. Country Learning Hub for Immunization Equity in Bangladesh: Findings from Rapid Assessment. icddr,b , Bangladesh; 2023

COVER DESIGN
Asif Zahan, redorange communications

INSIDE LAYOUT
Mohammad Inamul Shahriar/Communications/icddr,b/2023

PRINTED BY
Dina offset printing press, Dhaka, Bangladesh

COUNTRY LEARNING HUB FOR IMMUNIZATION EQUITY IN BANGLADESH: Findings from Rapid Assessment

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CONTENTS

ABBREVIATIONS

AIC	Akaike Information Criterion
BDHS	Bangladesh Demographic and Health Survey
CC	City Corporations (CC)
CES	Coverage Evaluation Survey
CLH	Country Learning Hub (CLH)
CNG	Compressed Natural Gas
CSMR	Center for Social and Market Research
DGHS	Directorate General of Health Services
DNCC	Dhaka North City Corporation
DSCC	Dhaka South City Corporation
DTP	Diphtheria, Tetanus, and Pertussis
EDD	Expected Date of Delivery
EPI	Expanded Programme on Immunization
FRA	Field Research Assistant
GIS	Geographic Information System
GoB	Government of Bangladesh
HA	Health Assistant
HR	Human Resource
HTR	Hard-to-reach
IDI	In-depth Interview
IPC	Interpersonal Communication
IR	Implementation Research
IRMMA	Identify, Reach, Monitor, Measure, and Advocate
KIIs	Key Informant Interviews
LQAS	Lot Quality Assurance Sampling
MoHFW	Ministry of Health and Family Welfare
NGO	Non-governmental Organizations
NID	National Immunization Day
NIPORT	National Institute of Population Research and Training
SHN	Surjer Hashi Network
UI	Under-immunized
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VPD	Vaccine-preventable Diseases
WHO	World Health Organization
ZD	Zero-Dose

EXECUTIVE SUMMARY

BACKGROUND

To support Gavi 5.0, the new five-year strategy of Gavi, the Vaccine Alliance, with an aim to improve equity in vaccination coverage, zero-dose (ZD) Country Learning Hubs (CLHs) are being set up in Bangladesh, Mali, Nigeria, and Uganda. For the Bangladesh CLH, a rapid assessment was conducted to assess the status, locate missed communities with clusters of ZD and under-immunized (UI) children, and identify barriers to reach them so that effective and targeted interventions can be developed to address the issues relating to ZD and UI children.

METHODOLOGY

The rapid assessment was conducted between December 2022 and May 2023, using nationally-representative secondary data as well as primary data to identify missed communities with high numbers of ZD and UI children in Bangladesh. Identification of ZD, UI and missed communities was done in two steps. In Step 1, we identified areas with high numbers of ZD and UI children by analyzing data from the Bangladesh Coverage Evaluation Survey (CES) (2014, 2015, 2016, and 2019) and administrative EPI data (2019 to 2022) obtained through DHIS2. In Step 2, we confirmed the areas identified in Step 1 through Lot Quality Assurance Sampling (LQAS) and validated with field visits. In areas identified as missed communities via LQAS, characteristics of the locality and population were mapped using a standard recording-form. To identify the socio-economic determinants of ZD and UI, we did a secondary analysis of data from the Bangladesh Demographic and Health Survey (BDHS) 2017-2018. Finally, we conducted key informant interviews (KIIs) and in-depth interviews (IDIs) with national and sub-national managers, service providers, and caregivers to supplement the quantitative findings with additional insights into demand-and supply-side barriers/challenges of ZD and UI children and obtain stakeholders' suggestions to reduce the numbers of ZD and UI children.

RESULTS

Identification of ZD and UI children and missed communities

The rapid assessment identified five rural districts and one urban (city corporation) areas with ZD and UI children and missed communities. Two upazilas (sub-districts)/zones in each of the five selected districts were selected in the later step. To elaborate; the selected rural areas were two upazilas of Sunamganj district in the north-east (haor/wetlands) of Bangladesh, two upazilas in Gaibandha district in the central north (char area--sandy/silty land surrounded by water), two upazilas from Noakhali district in the central south (coastal area), and two upazilas in Sherpur district in the north (plain land). Ward no. 26 and 30 of Zone 5 of Dhaka North City Corporation (DNCC) were also identified. Implementation research will be conducted at each of the selected upazilas/wards.

Mapping of missed communities

Findings from the LQAS in missed communities with high numbers of ZD and UI children, confirmed that the initially-identified areas were mainly inhabited by the poor and lacked educational institutions and health centers. The transportation system and household condition of these areas were also poor. The most common profession of household heads of those clusters were farming followed by service, with the exception of urban clusters where most of the residents were day-laborers.

Characteristics of ZD and UI children according to BDHS

Our multivariate analysis of BDHS 2017-2018 data showed that mothers with less education, with no formal work, having no antenatal visits, not wanting their last child, and living in Sylhet division were more likely to have a ZD child. Similarly, mothers with less education, no access to media, with no formal work, having no antenatal visits, and living in Sylhet and Khulna divisions were more likely to have UI children. Compared to the mothers of UI children, the mothers of ZD children were more likely to report 'not wanting' their last child. These findings highlight the importance of broader issues of gender inequity in terms of women's access to education, employment, and reproductive healthcare (family planning and antenatal care). However, we will do the same analysis whenever new data from CES and Multiple Indicator Cluster Surveys (MICS) are available since information on immunization is not included in BDHS 2022.

Demand- and supply-side factors/challenges behind prevalence of ZD and UI children

The reasons behind ZD and UI include both demand- and supply-side factors which are highlighted below.

The most important demand-side reasons included the following:

- Migration due to environmental damage (river erosion) or cultural reasons (moving from parental to husband's home)
- Inappropriate contra-indications or concerns about minor side-effects
- Pre-occupation with family duties, especially at harvest time
- Some misconceptions and hesitation

The most important supply-side reasons included the following:

- Shortage of health assistants (HA) and overload of work
- Absence of opportunity to provide inter-personal communication (IPC)
- Distance to EPI centers and unavailability of transport
- Inaccurate denominator in Expanded Programme on Immunization (EPI)

CONCLUSIONS AND RECOMMENDATIONS

This rapid assessment was conducted to locate missed communities with ZD and UI children and identify the appropriate programs to address the related issues. Findings confirmed the existence of ZD and UI children, especially in different geographical locations, such as haor (wetlands), hill, coastal area, char area (sandy/silty land surrounded by water), urban slums, and even in plain land. A few effective interventions such as special crash program (i.e. special programs undertaken at different times to improve the coverage of EPI at respective areas) and evening sessions, were cited by the national and sub-national-level stakeholders in immunization to reduce the numbers of ZD and UI children in Bangladesh. Findings of the rapid assessment were shared with monitoring committee of the Bangladesh CLH where all EPI stakeholders were present. The stakeholders appreciated the process

followed for identifying missed communities. The monitoring committee and Bangladesh CLH team have decided to conduct implementation research (IR) study in those areas. The interventions proposed by respondents who participated in rapid assessment will be shared with the stakeholders in a workshop with all EPI stakeholders and finalized for IR. As part of findings dissemination of rapid assessment, the Bangladesh CLH team presented their findings in a meeting held at Kampala during 6-8 June 2023 for launching of the global learning hub (GLH). The Bangladesh CLH team has been working to publish the findings as a working paper and journal articles. The report of rapid assessment will also be posted on website of the Bangladesh CLH. The process followed for the rapid assessment and findings generated from the assessment may be used by other CLHs to identify the missed communities and formulating potential interventions to reach the ZD and UI children. Furthermore, the findings can also be used by other organizations, such as PATH and others who want to work on ZD. However, the study findings and key recommendations mentioned below will help policy-makers and program managers in designing program to reduce the numbers of ZD and UI children in Bangladesh.

- Use of the DHIS2 data is helpful in initial identification of areas with ZD children. Therefore, it is highly recommended to take measures for improving quality of administrative data, including solving denominator issue of target children.
- National surveys (e.g. CES, BDHS) should provide micro-level information, such as from upazila/ zone-level or, at least, from some upazilas with high proportions of ZD.
- LQAS survey can be widely used for identification and verification of missed communities.
- A Geographic Information System (GIS) mapping, including minimum human resource (HR) plan, should be developed for different hard-to-reach (HTR) areas through assessment of geographical context and local communication system to reach pocket population.
- A thorough assessment of current practice for estimation of denominators needs to be conducted. This is recommended in order to develop a standardized process of estimation of denominators for measuring vaccine coverage in urban and rural areas.
- Engaging local government representatives and community elites (members of Union Parishad, school teachers, social and community health workers, community support groups, and volunteers) in the EPI program should be strengthened to motivate caregivers for childhood vaccination.
- Electronic or mobile-based interventions should be invented to find alternative solutions for caregivers who lost their children's vaccination cards.
- To boost EPI coverage in areas with low coverage, frequent arrangement of crash programs (i.e. sensitizing the community by motivating mothers to attend the EPI sessions to vaccinate their children) should be made for different under-served areas to reach the ZD and UI children.
- In some urban areas, the Government of Bangladesh (GoB) has introduced evening EPI sessions for working mothers to vaccinate their children. Such an arrangement has been proven to be useful and, thus, EPI evening sessions/alternative strategies should be regularly organized to reduce numbers of ZD and UI children in urban areas.
- Instead of the paper-based monitoring system, a digital monitoring system (i.e. real-time monitoring system) should be introduced to make the monitoring more effective for increasing EPI coverage, especially for identification and vaccination of the ZD and UI children. One upazila-level health manager suggested that the Health Inspector (HI) should visit EPI outreach center for monitoring purpose and make a video call to the upazila manager, using online platforms, such as Facebook, Messenger, WhatsApp. However, Bangladesh EPI has been piloting e-tracker, e-registration, and GIS mapping in immunization program with support from UNICEF and WHO. We will discuss with EPI on how these can be used effectively in EPI routine program.
- Context-specific transportation cost to reach different segments of population in HTR areas should be estimated by the Ministry of Health and Family Welfare (MoHFW). Accordingly, a policy should be formulated to provide the transportation cost to HAs and their supervisors for regular field work and monitoring visits. Furthermore, to address the problem in regards to reimbursement of transportation cost, a mechanism should be developed for provision of advance payment to the field staff for transportation costs.

1. INTRODUCTION

The Bangladesh EPI was launched in early 1979 and is currently one of the most successful health programs of the country (1). This is depicted by the stellar rise in immunization coverage over the years, from less than 2% in 1985 to 83.9% in 2019. Despite this, the success of EPI has been uneven within the country. CES 2019 found that vaccination coverage is 80%-84% over the past decade (2).

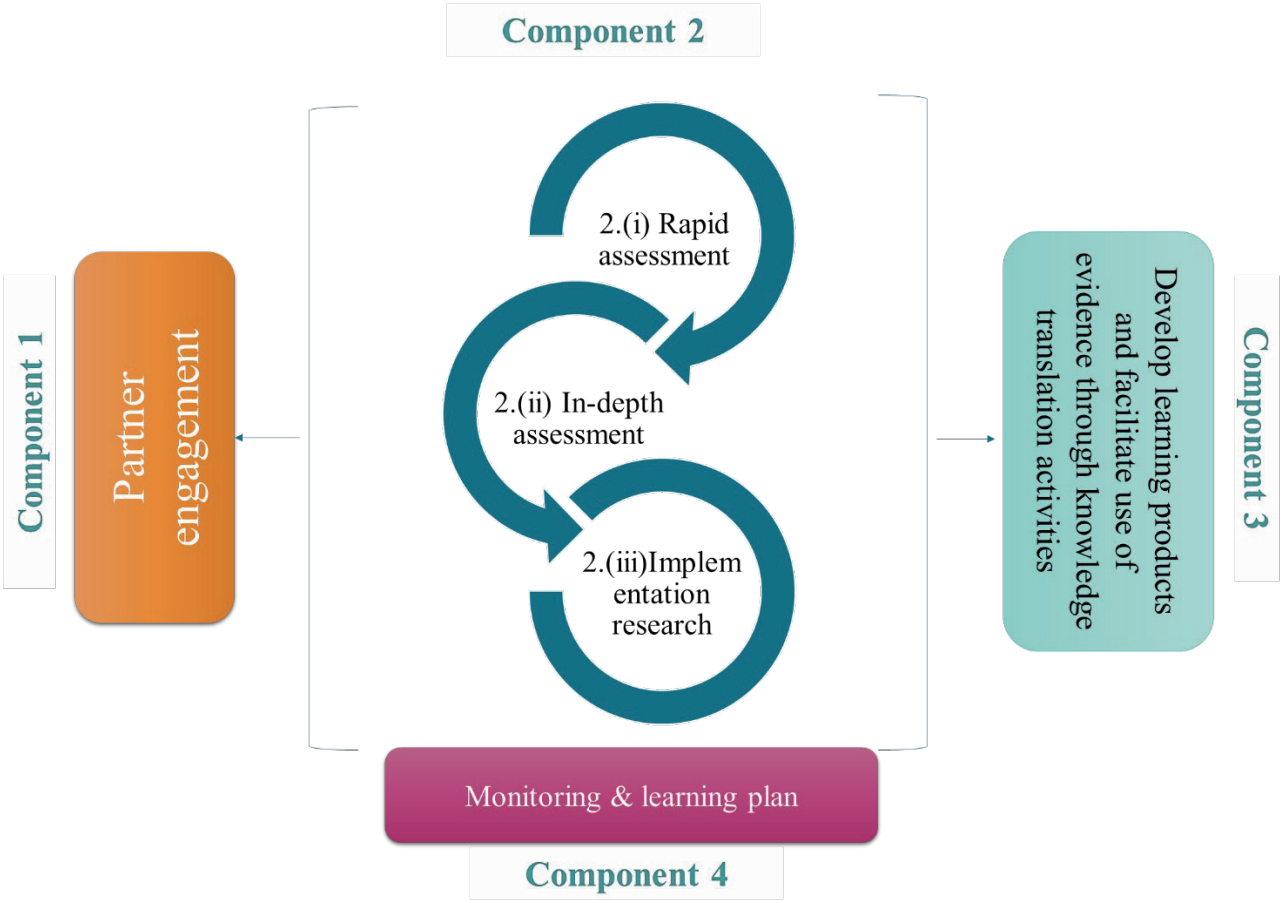
Communities in Bangladesh are dispersed across a varied landscapes/topographies: (a) haor area (wetlands), (b) hilly area, (c) coastal area, (d) char area (sandy/silty land surrounded by water), (e) plain areas, and (f) urban city corporations (CCs). Among these, there are known vulnerable and underserved communities in areas defined as 'hard-to-reach' (HTR), and among migrant populations in urban areas. Understanding the key barriers to the uptake of immunization in these areas is essential to achieve the highest possible vaccination rates. Understanding the key operational challenges is critical to improving program efforts. Bangladesh's immunization program is administered in line with the country's sub-national administration structures that comprise 495 upazilas (sub-districts) in rural areas and 12 CCs in urban areas.

In Bangladesh, the ZD children are defined as those who did not receive the first dose of pentavalent vaccine (PENTA-1). Children who missed the third dose of this pentavalent vaccine (PENTA-3) are considered UI. Identifying and addressing pockets of ZD and UI children within the country are critical to further improving immunization coverage and ensuring protection of the population.

After more than two decades, Gavi, the Vaccine Alliance has increased access to immunization globally and vaccinated half of the world's children. For the current decade, Gavi and the Global Immunization Agenda 2030 have greatly intensified their emphasis on equity with an aim of reaching ZD and UI children and their communities. To reduce inequities in accessing immunization and other essential health services, the focus of Gavi's support is to build and strengthen immunization services that sustainably reach such children and communities. Under Gavi 5.0, the new five-year strategy, the organization aims to improve equity in vaccination coverage and hinges on five key intervention areas: Identify, Reach, Monitor, Measure, and Advocate (IRMMA). The use of this framework ensures a more systematic approach to reaching ZD children and missed communities. To support improving the evidence generation and use of IRMMA-aligned interventions, Gavi is setting up "Gavi zero-dose country learning hubs (CLHs)" in Bangladesh, Mali, Nigeria, and Uganda (3).

The Bangladesh CLH works on four main components (Figure 1): partner engagement activities (Component 1), primary and secondary data collection through a set of linked studies (Component 2), developing learning products and facilitating use of evidence through knowledge translation activities (Component 3), and monitoring and learning (Component 4). One of the sub-components or linked studies of Component 2 is a rapid assessment. Beebe (2005) defines rapid assessment as, "intensive, team-based qualitative inquiry using triangulation, iterative data analysis, and additional data collection to quickly develop a preliminary understanding of a situation from the insider's perspective" (4).

Figure 1. Four components of the Bangladesh CLH



Under the CLH of Bangladesh, the rapid assessment, which is described in this report, was conducted with the following objectives:

2. OBJECTIVES

GENERAL OBJECTIVE

Assess the status and locate the ZD and UI children, including identification of barriers to reaching them so that implementation research (IR) can be developed for reduction of the numbers of ZD and UI children.

SPECIFIC OBJECTIVES

(i) Assess the location of ZD and UI children
(ii) Identify known barriers to and determinants of UI
(iii) Assess geographic and socio-economic disparity in child immunization
(iv) Identify factors relating to effectiveness of and barriers to intervention for child immunization
(v) Identity challenges in monitoring data-use for effective implementation of the intervention
(vi) Generate suggestions for designing the intervention(s) for the planned IR

The other objectives are as follows:

(i) Support Gavi and EPI Bangladesh in strategy development /policy formulation in identifying and reaching ZD and UI children
(ii) Assist other Gavi-supported countries in identifying ZD and UI children and designing IR in their countries

3. METHODOLOGY

DESIGN OF THE RAPID ASSESSMENT

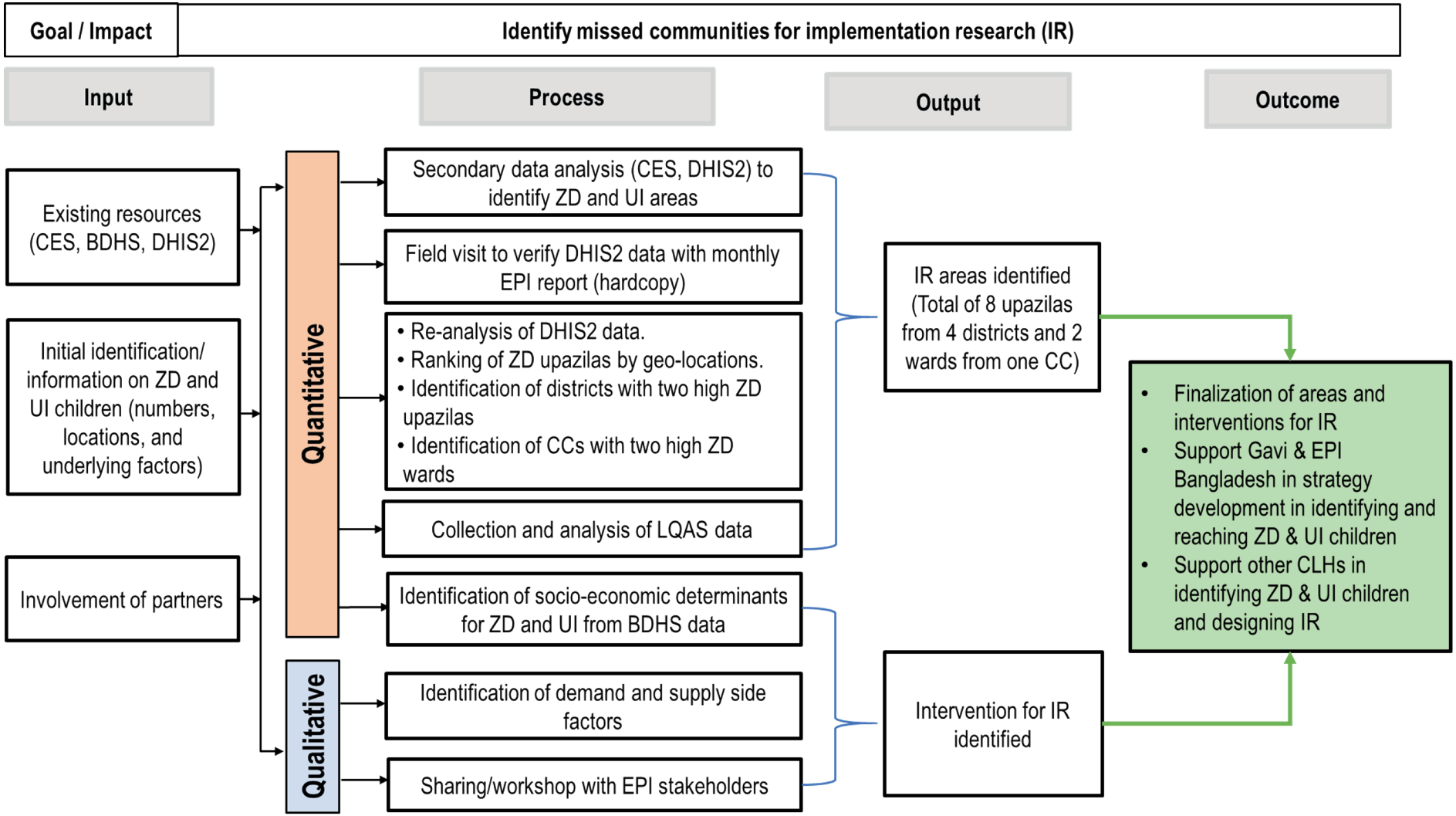
This rapid assessment was conducted between December 2022 and May 2023, using nationally-representative secondary data as well as primary data. We analyzed secondary data from the Bangladesh CES and administrative DHIS2 data to identify missed communities (areas with clusters of ZD and UI children). Primary data collection using LQAS was done to confirm the identified missed communities. In areas identified as missed communities via LQAS, mapping was done through spot-visits by the study team members. In addition to sketch maps, characteristics of the locality, population, and estimated number of children below two years of age living within each missed community were recorded using a standardized record-form. BDHS 2017-2018 data were used for identifying determinants of ZD and UI children. Finally, primary qualitative interviews with key stakeholders, including mothers in missed communities, were conducted to supplement the quantitative findings.

Research Review Committee (RRC) and Ethical Review Committee (ERC) of icddr,b provided approval (5 March 2023) to conduct this research. Informed written consents were obtained from the respondents before starting interviews with each of the respondents.

CONCEPTUAL FRAMEWORK

Considering the objectives of rapid assessment, a theory of change (TOC) has been developed to guide the activities (Figure 2). Our proposed analysis was developed based on current evidence, including the

Figure 2. Conceptual framework for rapid assessment of ZD and UI children



Assumptions: EPI program is functional in study areas; Study areas are accessible to the study team; EPI partners will be on board; the hub's suggestions for changing the design of reach interventions; Government will fund interventions (including EAF); local level EPI staff will participate in data reviews

global analyses developed by Gavi and other partners. This was one reason for our initial rapid analysis of existing data (e.g. CES, administrative DHIS2, BDHS), which was necessarily based on some key assumptions and the limitations of currently-available data. These were mined to their best capacity for immediately actionable insights. Result of initial analysis was verified through several steps, such as presentation among EPI and other stakeholders, field visits and primary data collection using LQAS and KIIs. These activities led to the finalization of missed communities and interventions for IR.

DATA SOURCES

(i) Secondary data

a. CES report (2014, 2015, 2016, and 2019)

The EPI in Bangladesh has been conducting a nationwide CES each year since 1991 as a regular measure of program performance. CES 2019 is the 23rd round of the survey which was conducted by the Center for Social and Market Research (CSMR), Bangladesh, with financial assistance from WHO and technical support from WHO, UNICEF, and EPI of Bangladesh. For CES, information on the uptake of vaccinations was collected from caregivers. The main objective of the CES 2019 was to assess childhood vaccination coverage of different antigens so that policy-makers can have a solid recommendation in planning for the improvement of routine immunization activities. A total of 40,247 children aged 12-23 months from 5,925 clusters were selected for interviews to assess childhood vaccination coverage in CES 2019 (2).

b. DHIS2 EPI data (2019 to 2022)

The Government of Bangladesh (GoB) has created an information dashboard that provides real-time health information on several health indicators as part of achieving the goal of Smart Bangladesh Vision 2041. The dashboard is supervised and maintained by the Directorate General of Health Services (DGHS) and utilizes the DHIS2 software platform to consolidate information from more than 14,000 public health facilities in Bangladesh, which visualizes health data from both facility and community levels. DHIS2 data are the aggregate service delivery data collected by EPI service providers. As part of strengthening the information system, the dashboard also provides information on EPI indicators on a monthly basis at the upazila level. DHIS2 uses a central server to accumulate data from health facilities. Upazila-level data from DHIS2 from 2019 to 2022 were collected for our analysis (5).

A total of 495 upazilas from 64 districts and 46 zones from 12 CCs were analyzed from DHIS2 dashboard data. Notably; we dropped 8 upazilas for the period 2019-2020 due to unavailability of PENTA-1 data.

c. Bangladesh Demographic and Health Survey (BDHS) data 2017-18

The BDHS 2017-2018 is the eighth national survey to report on the demographic and health status of women and children. The 2017-2018 BDHS was conducted under the authority of the National Institute of Population Research and Training (NIPORT) (6). Mitra and Associates implemented the survey, and icddr,b and ICF provided technical assistance. The survey was financially supported by the United States Agency for International Development (USAID). For the analysis of socio-demographic determinants of ZD and UI children, we used the dataset on children from the BDHS 2017-2018. The dataset on children contains information on every child born to the interviewed women five years preceding the survey (0-59 months). The 2017-2018 BDHS includes data on 8,759 children for their immunization, health, and nutrition. It also includes data on the characteristics, pregnancies, antenatal care and postnatal care received by mothers of these children.

(ii) Primary data

a. Lot quality assurance sampling (LQAS)

The LQAS technique is widely used in public health as a monitoring tool to identify low-performing areas. LQAS infers about a lot or cluster based on the probability of having inadequate service to be less or equal to a specified number (7,8). The EPI sampling methodology follows cluster-sampling technique and hence, it cannot provide reliable estimates for small population units or health areas (7). On the other hand, LQAS is basically a stratified random-sampling plan that overcomes this limitation of the EPI methodology by conveying information for smaller health service units. LQAS has the advantage of simplicity, interpretability, and assurance of predetermined level of accuracy and confidence (8).

An unacceptable lot or cluster in LQAS applied in public health is identified as the one that fails to match the specifications in one or more quality characteristics (9). A decision value 'd' is specified as maximum acceptable units that do not meet desired specification using proper statistical technique with high chance of accepting cluster. The choice of the number of households in each cluster and the decision value completely depend on the variable of interest and research question under study (10).

Study Population:
Caregivers of children aged 4.5 months (4 months 15 days) to 23 months were interviewed for LQAS survey. The inclusion criteria of caregivers considered respondents aged above 18 years who were taking care of at least one child aged 4.5-23 months. They were regular residents (i.e. residing at least for 3 months) of the households in our selected study clusters.

Sample-size Determination for LQAS:
According to Bangladesh CES 2019, the valid PENTA-3 vaccination coverage is 93.3% (2). This implies that about 7% of children are either ZD or UI at the national level, with geographic variation. We applied the LQAS method under single sampling plan to select clusters with high (≥ 10%) ZD or UI for this study. We assumed that the prevalence of ZD or UI children follows the binomial probability distribution and limited the type I error to 5%. We set the decision value to d=5. According to Sathakatullah and Murthy (10), to detect the clusters with ZD or UI prevalence P≥0.10 and d=5, the required sample size of households with eligible child in each cluster is 28. Thus, we conducted 28 interviews from each cluster.

Sampling design for LQAS:
As part of the rapid assessment, we used LQAS to confirm the clusters with a high percentage (>10%) of ZD or UI children according to the secondary survey, and DHIS2 data analyses are done under immunized clusters. LQAS is a quantitative approach based on small numbers but the results are and should be only interpreted qualitatively at the lot/cluster level and be used as strong evidence to make conservative inference to protect any errors due to small sample-sizes typically used in LQAS. As the conservative null hypothesis is P (prevalence of ZD and UI) ≤10%, meaning any value ranging between 0 and 10), LQAS was planned to conduct in 24 clusters in 12 upazilas (sub-districts)/zones. The confidence interval and power of the test is calculated from pooled data.

According to sampling design, we set a decision value for cluster to accept or reject it based on ZD or UI status. If any cluster had higher number of ZD or UI children than the decision value, it was identified as a missed community. The details about this are described below.

- Selection of cluster for LQAS

As stated, a total of 10 upazilas and 2 zones of Dhaka North CC were preliminarily selected based on the results of secondary data analysis that showed they had a high proportions of ZD or UI children. The EPI service providers of the selected upazilas and zones were consulted to identify unions (lower-level administrative units) likely to have high numbers of ZD or UI children from the selected upazilas. After that, two EPI clusters with the highest rate of ZD or UI children within the union of the upazila or zone were selected. The selected EPI clusters in the upazilas were classified into six different geographic locations–haor area, hilly area, coastal area, plain land, char area, and urban slum.

- Eligibility criteria of LQAS

The eligibility criteria for selection of households from within selected clusters were as follows:

1. The respondent had been living in a household of the selected cluster with a target child for at least 3 months.
2. The household had a child aged 4 months 15 days to 23 months 29 days at the time of data collection. To avoid complexity in age calculation during data collection, we specified the relevant dates of birth for selection.
3. The respondent were aged above 18 years.
4. If two or more eligible children lived in a household, we selected the older child for the focus of the interview.

Data collection for LQAS:
A total of six field research assistants (FRAs) with experience in survey data collection were recruited. They were trained on the LQAS process. They were instructed to visit the EPI center of the enlisted clusters. The FRAs commenced their data collection from the household situated in the north-east corner of the selected cluster and searched for children who were born between 25 March 2021 and 8 November 2022. The reasons for following purposive sampling method were unavailability of the list of households with children aged 4 months 15 days to 23 months 29 days and selecting north-east corner of the selected EPI outreach center (cluster) to avoid the possible selection bias by data-collectors. The data-collectors collected information from caregivers of the child from the eligible households. They consecutively visited the next door until 28 households were interviewed. Not all the clusters had 28 eligible households. In such cases, the interviewer went to the nearest adjacent EPI cluster to complete the required sample-size.

If any of the listed upazilas was found to have fewer than the threshold number to be confirmed as ZD or UI children through the process, the next upazila having high ZD or UI children of that district was considered for LQAS. Again, if all clusters of a selected district failed to meet the specified number of ZD and UI children, another district of similar geographical location was selected

as rapid assessment site based on expert suggestion of EPI officials. A tab-based structured questionnaire using KoboToolbox was used in data collection. The questionnaire was pretested before data collection. Data were collected on status of vaccination of the targeted children and on reasons for vaccination/not vaccination of the children.

b. Mapping of missed communities

Data-collectors sketched a map of each cluster where they were assigned to collect data. They used blank paper and a pencil to map landmarks (e.g., school, health center). They then entered characteristics of the locality (i.e., population type, literacy rate, household structure, and estimated number of children below two years of age) in a listing format for each missed community. The entered data were determined by observation through a transect walk of the community and based on informal discussion with key community members.

c. Qualitative data

To identify known barriers to and challenges of ZD and UI children, including demand- and supply-side factors and to obtain stakeholders' suggestions to reduce the numbers of ZD and UI children, qualitative data were collected through KIIs and in-depth interviews (IDIs). Based on the initial analysis of quantitative data, we selected six areas, including an urban area, where the prevalence of ZD and UI children was relatively higher than in other areas of the country. These included Hatiya upazila of Noakhali district, Saghata of Gaibandha district, Sadar upazila of Rangamati district, Shibganj upazila of Chapainawabganj district, Jamalganj upazila of Sunamganj district, and Zone 5 of Dhaka North CC.

d. Tools preparation for qualitative data collection

We developed separate KII and IDI guidelines according to the type of participants, their job responsibilities and working expertise on the EPI. The KII guideline included information on the overall status of EPI program, EPI coverage, and the challenges they are facing in implementing the EPI in Bangladesh. We wanted to understand the prevalence of ZD and UI children, the reasons behind the prevalence, identification and likely determinants of ZD and UI, and the monitoring system in place to identify and track them. We also aimed to determine the supply- and demand-side challenges relating to EPI in Bangladesh. We also sought participants' recommendations on how to reduce the numbers of ZD and UI children and, thus, improve the overall EPI coverage in Bangladesh. Likewise, during IDIs with mothers, we tried to explore the knowledge of mothers on EPI, service centers, and service providers. We wanted to assess their understanding of the importance of immunization, inter-personal communication (IPC) before immunization day, advantages of immunization, reasons behind providing or not providing vaccine to their children, and behaviors of vaccinators. IPC is an important assignment for the HAs/vaccinators to motivate and remind caregivers about vaccination of their eligible children prior to vaccination session. All the tools were pretested and finalized through comprehensive training with the data -collection team.

A team of experienced data collectors was involved in data collection. Extensive training was provided to the data collectors and their supervisors before data collection.

e. Sample selection

For KII, we used a purposive selection process to identify the appropriate participants to get adequate information on our research topics. At the national level, the team identified a list of stakeholders currently working on EPI with different roles and responsibilities from both government and non-government sides and with vast experience on EPI. Staff members ranging from district-level managers (civil surgeons) to frontline health workers (HAs) were identified from the selected districts with the help of a consultant who is an EPI expert. After reaching the field sites, we also consulted the district- and upazila-level managers to find the areas with higher percentages of ZD and UI children. Based on information provided by concerned district- and upazila-level managers, the data-collection team went to those places to select participants from upazila levels and below. Participants from urban zone of Dhaka were: assistant health officers, EPI supervisors, clinic managers, and paramedics. The list of participants is given in Table 1.

For selecting the IDI participants, we asked HAs to get the address of a few mothers living in their catchment area. After that, we visited the households of those mothers and selected them purposively. We took written consents of mothers before we interviewed them.

Table 1. Category and number of participants we interviewed

Level and data-collection methods	Participant type	Designation	Number of interviews
National/ Cen-tral (KII)	Policy-makers/ EPI Spe-cialists/ Stakeholders	Deputy Program Manager, EPI, DGHS.	1
		Former National Coordinator, Gavi-HSS Program	1
		Former Program Manager, EPI, DGHS	1
		UNICEF Representative	1
		WHO Representative	1
		PATH Representative	1
Sub-total			**6**
Urban (City Corporation) (KII)	Service provider and manager from non-governmental and govt. offices	Assistant Health Officer, Dhaka North City Corporation	1
		EPI Supervisor, Dhaka North City Corpora-tion	1
		Clinic Manager, Surjer Hashi Network (SHN)	1
		Paramedics/Vaccinator, SHN	1
Sub-total			**4**
Sub-national (KII)	District, sub-district and union-level govt. officials and service providers	Civil Surgeon/ Deputy Civil Surgeon	4
		District EPI Superintendent	2
		Upazila Health and Family Planning Officer	4
		Upazila Family Planning Officer/ Assistant Upazila Family Planning Officer	4
		Resident Medical Officer	1
		Health Inspector/Assistant Health Inspector	5
		Health Assistant	5
		Medical Technologist (MT)-EPI	3
Sub-total			**28**
Community (IDI)	Mother having a living child below 2 years	Mother	10
Grand Total			**48**

DATA ANALYSIS

Different approaches were used for analysis of secondary, LQAS, qualitative data, and determinants. Details about these are as follows:

(i) Analytical approach for identification of missed communities

The process of identification of ZD, UI, and missed communities included several steps as follows:

Initial identification of missed communities

First, we used information on PENTA-1 coverage from the CES report (2014, 2015, 2016, and 2019) to identify the districts and CCs with the highest percentage of ZD children in each wave of the survey (Annexure 1). We sorted the districts according to their ZD percentage in descending order for each year and ranked the highest 10 districts and 5 CCs.

Next, we used EPI data through DHIS2 from 2019 to 2022 [January-November] to list upazilas by the highest percentage of ZD each year. From the list, the top 10 upazilas were selected. We excluded the upazilas with ZD of >20% because we thought it was likely a data error rather than a true measure.

Verification of initial findings and updating data

After selection of top 10 upazilas, we sent a study team to those upazilas and collected monthly reports OF EPI from upazila offices, along with EPI micro-plan to check if monthly report data are matched with DHIS2 data that we used in analysis.

Afterward, we updated the list of upazilas from the EPI database in DHIS2 for 2022 (Annexure 2) and sorted them according to the ZD percentage from the highest to lowest order. For the city corporation, we collected zone-level data from statisticians of EPI HQ for the year 2022 [January-November]. These data are not available on the DHIS2 website. We used these data to identify high ZD zones from urban areas following the same process as in upazilas.

LQAS data analysis

Tab-based data were converted to STATA (version 17.0) and cleaned. These data were then analyzed using frequency distribution of ZD and UI status. A child was considered to be ZD if s/he had missed the 1st dose of pentavalent vaccine and as UI if s/he had received the first dose but missed the 3rd dose of pentavalent vaccine (11). We considered LQAS combining ZD and UI. As discussed in the sample-size section, the decision value was 5 to accept or reject a cluster. Thus, if we found 5 or more households (out of 28 sample households) with ZD or UI children in a cluster, the cluster was considered a missed community and included as a study site. If we found fewer than 5 households with ZD or UI children, we excluded that cluster from the analysis (10).

(ii) Analytical approach for mapping of missed communities

For mapping of missed communities, data were entered and analyzed using SPSS (version 20). Frequency distributions were used to show the general characteristics of the selected cluster.

(iii) Analytical approach for determinant analysis for ZD and UI children

We considered two dichotomous outcome variables: ZD and UI as defined thus: among children aged 10 weeks or more, those who missed PENTA-1 were recoded as ZD; children aged 18 weeks or more, who missed PENTA-3 were recoded as UI. We fit a binary logistic regression model to identify the potential socio-economic determinants of being a ZD and UI child. Our primary explanatory variables were: sex of child, birth order, number of antenatal visits by mother, division, type of residence, mothers' education, father's education, household wealth quintile, whether wanted the last child, mothers' occupation, access to mass media, visit by FP worker, postnatal check-up within 2 months, women empowerment, religion, and ethnicity. To assess validity of the model, Akaike Information Criterion (AIC) and collinearity were checked after checking the association between dependent and independent variables. Our finally-fitted models included: sex of child, number of antenatal visits by mother, division, type of residence, mothers' education, household wealth quintile, whether wanted the last child, mothers' occupation, and access to mass media.

(iv) Analytical approach for qualitative data

To analyze the qualitative data, we applied the 'Framework Approach' (12-14). In doing so, we identified the emerging themes and sub-themes and highlighted common ideas and recurrent themes. After that, the qualitative data were systematically coded, synthesized, and interpreted to provide explanations of the findings. We analyzed data in different steps. We prepared an outline of the purpose and plan of data analysis at the initial stage of data collection. At this stage, we listened to the tape-recorded interviews conducted to identify pre-determined themes, emergent themes, strengths and weaknesses of the interview techniques, and any missed opportunities for further exploration. This step was essential to improve the quality of future interviews and start the initial data analysis. After that, we transcribed the interviews (recorded in the native language Bangla) in their original form as soon as these were available; the process was termed 'verbatim transcription'. In verbatim transcription, we transcribed everything that was said and the way it was said without editing or changing the conversation. Field notes and interviewers' observations were also incorporated into the transcriptions. Finally, data were systematically indexed or coded, synthesized, and interpreted with a view to providing explanations of the findings under the context of the objectives.

4. RESULTS

i. WHERE ARE THE ZD AND UI CHILDREN?

Initial identification of ZD and UI children and missed communities

Tables 2 and 3 show the upazilas and CCs with the highest ZD and UI children as determined using the methods described in a preceding section. Jamalganj upazila of Sunamganj district had the highest prevalence of ZD (11.4%) and UI (15.9%). Although Shailakupa upazila of Jhenaidah district had the second highest prevalence of UI (14.4%), it had lower prevalence of ZD (8.3%). We also observed that these identified upazilas under districts were distributed in different parts of the country, such as Sunamganj (north-east), Bandarban (south-east), Jhenaidah (south-west) and Joypurhat (north-west).

Dhaka South City Corporation (DSCC) (ZD 11.9% at zone-1 and UI 19.2% at Zone-1) and North City Corporation (DNCC) (ZD 8.1% and UI 22.2% at Zone-6 and Zone-8 respectively) were identified as top two high-ZD and UI areas in the urban zones (Table 3). Map of the initial findings is shown in Figure 3.

Table 2. Top high-ZD and UI upazilas

Sl.	District	Upazila	ZD (%)	Sl.	District	Upazila	UI (%)
1	Sunamganj	Jamalganj	11.4	1	Sunamganj	Jamalganj	15.9
2	Jhenaidah	Sadar	11.1	2	Jhenaidah	Shailakupa	14.4
3	Chapainawabganj	Sadar	11.0	3	Naogaon	Patnitala	14.4
4	Jhenaidah	Kaliganj	10.0	4	Joypurhat	Panchbibi	14.2
5	Mymensingh	Gaffargaon	9.1	5	Mymensingh	Gaffargaon	12.0
6	Joypurhat	Panchbibi	8.7	6	Cumilla	Debidwar	11.8
7	Bandarban	Ruma	8.5	7	Naogaon	Atrai	11.2
8	Joypurhat	Akkelpur	8.4	8	Chapainawabganj	Nachol	11.2
9	Cumilla	Debidwar	8.4	9	Jhenaidah	Sadar	11.0
10	Jhenaidah	Shailakupa	8.3	10	Bandarban	Ruma	10.5
11	Magura	Mohammad-pur	7.6	11	Sunamganj	Dharmapa-sha	10.2
12	Magura	Sreepur	7.4	12	Sunamganj	Dowarabazar	10.1
13	Bagerhat	Sadar	7.2	13	Joypurhat	Sadar	10.1
14	Lakshmipur	Ramgati	7.0	14	Lakshmipur	Ramgati	9.8
15	Sunamganj	Dharmapasha	6.9	15	Patuakhali	Kalapara	9.7
16	Jhenaidah	Moheshpur	6.3	16	Joypurhat	Akkelpur	9.5
17	Magura	Sadar	6.2	17	Naogaon	Raninagar	9.5
18	Sunamganj	Dowarabazar	6.1	18	Sylhet	Gowainghat	9.2
19	Jhenaidah	Kotchandpur	6.1	19	Sunamganj	Sulla	9.2
20	Sunamganj	Sulla	6.0	20	Gazipur	Kaliganj	9.0
21	Noakhali	Hatiya	5.9	21	Jhenaidah	Harinakunda	8.7
22	Jhalakathi	Nalchity	5.8	22	Bogura	Sariakandi	7.9
23	Joypurhat	Sadar	5.8	23	Coxbazar	Ramu	7.8
24	Coxsbazar	Teknaf	5.7	24	Coxbazar	Teknaf	7.7
25	Jhenaidah	Harinakunda	5.4	25	Shariatpur	Zajira	7.5

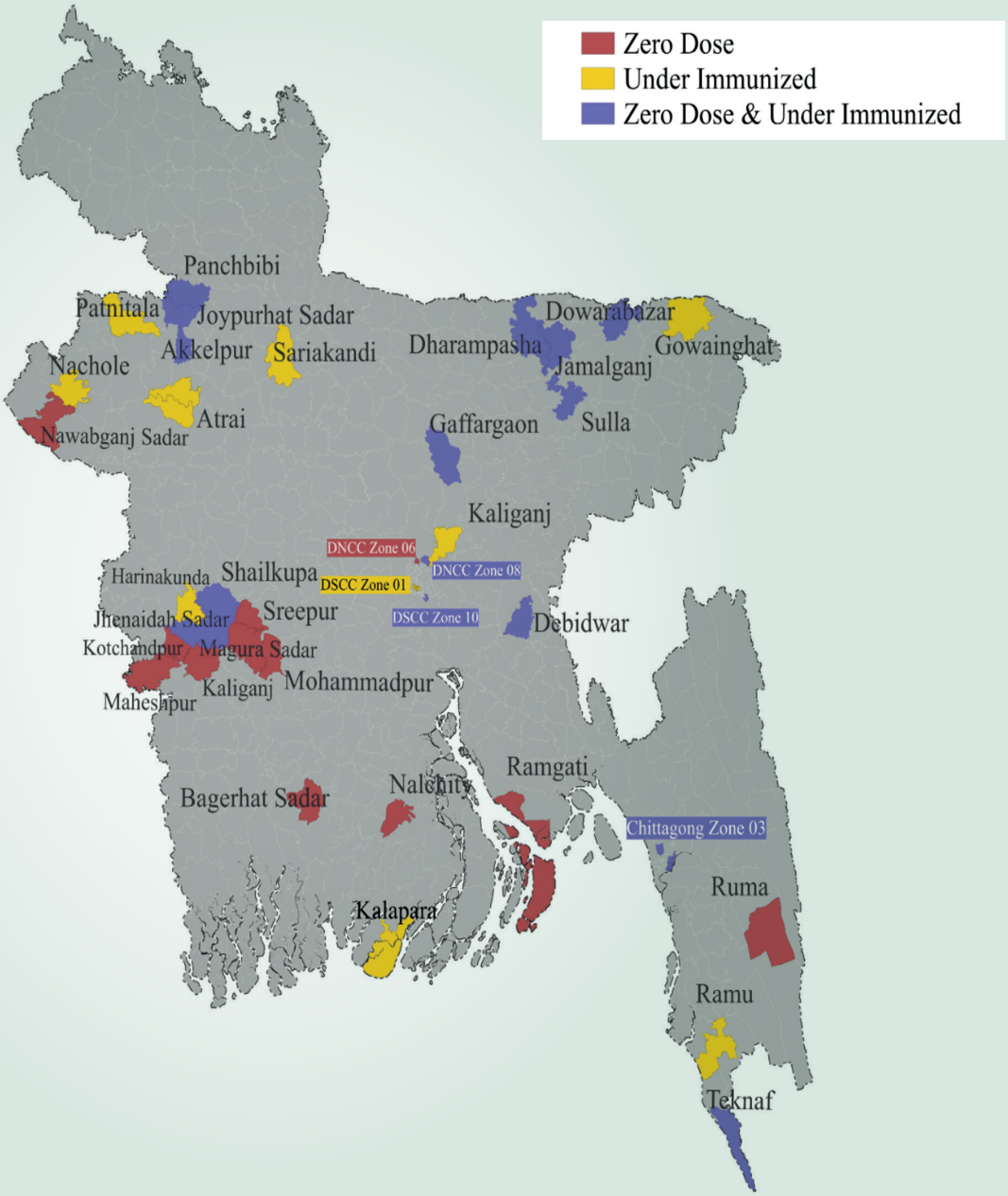
Data source: EPI data 2022 (January-November) from DHIS2

Table 3. Top high-ZD and UI zones of CC

Sl.	District	Zone of CC	ZD (%)	Sl.	District	Zone of CC	UI (%)
1	Dhaka	Zone-1 (DSCC)	11.9	1	Dhaka	Zone-8 (DNCC)	22.2
2	Dhaka	Zone-6 (DNCC)	8.1	2	Dhaka	Zone-1 (DSCC)	19.2
3	Khulna	Zone-1	5.7	3	Dhaka	Zone-10 (DSCC)	8.7
4	Dhaka	Zone-10 (DSCC)	4.6	4	Chattogram	Zone-3	7.9
5	Chattogram	Zone-3	2.8	5	Khulna	Zone-1	7.7
6	Barishal	Zone-1	2.7	6	Sylhet	Zone-1	6.0
7	Sylhet	Zone-1	2.0	7	Barishal	Zone-1	4.0
8	Dhaka	Zone-3 (DNCC)	1.7	8	Khulna	Zone-4	4.0

Data source: EPI data 2022 (January-November) from DHIS2

Figure 3. Map of top high-ZD and UI upazilas and CCs of Bangladesh



A study team went to two upazilas (either high-ZD/UI or adjacent upazila of a high-ZD/UI) area of Bandarban, Meherpur, Sunamganj, Jhenaidah and Joypurhat districts as shown in Table 4. The team noticed that there was low coverage of vaccination for several months in those upazilas. No significant difference was observed in coverages of PENTA-1 & PENTA-3 between DHIS2 and monthly hard copy of EPI report. Hence, the data of DHIS2 were updated for the period of January 2022 to December 2022 and re-analyzed considering the findings of the field visit.

Table 5 shows the updated results of top high-ZD upazilas based on DHIS2 (2022) data. After finding the top high-ZD upazilas, we sorted ZD upazilas from top to low by selected geo-locations and districts. Map of areas identified after updating the DHIS 2 data is shown in Figure 4.

Table 4. Status of ZD and UI according to data collected through DHIS 2 and field visits (hard copy)

District	Upazila	PENTA-1 data (# of children receiving vaccine)		PENTA-3 data (# of children received vaccine)		Observations	Decision after field visit
		DHIS2 (2022)	Hard copy (2022)	DHIS2 (2022)	Hard copy (2022)		
Joypurhat	Panchbibi	4250	4250	3922	3922	No major difference was observed, except a few	Decided to update DHIS2 data for the period of January to December 2022, and LQAS will be conducted in top-ranking ZD and UI upazilas
	Akkelpur	2510	2556	2503	2574		
Jhenaidah	Shailakupa	8013	8013	7058	7058		
	Kaliganj	5162	5162	5133	5115		
Bandarban	Ruma	828	795	806	740	No difference between DHIS2 and hard copy of monthly EPI report	
	Lama	4185	4185	4194	4194		
Meherpur	Mujibnagar	2098	2098	2125	2124		
	Gangni	6730	6730	6605	6605		
Sunam-ganj	Jamalganj	5717	5811	5480	5485		
	Dowarabazar	7197	7197	6959	6949		

Table 5. Top high-ZD upazilas identified after updating DHIS2 data

Sl.	Division	District	Upazila	ZD (%)
1.	Mymensingh	Mymensingh	Gaffargaon upazila	15.7
2	Sylhet	Sunamganj	Jamalganj upazila	11.1
3	Barishal	Jhalakathi	Kathalia upazila	10.8
4	Khulna	Meherpur	Mujibnagar upazila	10.2
5	Rajshahi	Chapainawabganj	Shibganj upazila	9.9
6	Chattogram	Bandarban	Ruma upazila	9.2
7	Rangpur	Gaibandha	Saghata upazila	8.5
8	Khulna	Bagerhat	Sadar upazila	8.2
9	Dhaka	Manikganj	Gior upazila	7.5
10	Rajshahi	Chapainawabganj	Sadar upazila	7.4
11	Chattogram	Cumilla	Debidwar upazila	7.4
12	Rajshahi	Joypurhat	Akkelpur upazila	6.6
13	Rajshahi	Joypurhat	Sadar upazila	6.4
14	Chattogram	Chattogram	Chandanaish upazila	6.3
15	Sylhet	Sunamganj	Dowarabazar upazila	6.0
16	Sylhet	Sunamganj	Dharampasa upazila	5.6
17	Rangpur	Gaibandha	Palashbari upazila	5.5
18	Chattogram	Noakhali	Hatiya upazila	5.4
19	Chattogram	Lakshmipur	Ramgoti upazila	5.2

Sl.	Division	District	Upazila	ZD (%)
20	Sylhet	Sunamganj	Sulla upazila	5.1
21	Khulna	Jhenaidah	Sadar upazila	5.0
22	Mymensingh	Netrakona	Khaliajuri upazila	4.5
23	Chattogram	Noakhali	Sonaimuri upazila	4.5
24	Khulna	Jhenaidah	Kaliganj upazila	4.4
25	Mymensingh	Mymensingh	Sadar upazila	4.3
26	Rajshahi	Sirajganj	Sadar upazila	4.3
27	Sylhet	Maulavibazar	Rajnagar upazila	4.2
28	Barishal	Patuakhali	Dashmina upazila	4.2
29	Chattogram	Rangamati	Sadar upazila	4.1
30	Sylhet	Sylhet	Sadar upazila	4.1
31	Dhaka	Rajbari	Sadar upazila	4.0

Data source: DHIS2 (2022)

Figure 4. Top high-ZD upazilas from updated data of DHIS2 (2022)

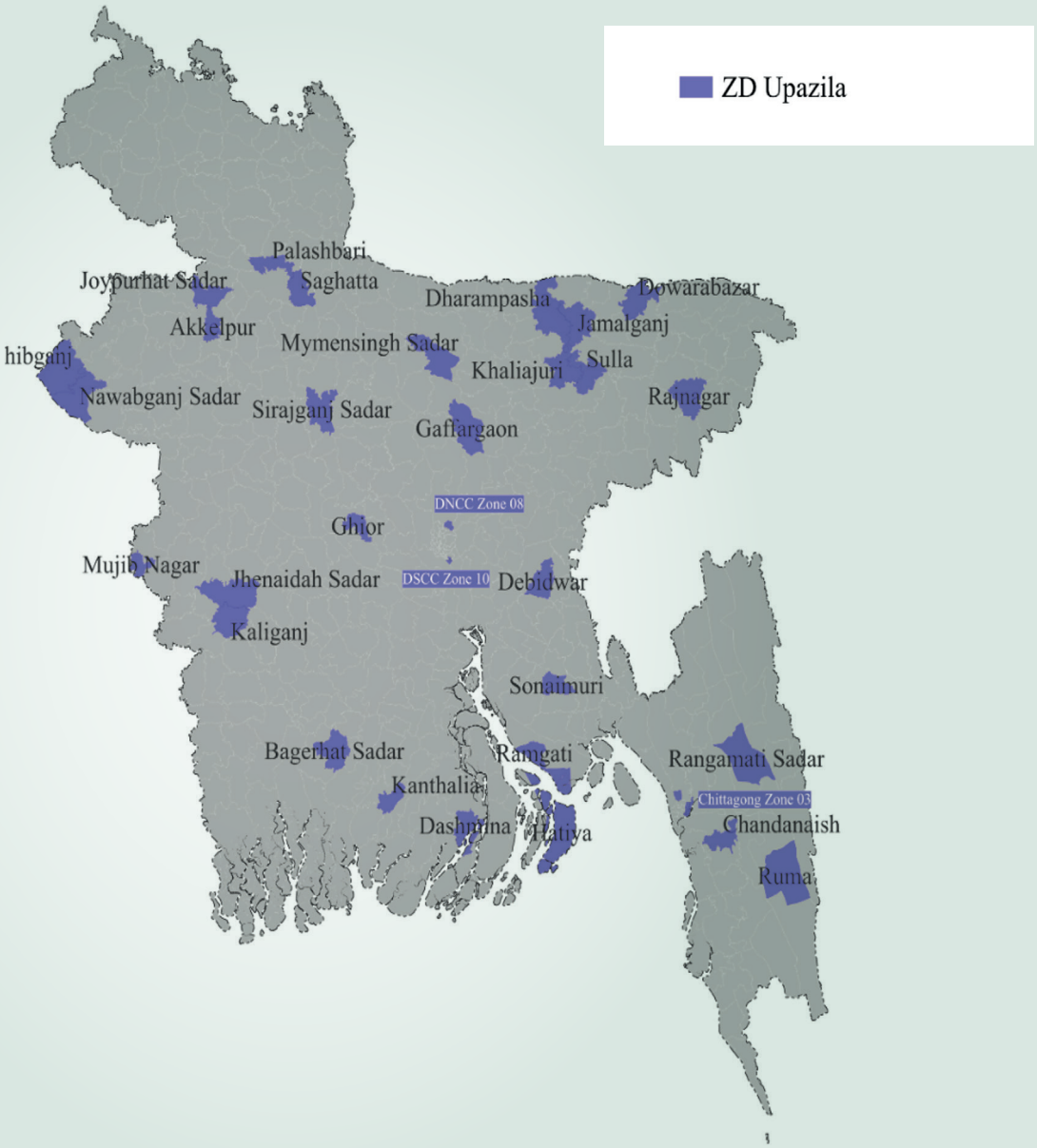


Table 6. Potential areas for implementation research

Geographic location	District	Upazila/Zone	Number of 0-11 months old children targeted per year[1]	ZD2 (%)	Projected number of ZD children	UI[2] (%)	Projected number of UI children
Haor	Sunamganj	1. Jamalganj	6432	11.1	714	14.8	952
		2. Dowarabazar	7656	6.0	460	9.1	697
Hilly	Rangamati	1. Sadar	720	4.1	30	4.6	34
		2. Naniarchar	1056	2.2	24	3.5	37
Char	Gaibandha	1. Saghata	7980	8.5	679	8	639
		2. Palashbari	6660	5.5	367	9.9	660
Coastal	Noakhali	1. Hatiya	15888	5.4	858	3.9	620
		2. Sonaimuri	11400	4.5	513	0.3	35
Plain land	Chapainawabganj	1. Shibganj	16308	9.9	1615	27.8	4534
		2. Sadar	10776	7.4	798	5.1	550
Urban (CC)	Dhaka	1. Zone-1 of DSCC	8208	11.9	977	19.2	1576
		2. Zone-6 of DNCC	2340	8.1	190	0.9	22

[1]Collected from EPI monthly report
[2]According to DHIS2 (2022)

From the above lists, we identified potential areas to conduct LQAS for final selection of IR study areas. The primary consideration in prioritization of these sites included high numbers of ZD and UI children. However, we also considered some other factors in identifying the areas for conducting LQAS. For example, the districts which have at least two upazilas with ZD children were considered for conducting LQAS. The reason behind this was to select the intervention and comparison upazilas from the same districts. However, Table 6 shows the districts and upazilas identified considering the above criteria, including overall number and % of ZD and UI children for final selection of areas for IR.

Results from LQAS

The clusters identified through the above exercise where LQAS was conducted for confirming the missed communities are shown in Annexure 3. We made some subsequent changes in order to get balanced topographies, in line with our predetermined purposive sampling frame. We noted that there are no 'char' areas in Palasbari upazila of Gaibandha district; hence, we have replaced this upazila by Phulchari upazila of the same district. Similarly, Sonaimuri upazila of Noakhali district was replaced by Subarnachar upazila to ensure there was a coastal topography studied in this district.

The summary of data-collection status, with final selected upazilas, are shown in Table 7. After confirmation of study areas, these were allocated to intervention and control sites randomly. Selected upazilas of Sunamganj (haor area), Gaibandha (char area) and Noakhali (coastal area) were confirmed as intervention and control sites based on LQAS findings. Chapainawabganj (plain land) had to be dropped due to low ZD and UI status and replaced by Sherpur district which had a low immunization coverage as per CES 2019. Findings of LQAS confirmed the selection of Sherpur as a plain area for our IR. Additionally, hilly areas were excluded from LQAS due to restriction on mobility from local government authority. However, the results of LQAS are presented in Table 7. Mapping of the primarily-selected areas for IR was also done (Figure 5).

For certain CCs in urban areas with known high concentrations of high-income households, we made pragmatic decisions on their exclusion from the LQAS process. However, we considered Ward no. 26 and 30 of Zone-5 in DNCC as alternatives based on discussions with city corporation and NGO officials involved in the immunization program. The list of slums under Ward no. 26 and 30 is provided in the box below. The results of LQAS conducted in the wards are presented in Table 7.

Box. List of slums under Ward no. 26 and 30 in Dhaka North CC where LQAS was conducted

WARD NO. 26

Name of slum

- Kawran Bazar Railway slum
- Tejkunipara Railway slum
- Paschim NakhaIpara Railway slum
- Uttar Nakhalpara Rail Line slum

WARD NO. 30

Name of slum

- Housing Basti
- BaIur Math Basti
- Sunibir Housing Basti

The results of LQAS are presented in Table 7 below. The intervention and comparison areas from each district are determined through random selection process. The table shows that a total of 18 clusters from 8 upazilas and 1 zone from CC have been accepted for LQAS. Out of 504 successful interviews, 39 ZD (7.7%) and 121 UI (24.0%) children were identified in the accepted clusters.

Table 7. Areas of ZD and UI children aged 4.5 to 23 months by EPI outreach cluster, upazila, and district

District	Upazila	EPI Cluster	Total	ZD	UI	Decision Value≥5	Primary selection
Sunamganj	Jamalganj	Cluster-1 (Alipur)	28	0	5	Accept	Comparison
		Cluster-2 (Harinkandi)	28	1	5	Accept	
	Dowarabazar	Cluster-1 (Vobanipur)	28	4	19	Accept	Intervention
		Cluster-2 (Purapara)	28	6	3	Accept	
Chapainawabganj	Shibganj	Cluster-1 (Shibnarayanpur)	28	0	2	Reject	Dropped
		Cluster-2 (Pakan School)	28	0	1	Reject	
	Sadar	Cluster-1 (Nimgachi Kazipara)	5	0	0	Undecisive	Dropped
Gaibandha	Saghata	Cluster-1 (Dighulkandi)	28	2	10	Accept	Intervention
		Cluster-2 (South Dighulkandi)	28	1	5	Accept	
	Phulchari	Cluster-1 (Khatimari)	28	2	8	Accept	Comparison
		Cluster-2 (Kutub Member)	28	0	5	Accept	
Noakhali	Hatiya	Cluster-1 (Saddam House)	28	3	6	Accept	Intervention
		Cluster-2 (Mirpoka)	28	2	4	Accept	
	Subarnachar	Cluster-1 (Soudagor Bari)	28	5	1	Accept	Comparison
		Cluster-2 (Chorlokkhi)	28	3	3	Accept	
Rangamati	Sadar	Cluster-1 (Duluchhari)	8	0	0	Undecisive	Restriction on mobility from local government authority
		Cluster-2 (Modhyo Manikchhari)	8	0	0	Undecisive	
		Cluster-3 (Islampur)	28	0	4	Reject	
		Cluster-4 (Jaillapara)	16	0	1	Undecisive	
		Cluster-5 (Katachhari)	16	0	0	Undecisive	
		Cluster-6 (Shariatpur)	2	0	1	Undecisive	
	Naniarchar	Cluster-1 (Egarlachra)	4	0	0	Undecisive	

District	Upazila	EPI Cluster	Total	ZD	UI	Decision Value≥5	Primary selection
Sherpur	Nalitabari	Cluster-1 (Paikka Tala)	28	0	5	Accept	Intervention
		Cluster-2 (World Vision Center)	28	0	7	Accept	
	Sreebardi	Cluster-1 (Chukchuki)	28	0	5	Accept	Comparison
		Cluster-2 (Khatiadanga)	28	0	7	Accept	
Dhaka	DNCC	Cluster-1 (Zone-5, Ward-26)	28	5	12	Accept	Intervention
		Cluster-2 (Zone-5, Ward-30)	28	5	11	Accept	Comparison

Figure 5. Selected areas for IR

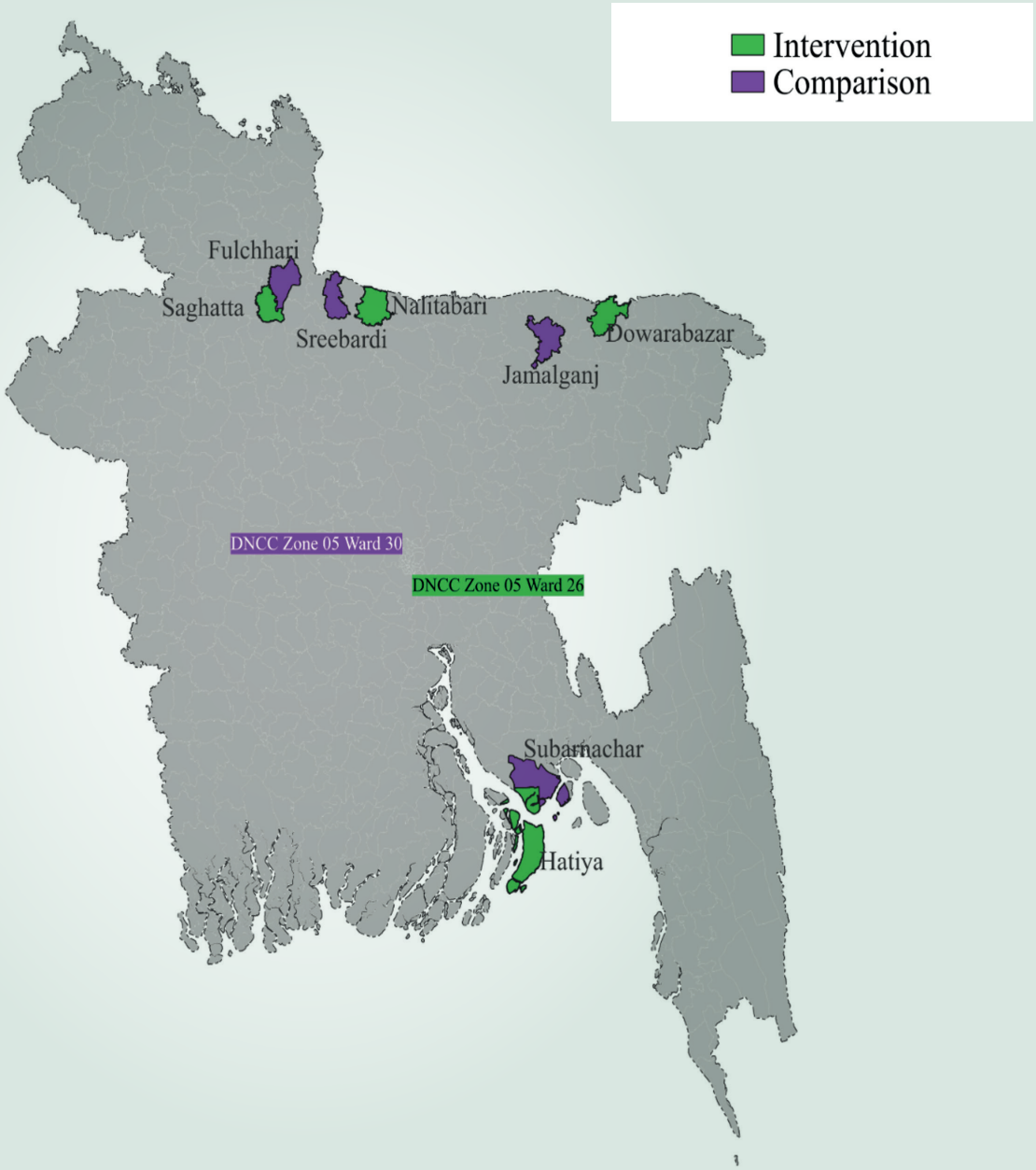


Table 8. Status of EPI card shown among those who have received at least one dose of PENTA vaccine by cluster

District	Upazila	EPI Cluster	Number	Percentage
Sunamganj	Jamalganj	Cluster-1 (Alipur)	28	100.0
		Cluster-2 (Harinkandi)	27	81.5
	Dowarabazar	Cluster-1 (Vobanipur)	24	83.3
		Cluster-2 (Purapara)	22	90.9
Gaibandha	Saghata	Cluster-1 (Dighulkandi)	26	76.9
		Cluster-2 (South Dighulkan-di)	27	85.2
	Fulchhari	Cluster-1 (Khatimari)	26	84.6
		Cluster-2 (Kutub Member)	28	92.9
Noakhali	Hatiya	Cluster-1 (Saddam House)	25	76.0
		Cluster-2 (Mirpoka)	26	92.3
	Subarnachar	Cluster-1 (Soudagor Bari)	23	91.3
		Cluster-2 (Chorlokkhi)	25	88.0
Sherpur	Nalitabari	Cluster-1 (Paikka Tala)	28	96.4
		Cluster-2 (World Vision Center)	28	100.0
	Sreebardi	Cluster-1 (Chukchuki)	28	85.7
		Cluster-2 (Khatiadanga)	28	78.6
Dhaka	DNCC	Cluster-1 (Zone-5, Ward-26)	23	100.0
		Cluster-2 (Zone-5, Ward-30)	23	91.3
Total			465	88.6

The findings from LQAS show the reasons for not being vaccinated by PENTA-1 and PENTA-3 by districts (Annexure 4). The primary reason why children missed PENTA-1 and PENTA-3 vaccines was illness at the time of vaccines were due.

The findings also showed that children missed vaccines because women were not permitted at Sunamganj and Noakhali. For example, Sunamganj is an area where surface communication is very rough and travel alone by women is not always safe. Therefore, women need to be accompanied by male individual (usually the husband).

However, about 30% of caregivers could not vaccinate their children with PENTA-1 due to financial problems whereas about 15% did not receive the 3rd dose of PENTA vaccine due to their busy schedule.

Retaining vaccination card is important for determining valid and invalid doses. Table 8 focuses on the availability of vaccination card among those who have received at least one dose PENTA vaccine by cluster. It is apparent that about 89% have shown their child's vaccination card during the interview.

Our mapping of the characteristics of five districts selected for IR found a range of features that could potentially be important to understand the underlying determinants of ZD or UI. Among the selected districts, we found the highest number of total populations, total households, and the number of children aged below 2 years at Gaibandha where the selected clusters were located at char areas (Annexure 5).

Annexure 6 depicts the status of institutions, facilities, and transport system at selected clusters of the LQAS survey. Most clusters of all the districts had primary schools but fewer had secondary and/or missionary educational institutions. Notably, the clusters of Noakhali that are in coastal area did not have any educational institutions within the encompassing region. In regard to healthcare facilities, none of the clusters had an NGO clinic. Furthermore, only one cluster from an upazila of Gaibandha district (char area) and one cluster from an upazila of Noakhali district had public/government health centers. Private clinics were only found at the urban clusters. In regard to the transport system, bus was used only at the urban areas for transport, and vans were used only at the haor clusters of Sunamganj. Boat was a prominent medium of transport used by individuals of the haor and char clusters whereas rickshaw, compressed natural gas (CNG)-run vehicles, motorcycles, and auto-bikes were used more in the coastal, plain and urban clusters.

Annexure 7 shows the household structure and occupation of residents according to rank in the selected cluster of LQAS survey. Most households in almost all the clusters were mud-built (i.e. kancha), with the exception of urban clusters. The urban clusters had households that were mostly shacks and mud-built, followed by half-cemented houses. In regard to occupation, most were involved in agriculture, followed by services, with the exception of residents at the urban clusters where most were day-laborers. A sample drawing of a cluster map is shown in Annexure 8.

ii. WHY ARE CHILDREN ZD OR UI: POTENTIAL REASONS

Socio-economic associations of ZD in the Bangladesh Demographic and Health Survey

The socio-economic determinants for being ZD children are shown in Annexure 9 based on the Bangladesh Demographic Health Survey 2017-2018.

Important associations exist among issues of gender equity and women's education or economic activity and women's access to reproductive healthcare. Our multivariate analysis shows that mothers' education, occupation, number of antenatal visits, and desire for the last birth were significantly associated with having a ZD child. However, sex of child and access to media were found to be significantly associated with ZD.

Mothers who had educational attainment more than primary level were significantly less likely to have ZD children. Mothers having more antenatal visits were found to be less likely to have ZD children than mothers who made no antenatal visits. Mothers who were not in formal employment were more likely to have ZD children than working mothers.

Most of these maternal characteristics were also important determinants of having UI children. However, one factor seemed more associated with ZD compared to UI. This relates to access to family planning services: mothers who reported that "their last child was wanted" were less likely to have a ZD child.

Geography also played a part. Families living in Sylhet are more likely to have ZD children than those residing in Rangpur.

The other factors we assessed, such as type of residence and wealth quintile, were not found to be significantly associated with having ZD children.

Socio-economic associations of UI children

Multivariate logistic regression analysis of the associations with UI shows that mothers' education, occupation, access to media, and number of antenatal visits were significantly associated with having UI children. Mothers who have educational attainment of primary or higher level were less likely to have UI children than those mothers who had no education. Mothers having more antenatal visits were less likely to have UI children than those mothers who had no antenatal visits. Unemployed mothers were more likely to have UI children than those mothers who were working. UI children were more likely to be born to mothers with no access to media compared to those had access to media. Children living in Sylhet and Khulna were more likely to be UI than those residing in Rangpur. None of the other factors, like sex of child, type of residence, wanting the last child, and wealth quintile was found to be significantly associated with the prevalence of UI children (Annexure 10).

This section presents the results of our thematic analysis of qualitative findings drawn from KIIs and IDIs. The findings are presented below under themes and sub-themes:

(a) Perceptions of service providers on ZD and UI status in Bangladesh

- Perceived size of ZD and UI problems: Most of the national, sub-national and community-level service providers and their supervisors at rural and urban slum areas opined that they had few ZD and UI children in their areas. However, they were unable to provide precise estimates. Some claimed that there were no ZD and UI children in their areas. A few estimated and suggested that the percentage of ZD and UI children might be one to two in their respective working areas. A participant said:

> *"The overall status of EPI is good. Despite 40% posts of HAs being vacant, the success rate is higher in the real field but there is a target/denominator problem. Practically, the unvaccinated children cannot be found. Even if you find the unvaccinated children, they cannot be more than 1 to 2 percent"* (KII_13).

Since currently there is no reliable statistics about the status of ZD or UI, our plan is to share the data that are generated from rapid assessment and will be generated from household surveys and review of secondary data in our developed website. We have also planned to organize a workshop with all EPI stakeholders from national to the selected sub-national level for sharing the results of rapid assessment. Furthermore, we plan to form technical committees with managers of sub-national level and community leaders where implementation research will be implemented. We will share data related to ZD and UI time to time with the committees so that they can know the status and take necessary steps for reducing the numbers of ZD and UI children in their areas.

In urban areas, all the interviewed participants reported a higher prevalence of ZD and UI children. Based on several estimates, it was suggested that the percentage of ZD and UI children may range from 5 to 10%. One of the participants said:

> *"According to the last year's calculations, the number of zero-dose children in urban areas will be ten percent"* (KII_32).

- Processes of identifying ZD and UI children and related challenges: Most managers at the district and sub-district levels as well as service providers informed that they do come across and identify the ZD and UI children. However, they use different terminologies, such as 'left-out' and 'drop-out; to point them out. Health Assistants (HAs) register the information of a newborn during household visits. Afterwards, the HAs check birth registers and follow up the children who had missed the EPI sessions by visiting their households. They also inform the mothers during IPC, before or on the immunization day. Some service providers also said that they followed up over telephone if the phone number was available.

In urban areas, the identification process involves systematic checking of immunization records of each child during household visits by field staff, tallying the number of vaccines they have received and comparing this to the recommended schedule. Any child who has not received any vaccines or is behind schedule is flagged as ZD or UI, and steps are taken to ensure vaccination for the child. Furthermore, most participants reported that the prevalence of ZD and UI children is higher in slum areas compared to non-slum areas. Challenges in identifying ZD children at these areas included difficulties in gaining access to high-rise buildings or insecure locations or mobile populations.

Most upazila-level managers, service providers, and their supervisors mentioned that they faced difficulties in monitoring or finding ZD and UI children. The mentioned challenges were shortage of human resource at field level, irregular IPC, and difficult road condition. In rural areas, especially in hard-to-reach areas, the houses are scattered, the EPI centers are far away from upazila, and communication/transport system is very bad. According to the service providers, this is a big problem for the field staff to carry out EPI activities in those areas.

In urban areas, the target number of children is not well-determined, which poses a significant challenge in covering a large population with limited workforce. Identifying ZD children in slum settlements is also challenging due to high migration rates, and most mothers in these areas work as laborers, rendering it difficult to ensure proper vaccination for their children. One of the service providers said:

> *"It has been observed that after receiving two doses of the vaccine, some individuals migrate from one location to another before receiving their third dose. However, they are often unaware of the vaccination procedures in their new location, resulting in a missed opportunity to receive the third dose."* (KII_33).

Additionally, gaining access to large buildings in the city remains a problem as permits to enter are not granted to individuals who do not reside there. It is difficult even for EPI/government staff to get access to the large/high-rise buildings in some urban areas where elite people reside. Normally, the gates of the buildings remain closed or the gatemen do not allow the field staff to reach the families that live in those buildings. This makes identification of households and administering vaccinations quite challenging. Apart from migration issues, poor urban women do not know where to vaccinate their children. Sometimes, they do not know the importance of vaccination and are not interested in receiving vaccines.

(b) Reasons why ZD and UI are related with EPI

The reasons why ZD and UI are related with EPI include both demand- and supply-side factors. These are described below.

The most important demand-side reasons reported for the prevalence of ZD and UI children include the following:

Migration due to environmental damage (river erosion) or cultural reasons (moving from parental to husband's home): In coastal and char areas, the district- and upazila-level health managers, including all service providers, mentioned that migration occurs due to river erosion, which is a big challenge to conduct EPI activities in coastal areas. Some participants informed that it is extremely difficult for the service providers to prepare a micro-plan as the denominator is primarily unknown to them due to the lack of a fixed population or due to the mobility of population. Migration was also mentioned frequently as a challenge in the plain land. As noted by most participants, people from Chapainawabganj areas (plain land) migrated to urban areas due to poverty. This migration also created problems for the service providers in fixing the target. A participant said:

"EPI activities cannot be carried out properly in river erosion areas because the vaccine recipients move to other areas due to the river erosion which means they migrate. Many people think that our area is a poor area, Char area is a poor area. Many people migrate to Dhaka for work. Due to this migration, the EPI activities are hindered." – (KII_28).

Inappropriate contra-indications or concerns about minor side-effects: A few mothers and service providers mentioned that fear of side-effects of vaccination sometimes hinder the uptake of immunization.

Pre-occupation with family duties, especially at harvest time: This issue was discerned in Chittagong Hill Tracts and haor areas of Sunamganj. Some of the community people did not feel the necessity to get vaccinated during the time of harvest. Mothers believed that their children won't be able to go outside for work if they contracted fever after vaccination. The mothers also believed that their harvesting process would be disrupted if their children became sick after vaccination. A participant said:

"In the villages or areas where greater numbers of working people live, they go to other areas to harvest [crops] during the harvesting season or are busy with harvesting. Even if you call the parents of those children, they often do not come to get their child vaccinated. Those parents want to vaccinate their children later. Hence, vaccination rates are low in these areas" – (KII_23).

Some misconceptions and hesitation: This type of challenges was found only in the Sunamganj district. Some participants mentioned that religious prejudice and misperceptions about EPI are widely prevalent, which adversely affect the performance of EPI in Sunamganj areas. It may be mentioned that the people of Sylhet region (Sunamganj district) are as a whole conservative (both Muslim and non-Muslim), and the coverage of reproductive, maternal and child health indicators is low there. Due to such prejudice and misperceptions, some community members believe that the vaccine has no power and cannot do good to their children. Thus, they do not want to vaccinate their children. Even disseminating the message of EPI by using mike (loudspeaker) is not allowed in some areas by some religious leaders. One of the participants said:

"There were some social stigmas in regard to vaccination; when a child gets fever after taking the vaccine, the person spread this message to other people surrounding them telling that the child got sick from receiving vaccination. This discourages other women and [this] was a problem to carry out EPI activities in hilly areas." (KII_01).

Another one said:

"Many mothers think that, after vaccination, the child will become blind, crippled, sick, etc. They think that their children won't remain alright" – (KII_28).

The most important supply-side reasons reported for the prevalence of ZD and UI children were the following:

Shortage of HAs and overload of work: Shortage of personnel was mentioned frequently as a challenge across all the study sites. Large catchment area, inadequate HAs, and porters led to poor service coverage in some areas. The inadequate numbers of service providers in HTR areas, such as coastal areas, char areas, and hill tracts, exacerbated the situation.

All the HAs and their supervisors mentioned about HAs being overburdened with their workload. In some places, HAs are used to work in three wards or more, and these locations are often geographically isolated. Visiting every site more than once a month is impossible due to the long distance, which is a prominent challenge for optimum coverage. In addition to working for EPI, the HAs have to perform many other tasks. To exemplify, they have to sit in community clinic, implement corona vaccination program, attend different health campaigns and rallies, work on National Immunization Day (NID), and services relating to measles. A participant mentioned:

"In the hard-to-reach areas, the HAs cannot move to outreach centers routinely and perform the IPC before the immunization day due to long distances, shortage of human resources, and higher transport fares."

Absence of opportunity to provide IPC: This is a common challenge that we discerned in all the five study sites visited for data collection. Notably, this is more acute in HTR locations, including coastal, char and hilly areas. In HTR locations, it is not generally possible for service providers to visit the sites the day before the immunization to inform the community people as mentioned by most of the KII respondents. A few participants stated that they regularly carry out the IPC in their catchment areas. Some upazila-level managers mentioned that the service providers, usually the HAs, are locally recruited so that they can understand the context, and they do not have to travel a long way. However, they usually migrate to urban areas after their recruitment, hoping to provide better education to their children. This means that they move away from their assigned area (do not reside there). Since many of the HAs stay outside the community, they do not visit the vaccination sites the day before the vaccination session and so the IPC does not happen as planned.

Most mothers mentioned that they received information on immunization day through loudspeaker (miking) and phones in their areas. However, there was a lack of IPC sessions.

Distance to EPI centers and unavailability of transport: Across all five sites, we found that road communication was one of the major challenges in EPI. As mentioned before, this problem persists during both dry and rainy seasons. The service providers and service recipients struggle to cope with the difficult situation of road communication. To be more specific, vaccination in Rangamati district becomes a difficult task due to poor conditions of the roads. The district is surrounded by mountains, springs, and rivers. Normally, the service providers need to walk a long distance to reach their destination, especially in summer when water dries up and no vehicles are available, leaving people with no choice but to walk. This long-distance walk poses a significant challenge for vaccine delivery in the region. The vaccine provider has to carry the vaccine-carrier and two registrars while walking long distances. Climbing up the steep mountains is very difficult, and walking-tracks also become slippery during the rainy season. Some HTR unions do not have any means of communication, except the river route, and there is no way to use any vehicles in these areas during the dry season. The HAs used to travel by boat for 2/3 days continuously to reach the destination.

Boat is the main transport in the coastal areas of Noakhali. The boat needs to be reserved and the rent is high. Hence, an HA cannot conduct EPI sessions and IPC routinely in these areas. The service providers usually arrange a day-long crash program in these areas, instead of arranging routine EPI sessions. As mentioned by the service providers, some EPI centers are about 45-50 km away from upazila headquarter, and there is lack of transport.

Some mothers and service providers informed that the service recipients do not feel encouraged to receive vaccination if the service center is located far from the residences of mothers and if it takes a long time to reach destination. Such predicament also requires mothers to pay the transportation cost which is high. Some respondents from urban areas also mentioned a similar situation in regard to transportation.

Inaccurate denominator in EPI: Almost all participants at the national, district and upazila levels informed that they used a bottom-up approach to fix the denominator. The interviewed participants have stated various ways to calculate the denominator. Among them, one has said that the current year's denominator is determined by multiplying the number of children who received vaccine in the previous year by population growth rate. One of the participants said that formulation of the denominator involved a micro-plan, made annually, where the highest vaccine coverage of the previous year is added to it by a certain percentage to get the denominator of the following year. Another participant mentioned that they calculated it with the number of children who received BCG and added 5% more than that for the next year. A participant stated that the target is calculated every year by adding PENTA-1 to PENTA-3 and adding 2.7 to it in the micro-plan prepared every year.

However, in some areas, especially in char and coastal areas, determination of the denominator is a great challenge. Some participants informed that it is extremely difficult for the service providers to prepare a micro-plan as the denominator is mostly unknown to them due to lack of a fixed population or presence of mobile population.

(c) Existing special programs to reduce the numbers of ZD and UI children

Crash program: Some stakeholders at the national and sub-national levels, including service providers at the community level, mentioned that a few special programs were undertaken at different times to improve the coverage of EPI at the respective areas. Special programs are undertaken in some areas with low EPI coverage. For example, periodic intensifications of service delivery (locally known as 'crash program') are being undertaken to boost EPI coverage, especially in HTR areas.

Most participants mentioned that the special programs become quite successful because they can cover a huge number of children on such occasions. None of the national and sub-national-level managers and service providers mentioned failure of any special programs undertaken nationally or locally.

Evening session: Half of the KII participants informed that the evening EPI sessions were launched in different parts of Dhaka city to increase vaccination coverage. This program was specifically designed for working mothers considering their needs. The aim was to ensure that these mothers had access to the required vaccination. One of the participants said:

"Evening vaccination programs were not available everywhere but they were introduced in many places. These sessions were centrally controlled, and the result showed that many working mothers, such as those who worked in garments or those who could not take time off during the day, were being helped significantly through these evening sessions. This resulted in good vaccination coverage day by day."

On the other hand, some participants said that evening sessions are yet to commence in their work areas. A few advised that evening sessions should begin to increase EPI coverage. One participant said:

"The problem is that any mother who works as a domestic helper at someone else's home may not be able to bring the child for vaccination. They may not be allowed by the homeowner, or unable to take time off. For all these mothers, if we can hold an evening EPI session somewhere, it will be helpful for them."

5.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

This rapid assessment was conducted to locate missed communities with ZD and UI children and identify the appropriate programs for addressing them. Findings confirmed the existence of ZD and UI children, especially in different geographical locations such as haor area, hilly area, coastal area, char area, urban slums, even in plain land.

A few effective interventions, such as special crash programs and evening sessions, were cited by immunization stakeholders at the national and sub-national levels to reduce the numbers of ZD and UI children in Bangladesh. Further consultation workshop with EPI stakeholders is needed to identify more context-specific interventions in this regard. The upazilas with ZD and UI children for IR are identified and we are in communication with EPI stakeholders at the national and sub-national levels to hold workshops on how to reach ZD and UI children in specific context of an upazila. Finally, the study findings and recommendations mentioned below will help policy-makers and program managers in identifying the ZD and UI areas and in designing programs to reduce the numbers of ZD and UI children in Bangladesh:

RECOMMENDATIONS

1. Recommendations for identifying and tracking ZD children

- Use of DHIS2 data is useful for initial identification of ZD areas. Therefore, taking measures to improve quality of administrative data by DGHS, including solving denominator issue of target children by EPI is highly recommended.
- The DHIS2 website should show urban CC, municipalities, and zone-level data.
- National surveys (e.g. CES, BDHS) should provide micro-level, such as upazila/zone-level information.
- LQAS survey can be widely used for identification and verification of missed communities.
- A GIS mapping, including minimum HR plan, should be developed for different HTR areas through assessment of geographical context and local communication system to reach pocket population.
- The job responsibilities of HAs and their supervisors and vaccination coverage in their current catchment population should be re-assessed to identify ZD and UI children and bring them under full vaccination coverage through IPC.
- The GoB should take effective steps to ensure that the HAs/vaccinators reside in their place of posting so that they can spend more time in their services to increase vaccination coverage and reduce the prevalence of ZD and UI children.
- Based on re-assessment of job responsibilities and development of the HR plan, action needs to be taken to hire additional manpower, including filling-up of the existing vacant posts. In future, recruitment of female HAs should be taken into consideration as they have better acceptability among mothers in regard to vaccinating their children.

- A thorough assessment of current practice for estimation of denominators should be re-visited for three different populations: rural where population grows in a more predictable way; urban population where there are environmental barriers to accessing kids; and areas with migratory population.

2. Recommendations for responding to demand-side challenges

- Demand-side incentives or voucher system should be introduced for caregivers who reported problem relating to transportation cost or possibilities of wage loss if visit to the vaccine center is made during work time. To ensure such support, the Government can link the poor families that have eligible children for vaccination with different ongoing safety-net programs (food assistance programs, cash benefits, and other poverty alleviation activities) by relevant ministries, such as the Ministry of Social Welfare. Furthermore, the factory owners may allow a break for the women for a certain period on work days without deducting their wages for vaccination of their children.
- BCC materials containing vaccine schedule, importance of vaccination, and location of nearby vaccine centers should be developed and distributed at the community level to improve knowledge of people who have migrated recently and caregivers with negative trust or attitudes toward vaccination. The migrated people, especially in urban areas, do not know the health centers, EPI service providers, and vaccination centers in new places. So, a mechanism can be developed for mother-to-mother education or by imparting knowledge of the existing motivated members to the migrated people for making them aware of vaccination for the newcomer children. Earlier, small-scale study found positive results from this mechanism (15).
- Engaging local government representatives and community elites (members of Union Parishad, school teachers, social and community health workers, community support groups and volunteers) in the EPI should be strengthened to motivate caregivers for childhood vaccination. Community people always listen to them and abide by their decisions and instructions. A few participants mentioned the successes obtained whenever they arranged any EPI campaign involving the local government representatives and community elites.
- Electronic or mobile-based interventions should be invented to find alternative solutions for caregivers who lost their children's vaccination cards.
- Caregivers who are permanently settled in urban slum areas could be encouraged to inform and motivate the newcomers and less-interested mothers through mother-to-mother communication system (15) for vaccinating their children.
- Myths and misperceptions regarding EPI continue to exist at the community level, affecting optimum utilization of vaccination across the study sites. Some mothers incorrectly believe that a child is immunized just by taking the first dose of MR and does not need to take the last dose. We also discerned that mothers become frightened and discouraged about getting their children vaccinated with remaining doses of scheduled vaccines if the child contracts fever after the first dose. Therefore, it is suggested to undertake massive awareness program nationwide to remove the misperceptions and, thus, improve the EPI coverage.

3. Recommendations for mobile populations and the urban poor

- To boost EPI coverage in areas with low coverage, frequent arrangement of crash programs (sensitizing the community by motivating the mothers to attend the EPI sessions to vaccinate their children) should be made for different underserved areas to reach the ZD and UI children.
- In some urban areas, the GoB has introduced evening EPI sessions for working mothers. This step was adopted to facilitate the working mothers in vaccinating their children and has been proven to be useful. Thus, it is recommended that such evening sessions/alternative strategies should be regularly organized to reduce numbers of ZD and UI children in urban areas.
- Many mothers in urban areas work in garment factories and cannot manage time to attend the routine EPI day. Therefore, an EPI session held during a holiday/Friday will be helpful to achieve improved EPI coverage in urban areas. Also, caregivers (mothers and fathers) need flexibility during working hours from employers; they

should be allowed to take time off (without any potential risks to their employement) to get their children vaccinated.

4. Recommendations for other supply-side improvements tailored to ZD

- Context-specific transportation cost to reach different segments of population in HTR areas should be estimated. Accordingly, a policy should be formulated to provide the transportation cost to HAs and their supervisors for regular field work and monitoring visits. Furthermore, a mechanism should be developed for provision of advance payment to the field staff against transportation cost to address the problem of reimbursement of the transportation cost.
- In both rural and urban areas, the EPI sessions could be arranged in alternative time slots; e.g. some mothers cannot bring their children to the morning EPI session due to household chores. Hence, both service providers and mothers may be suggested to arrange/attend the EPI session at a later time so that these mothers can bring their children to service centers after completing their household work.
- In most cases, we found that IPC is hardly conducted due to different problems mentioned earlier. The IPC has to be regular in informing mass people. According to some participants, the HAs should be provided with allowances, especially for field work in HTR areas, to regularize IPC. A mobile phone network system/auto-reminder system can be developed so that the HAs can communicate or auto-reminder system can send messages to the families with target children and motivate the caregivers for vaccination of their children, especially in HTR areas.
- According to some participants, monitoring and supervision are inadequate. Therefore, this should be prioritized and given importance from the supervisory level so that monitoring and supervision happen regularly from the national level to the sub-district level.
- Almost all participants across the study sites informed that domiciliary visit is irregular in rural areas. Hence, service providers do not have the exact information about the number of pregnant women, expected delivery dates (EDDs), and newborn babies. The supervisors of frontline health workers should regularly visit the field and work together with them. Supportive supervision would encourage service providers to work in a motivated way.
- Micro-credit workers in the community have good credibility and acceptability among women at the community. The loan recipients who are mostly women repay the loan in weekly installments. Micro-creadit workers have a small office within the community where they hold weekly meetings with loan recipients. This could be a good platform where the micro-credit workers may create awareness of EPI among women. The local-level EPI service providers, in consultation with concerned micro-credit workers, can make programs for vaccination of the children, using the platform as per requirements.
- Managers at the national and sub-national levels and field-level service providers emphasized the importance of arranging refreshers training regularly to improve skills of HAs. Refreshers training will be helpful in motivating them to work more effectively.
- Incentives for the HAs should be provided annually at the district and upazila levels for their outstanding performances. This reward system will improve the quality of their work and, eventually, increase EPI coverage.
- Instead of the paper-based monitoring system, a digital (real-time) monitoring system should be introduced to make the process more effective for increasing EPI coverage, especially for identification and vaccination of the ZD and UI children. One upazila-level health manager suggested that the health inspectors (HI) should visit the EPI outreach center for monitoring purpose and make video-calls to the upazila manager, using online platform, such as Facebook Messenger, and WhatsApp.
- Some of the participants at the national and sub-national levels suggested that volunteers should be recruited by the GoB in the HTR areas so that they can identify ZD and UI children to improve EPI coverage. If trained, they can perform IPC before the day of immunization and keep immunization-records which will help in reducing workload of HAs.

ACKNOWLEDGEMENTS

This research protocol was funded by Gavi, the Vaccine Alliance. icddr,b acknowledges with gratitude the commitment of Gavi, the Vaccine Alliance to its research efforts. icddr,b is also grateful to Dr. Md. Anwar Hossain Howlader, Secretary, Health Services Division (HSD), MoHFW; Dr. Md. Akhteruzzaman, Additional Secretary (Public Health Wing), HSD, MoHFW; Dr. Md Shibbir Ahmed, Joint Secretary (PH Wing), HSD, MoHFW; M. Jashim Uddin Khan, Deputy Secretary (PH-2), HSD, MoHFW; Dr. Zobayer Ibne Zaid, Technical Support Expert (PH-2), HSD, MoHFW; Dr. Mohammed Nizam Uddin, Director and Line Director (MNC&AH), DGHS; Dr. S. M. Abdullaha - Al – Murad, Program Manager (EPI), DGHS; all other officials of EPI Headquarters, DGHS. We also acknowledge all the data collection teams for their contribution in implementing field activities. Last but not the least, icddr,b expresses gratitude and appreciation to the Government of Bangladesh and Canada for providing core/unrestricted support.

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ANNEXURES

ANNEXURE 1. High-ZD districts and CCs [CES report (2014, 2015, 2016, and 2019)]

2019		2016		2015		2014	
District	**Percent**	**District**	**Percent**	**District**	**Percent**	**District**	**Percent**
Bandarban	3.1	Sunamganj	5.3	Bandarban	5.7	Rangamati	4.8
Narail	1.4	Dhaka	2.4	Chattogram	3.8	Sylhet	4.8
Cumilla	1.3	Rangamati	2.0	Sunamganj	3.8	Sunamganj	4.3
Sunamganj	1.2	Habiganj	1.9	Moulvibazar	3.3	Noakhali	3.3
Rangamati	1.1	Bagerhat	1.8	Habiganj	2.4	Netrokona	2.9
Habiganj	1.1	Sirajganj	1.7	Rangamati	1.9	Tangail	2.9
Chattogram	0.8	Sherpur	1.6	Bogura	1.9	Narsingdhi	2.4
Noakhali	0.8	Noakhali	1.5	Netrokona	1.4	Dhaka	1.9
Khulna	0.8	Bandarban	1.3	Tangail	1.4	Sariatpur	1.9
Meherpur	0.8	Lakshmipur	1.2	Khulna	1.4	Habiganj	1.9
City Corporation	**Percent**	**City Corporation**		**City Corporation**		**City Corporation**	
Cumilla	4.3	Sylhet	4.7	Dhaka (Slum)	2.4	Sylhet	3.3
Sylhet	2.1	Khulna	2.1	Narayanganj	1.9	Chattogram (Slum)	2.9
Khulna	0.9	Dhaka (Slum)	1.8	Sylhet	1.9	Dhaka (Slum)	1.9
Chattogram	0.8	Chattogram	1.3	Khulna	1.4	Cumilla	1.0
Narayanganj	0.3	Narayanganj	1.2	Gazipur	1.0	Narayanganj	1.0

ANNEXURE 2. Top 20 high-ZD upazilas from DHIS2 (2019-2022)

Rank	2019		2016		2015		2014	
	Upazila (District)	**ZD**	**Upazila (District)**	**ZD**	**Upazila (District)**	**ZD**	**Upazila (District)**	**ZD**
1.	Sundarganj (Gaibandha)	30.6	Saltha (Faridpur)	22.2	Ukhia (Coxbazar)	38.3	Teknaf (Coxbazar)	17.0
2.	Gaffargaon (Mymensingh)	15.7	Pangsha (Rajbari)	17.1	Thanchi (Bandarban)	24.0	Ukhia (Coxbazar)	15.6
3.	Jamalganj (Sunamganj)	11.1	Sadar (Brahmanbaria)	12.2	Teknaf (Coxbazar)	24.0	Barkal (Rangamati)	10.3
4.	Kathalia (Jhalakathi)	10.8	Sarail (Brahmanbaria)	11.0	Bijoynagar (Brahmanbaria)	20.8	Durgapur (Rajshahi)	9.6
5.	Mujibnagar (Meherpur)	10.2	Hathazari (Chattogram)	10.4	Sadar (Gazipur)	20.1	Kaharole (Dinajpur)	9.3
6.	Shibganj (Chapainawabganj)	9.9	Mujibnagar (Meherpur)	9.7	Dowarabazar (Sunamganj)	16.0	Sadar (Bandarban)	9.1
7.	Ruma (Bandarban)	9.2	Serajdikhan (Munshiganj)	7.9	Lama (Bandarban)	15.6	Sadar (Joypurhat)	8.9
8.	Saghata (Gaibandha)	8.5	Chandanaish (Chattogram)	7.4	Kulaura (Moulvibazar)	14.9	Alikadam (Bandarban)	8.8
9.	Sadar (Bagerhat)	8.2	Sadar (Rangamati)	7.4	Rajnagar (Moulvibazar)	14.9	Sadar (Bagerhat)	6.5

Rank	2019		2016		2015		2014	
	Upazila (District)	ZD	Upazila (District)	ZD	Upazila (District)	ZD	Upazila (District)	ZD
10.	Gior (Manikganj)	7.5	Sadar (Bagerhat)	7.1	Khaliajuri (Netrakona)	14.5	Sadar (Narayanganj)	6.4
11.	Sadar (Chapainawabganj)	7.4	Sadar (Chapainawabganj)	6.0	Shahjadpur (Sirajganj)	14.4	Badalgachhi (Naogaon)	6.2
12.	Debidwar (Cumilla)	7.4	Juraichhari (Rangamati)	5.8	Sreemangal (Moulvibazar)	14.1	Gurudashpur (Natore)	6.0
13.	Akkelpur (Joypurhat)	6.6	Faridganj (Chandpur)	5.6	Bholahat (Chapainawabganj)	14.0	Bhangura (Pabna)	6.0
14.	Sadar (Joypurhat)	6.4	Sadar (Madaripur)	5.6	Sadar (Sylhet)	13.6	Gangachara (Rangpur)	5.6
15.	Chandanaish (Chattogram)	6.3	Sonagazi (Feni)	5.5	Ullahpara (Sirajganj)	13.4	Bamna (Barguna)	5.4
16.	Dowarabazar (Sunamganj)	6.0	Basail (Tangail)	5.5	Mohanganj (Netrokona)	13.2	Baghaichari (Rangamati)	5.2
17.	Dharampasa (Sunamganj)	5.6	Gaffargaon (Mymensingh)	5.3	Hathazari (Chattogram)	12.9	Rajnagar (Moulavibazar)	5.2
18.	Palashbari (Gaibandha)	5.5	Nabinagar (Brahmanbaria)	5.2	Tahirpur (Sunamganj)	12.8	Balaganj (Sylhet)	5.1
19.	Hatiya (Noakhali)	5.4	Kulaura (Moulvibazar)	5.1	Sadar (Bandarban)	12.1	Thanchi (Bandarban)	4.9
20.	Ramgati (Lakshmipur)	5.2	Bagatipara (Natore)	5.0	Bagatipara (Natore)	12.0	Sadar (Faridpur)	4.9

ANNEXURE 3. Selected cluster for LQAS

Districts	Upazila/Zone	Union	Ward no.	Cluster-1	Cluster-2
Sunamganj	1. Jamalganj	Jamalganj	3	Ka-1	Kha-2
	2. Dowarabazar	Dohaliya	1	Ga-1	Kha-1
Rangamati	1. Sadar	Mogban	3	Gha-2	Kha-2
	2. Naniarchar	Sabekkhyang	2	Gha-2	Gha-1
Gaibandha	1. Saghata	Holdia	3	Ka-1	Ka-2
	2. Phulchari	Fazlupur	3	Ka-1	Gha-2
Noakhali	1. Hatiya	Nijhum Dip	1	Kha1	Ga-2
	2. Subarnachar	Mohammadpur	2	Ka-2	Gh-2
Chapainawabganj	1. Shibganj	Kansat	3	Ka-2	Gha-1
	2. Sadar	Baroghoria	2	Ka-1	Kha-1
Dhaka	1. Zone-05 of DNCC	-	-	-	-
	2. Zone-10 of DSCC	-	-	-	-

ANNEXURE 4. Reasons for not being vaccinated by PENTA-1 and PENTA-3 according to districts [LQAS data]

Reasons	Did not receive PENTA-1 (any routine EPI vaccine)						Did not receive PENTA-3						
	Total (n=39)	Sunamganj (n=11)	Gaibandha (n=5)	Noakhali (n=13)	DNCC (n=10)	Total (n=131)	Sunamganj (n=32)	Chapai N. (n=3)	Gaibandha (n=28)	Noakhali (n=14)	Ranga. (n=6)	DNCC (n=23)	Sherpur (n=25)
Due to the child's ill-ness	30.8	90.9	0.0	7.7	10.0	49.6	68.8	33.3	28.6	64.3	66.7	34.8	52.0
Monetary problem	30.8	9.1	80.0	7.7	60.0	3.1	0.0	0.0	3.6	0.0	0.0	13.0	0.0
Husband did not per-mit	30.8	72.7	0.0	30.7	0.0	3.8	15.6	0.0	0.0	0.0	0.0	0.0	0.0
for being busy	18.0	0.0	40.0	23.1	20.0	15.3	15.6	0.0	32.1	0.0	16.7	17.4	4.0
Didn't know where to go for vaccination	15.4	0.0	20.0	0.0	50.0	2.3	0.0	0.0	0.0	0.0	0.0	13.0	0.0
Fear of side-effects	10.3	9.1	0.0	23.1	0.0	4.6	6.3	0.0	3.6	7.1	16.7	0.0	4.0
Did not have faith on vaccination	10.3	0.0	20.0	23.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Didn't know that vac-cine should be given	10.2	0.0	40.0	7.7	10.0	2.3	3.1	33.3	0.0	0.0	0.0	0.0	4.0
Vaccination center is located very far	10.2	0.0	40.0	15.4	0.0	9.2	0.0	0.0	42.9	0.0	0.0	0.0	0.0
Thought of getting vac-cinated later	7.7	0.0	0.0	0.0	30.0	10.7	3.1	0.0	10.7	0.0	0.0	30.4	12.0
Forgot	7.7	0.0	20.0	7.7	10.0	6.1	0.0	33.3	14.3	14.3	0.0	0.0	4.0
Due to own illness	5.1	0.0	0.0	7.7	10.0	3.8	6.3	0.0	7.1	7.1	0.0	0.0	0.0
Change of residence	5.1	0.0	20.0	0.0	10.0	13	28.1	0.0	10.7	7.1	0.0	13.0	4.0
Due to the child's cries	2.6	0.0	0.0	7.7	0.0	15.3	21.9	0.0	39.3	7.1	0.0	4.3	0.0
Father-in-law/mother-in-law did not permit	2.6	0.0	0.0	7.7	0.0	3.1	6.3	0.0	3.6	0.0	0.0	4.3	0.0
Center was closed on scheduled day	0.0	0.0	0.0	0.0	0.0	3.1	0.0	0.0	3.6	7.1	0.0	0.0	8.0
Others	15.4	0.0	40.0	23.1	10.0	9.9	0.0	0.0	3.6	35.7	0.0	0.0	28.0

ANNEXURE 5. Basic information from checklist of selected cluster

District	Upazila	EPI Cluster	Total population	Total household	Number of children un-der 2 years
Sunamganj (Haor)	Jamalganj	Cluster-1 (Alipur)	2000	450	80
		Cluster-2 (Harinkandi)	1500	230	50
	Dowarabazar	Cluster-1 (Vobanipur)	1800	350	70
		Cluster-2 (Purapara)	2000	370	80
Gaibandha (Char)	Saghata	Cluster-1 (Dighulkandi)	2000	400	60
		Cluster-2 (South Dighulkandi)	3000	300	60
	Phulchari	Cluster-1 (Khatimari)	6000	1000	300
		Cluster-2 (Kutub Member)	3000	600	700
Noakhali (Coastal)	Hatiya	Cluster-1 (Saddam House)	1500	250	100
		Cluster-2 (Mirpoka)	2000	300	100
	Subarnachar	Cluster-1 (Soudagor Bari)	1194	199	47
		Cluster-2 (Chorlokkhi)	1824	304	47
Sherpur (Plain)	Nalitabari	Cluster-1 (Paikka Tala)	950	183	45
		Cluster-2 (World Vision Center)	1100	200	50
	Sreebardi	Cluster-1 (Chukchuki)	1400	250	50
		Cluster-2 (Khatiadanga)	1700	350	60
Dhaka (Urban)	Dhaka North City Corporation (DNCC)	Cluster-1 (Zone-5, Ward-26)	3395	679	115
		Cluster-2 (Zone-5, Ward-30)	3650	730	135

ANNEXURE 6. Status of institutions, facilities, and transport system in the selected clusters of LQAS survey

District	Upazila	EPI Cluster	Number of schools			Number of health center			Communication and transportation system							
			Primary	Secondary	Missionary	Public/govt	NGO	Private clinic	Bus	Rickshaw	Van	CNG	Boat	Motorcycle	Auto
Sunamganj (Haor)	Jamalganj	Cluster-1 (Alipur)	√	×	×	×	×	×	×	√	×	×	√	√	×
		Cluster-2 (Harinkandi)	√	×	×	×	×	×	×	×	×	×	√	√	×
	Dowarabazar	Cluster-1 (Vobanipur)	×	×	×	×	×	×	×	×	√	√	×	×	×
		Cluster-2 (Purapara)	√	×	×	×	×	×	×	×	√	√	×	×	×
Gaibandha (Char)	Saghata	Cluster-1 (Dighulkandi)	√	×	×	×	×	×	×	×	×	×	√	×	×
		Cluster-2 (South Dighulkandi)	√	×	×	√	×	×	×	×	×	×	√	×	×
	Phulchari	Cluster-1 (Khatimari)	√	×	×	×	×	×	×	×	×	×	√	×	×
		Cluster-2 (Kutub Member)	√	×	×	×	×	×	×	×	×	×	√	√	×
Noakhali (Coastal)	Hatiya	Cluster-1 (Saddam House)	×	×	×	×	×	×	×	×	×	×	×	√	√
		Cluster-2 (Mirpoka)	×	×	×	×	×	×	×	√	×	√	×	√	×
	Subarnachar	Cluster-1 (Soudagor Bari)	×	×	×	×	×	×	×	√	×	√	×	√	×
		Cluster-2 (Chorlokkhi)	×	×	×	√	×	×	×	×	×	×	×	√	√
Sherpur (Plain)	Nalitabari	Cluster-1 (Paikka Tala)	√	√	×	×	×	×	×	×	×	×	×	×	√
		Cluster-2 (World Vision Center)	×	×	√	×	×	×	×	×	×	×	×	×	√
	Sreebardi	Cluster-1 (Chukchuki)	√	×	×	×	×	×	×	√	×	×	×	×	√
		Cluster-2 (Khatiadanga)	√	×	×	×	×	×	×	√	×	×	×	×	√
Dhaka (Urban)	Dhaka North City Corporation (DNCC)	Cluster-1 (Zone-05 Ward-26)	√	√	√	×	×	√	√	√	×	√	×	×	×
		Cluster-2 (Zone-05 Ward-30)	√	√	√	×	×	√	√	√	×	√	×	×	×

'√' refers available
'×' refers Not available

ANNEXURE 7. Household structure and occupation according to rank in the selected clusters of LQAS survey

District	Upazila	EPI Cluster	Structure of house				Occupation					
				Half Paka	Kancha	Jhupri	Agriculture	Industrialize	Service	Day labor	Fishing	Small business
Sunamganj (Haor)	Jamalganj	Cluster-1 (Alipur)	-	2	1	-	1	-	2	-	-	-
		Cluster-2 (Harinkandi)	-	2	1	-	1	-	-	-	-	-
	Dowarabazar	Cluster-1 (Vobanipur)	3	2	1	-	1	-	2	-	-	-
		Cluster-2 (Purapara)	3	2	1	-	1	-	2	-	-	-
Gaibandha (Char)	Saghata	Cluster-1 (Dighulkandi)	2	1	-	-	1	-	2	-	-	-
		Cluster-2 (South Dighulkandi)	-	-	1	2	1	-	2	-	-	-
	Phulchari	Cluster-1 (Khatimari)	-	-	1	-	1	-	-	-	-	-
		Cluster-2 (Kutub Member)	-	-	1	-	1	-	-	-	-	-
Noakhali (Coastal)	Hatiya	Cluster-1 (Saddam House)	3	2	1	-	2	-	-	1	-	-
		Cluster-2 (Mirpoka)	3	2	1	-	1	-	-	-	-	-
	Subarnachar	Cluster-1 (Soudagor Bari)	3	2	1	-	1	-	2	-	-	-
		Cluster-2 (Chorlokkhi)	3	-	1	2	1	-	3	2	-	-
Sherpur (Plain)	Nalitabari	Cluster-1 (Paikka Tala)	3	1	-	2	1	-	2	-	-	-
		Cluster-2 (World vision Center)	4	1	3	2	1	3	2	-	-	-
	Sreebardi	Cluster-1 (Chukchuki)	4	1	2	3	1	-	2	-	-	-
		Cluster-2 (Khatiadanga)	4	1	2	3	1	-	2	-	-	-
Dhaka (Urban)	Dhaka North CC	Cluster-1 (Zone-5, Ward-26)	-	3	2	1	-	-	-	1	-	2
		Cluster-2 (Zone-5, Ward-30)	-	-	2	1	-	-	-	1	-	2

Note: 1= Highest; 2= Higher; 3= Middle; 4=Lower;
5=Lowest; "-" = Not available, CC= City corporation

ANNEXURE 8. A sample of cluster map

ANNEXURE 9. Socio-economic determinants of having ZD children [BDHS 2017-2018]

Covariate	n	Crude		Adjusted	
		OR (95.0% CI)	p-value	OR (95.0% CI)	p-value
Sex of child					
Male (Ref.)	2356	-	-	-	-
Female	2148	1.48 (1.035-2.117)	0.032	1.402 (0.954-2.062)	0.086
Number of ANC visits					
0 (Ref.)	365	-	-	-	-
1-3	1941	0.392 (0.245-0.628)	<0.001	0.531 (0.319-0.882)	0.015
>=4	2198	0.179 (0.106-0.304)	<0.001	0.374 (0.205-0.683)	0.001
Division					
Rangpur (Ref.)	501	-	-	-	-
Barishal	474	2.933 (0.928-9.272)	0.067	1.821 (0.564-5.879)	0.316
Chattogram	744	1.987 (0.637-6.195)	0.237	1.21 (0.369-3.966)	0.753
Dhaka	678	3.171 (1.06-9.479)	0.039	1.931 (0.622-5.992)	0.255
Khulna	465	2.45 (0.75-8.009)	0.138	2.235 (0.669-7.463)	0.191
Mymensingh	546	3.492 (1.151-10.59)	0.027	2.527 (0.822-7.772)	0.106
Rajshahi	479	1.58 (0.443-5.633)	0.481	0.95 (0.233-3.871)	0.943
Sylhet	617	10.72 (3.853-29.853)	<0.001	5.024 (1.741-14.493)	0.003
Type of residence					
Urban (Ref.)	1560	-	-	-	-
Rural	2944	0.975 (0.673-1.414)	0.895	0.774 (0.497-1.204)	0.255
Mothers educational attainment					
No education (Ref.)	278	-	-	-	-
Primary incomplete	764	0.785 (0.459-1.344)	0.378	0.986 (0.548-1.774)	0.961
Primary complete	470	0.614 (0.329-1.144)	0.124	0.617 (0.311-1.225)	0.168
Secondary incomplete	1931	0.205 (0.116-0.364)	<0.001	0.262 (0.134-0.513)	<0.001
Secondary complete or higher	1061	0.125 (0.058-0.268)	<0.001	0.221 (0.089-0.547)	0.001
Wealth quintile					
Poorest (Ref.)	953	-	-	-	-
Poorer	922	0.686 (0.41-1.148)	0.151	0.888 (0.505-1.563)	0.682
Middle	799	0.84 (0.504-1.399)	0.503	1.525 (0.837-2.779)	0.168
Richer	895	0.809 (0.491-1.332)	0.404	1.47 (0.765-2.822)	0.247
Richest	935	0.272 (0.134-0.549)	<0.001	0.659 (0.264-1.645)	0.371
Wanted the last child					
Wanted then (Ref.)	3545	-	-	-	-
Wanted later	598	1.422 (0.892-2.266)	0.139	1.710 (1.026-2.85)	0.040
Wanted no more	361	1.464 (0.825-2.598)	0.192	1.212 (0.661-2.22)	0.535
Mother's occupation					
Working (Ref.)	1815	-	-	-	-
Not working	2689	2.879 (1.838-4.508)	<0.001	2.797 (1.732-4.518)	<0.001
Media access					
Yes (Ref.)	2457	-	-	-	-
No	2047	2.409 (1.656-3.504)	<0.001	1.493 (0.941-2.369)	0.089

ANNEXURE 10. Socio-economic determinants for having UI children [BDHS 2017-2018]

Covariate	n	Crude		Adjusted	
		OR (95.0% CI)	p-value	OR (95.0% CI)	p-value
Sex of child					
Male (Ref.)	2192	-	-	-	-
Female	2000	1.196 (0.956-1.495)	0.117	1.184 (0.936-1.498)	0.158
Number of ANC visits					
0 (Ref.)	335	-	-	-	-
1-3	1805	0.509 (0.366-0.708)	<0.001	0.644 (0.454-0.913)	0.013
>=4	2052	0.261 (0.183-0.371)	<0.001	0.45 (0.303-0.667)	<0.001
Division					
Rangpur (Ref.)	474	-	-	-	-
Barishal	431	1.33 (0.724-2.442)	0.358	1.038 (0.557-1.935)	0.906
Chattogram	698	1.925 (1.14-3.251)	0.014	1.632 (0.943-2.824)	0.080
Dhaka	634	1.844 (1.08-3.149)	0.025	1.631 (0.924-2.878)	0.092
Khulna	436	2.105 (1.203-3.684)	0.009	2.196 (1.229-3.923)	0.008
Mymensingh	501	1.954 (1.126-3.393)	0.017	1.575 (0.896-2.77)	0.115
Rajshahi	451	1.448 (0.801-2.62)	0.221	1.316 (0.712-2.432)	0.381
Sylhet	567	3.563 (2.152-5.899)	<0.001	2.403 (1.408-4.102)	0.001
Type of residence					
Urban (Ref.)	1450	-	-	-	-
Rural	2742	1.151 (0.905-1.463)	0.252	0.891 (0.675-1.177)	0.416
Mothers' educational attainment					
No education (Ref.)	257	-	-	-	-
Primary incomplete	711	0.717 (0.49-1.049)	0.086	0.852 (0.568-1.279)	0.439
Primary complete	434	0.509 (0.325-0.796)	0.003	0.57 (0.354-0.919)	0.021
Secondary incomplete	1813	0.334 (0.232-0.481)	<0.001	0.439 (0.291-0.664)	<0.001
Secondary complete or higher	977	0.187 (0.118-0.295)	<0.001	0.323 (0.19-0.548)	<0.001
Wealth quintile					
Poorest (Ref.)	894	-	-	-	-
Poorer	846	0.71 (0.516-0.978)	0.036	0.851 (0.603-1.202)	0.36
Middle	738	0.696 (0.497-0.975)	0.035	0.981 (0.666-1.446)	0.923
Richer	843	0.741 (0.538-1.019)	0.065	1.153 (0.773-1.719)	0.486
Richest	871	0.329 (0.221-0.492)	<0.001	0.606 (0.357-1.03)	0.064
Wanted last child					
Wanted then (Ref.)	3298	-	-	-	-
Wanted later	560	0.942 (0.678-1.309)	0.724	0.987 (0.691-1.41)	0.942
Wanted no more	334	1.204 (0.824-1.759)	0.338	0.961 (0.643-1.437)	0.848
Mother's occupation					
Working (Ref.)	1725	-	-	-	-
Not working	2467	1.33 (1.052-1.681)	0.017	1.416 (1.097-1.827)	0.007
Media access					
Yes (Ref.)	2295	-	-	-	-
No	1897	1.983 (1.578-2.493)	<0.001	1.401 (1.056-1.858)	0.019

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