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Assessing the knowledge, attitude, and practice (KAP) of parents and service providers' perceptions on invalid vaccine doses: A study in urban slums of Bangladesh

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Abstract

This paper aims to assess the parental attitude, knowledge and practice regarding valid vaccination schedule of child immunization and identify the reasons for providing invalid vaccine doses. A cross-sectional, mixed-method study design was used to conduct in randomly selected urban slums of Bangladesh. Among the 456 respondents, 99.34% had good experience in vaccination services, and 95.83% believed that this service increased their children's immunity. But only 31.36% had adequate knowledge about the number of vaccinations provided by the routine immunization program, and only 4.17 % knew about invalid vaccine doses. The parent's knowledge level was significantly associated with mothers' education (p-value: 0.042) and media exposure (p-value: 0.014). The immunization practice was significantly associated with the number of living children (p-value: 0.004). Majority of the respondents (96.71%) reported that no one informed them about the invalid dose of the vaccine. According to service providers the service charges, urban-living people's mobility, NGO field staff workload, and inadequate training were the major causes of providing invalid vaccine doses in urban slums. It is recommended that service providers might engage the slum authority in immunization activity to mobilize the slum people about the vaccination program to create awareness among them and ensure valid vaccination doses.

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Introduction

The Expanded Program on Immunization (EPI) is one of the successful health programs of Bangladesh by providing a cost-effective and safe public health interventions for its population [1]. The World Health Organization introduced EPI in 1974 to ensure all children of the world benefited from life-saving immunizations. Bangladesh is one of the countries, where the immunization success rate is quite exemplary [2][3]. The full vaccination coverage was 83.9% in 2019 which was increased from 52% in 2001 [4][5]. Despite this success, the objective of EPI is not possible to achieve the target of 85% of full vaccination coverage in all districts and 90% of coverage nationally. However, various literature based on intervention results identified that high prevalence of invalid doses and vaccination dropout are the main obstacles to achieving the desired target. The vaccine dose is considered as invalid when it is given before a minimum age of the child or after a too short interval between two doses. In addition, the urban-rural analysis shows that urban children (77.1%) are lagging behind in getting valid doses compared to their rural counterparts (83.5%) in Bangladesh [4].

Though some of the challenging factors have already been identified for the low coverage in urban areas, such as rapid population growth, mushrooming growth of slums; different types of service providers from public and private sectors; less priority about immunization to meet other more pressing challenges [6][7][8][9]. Moreover, evidence suggests that a lack of knowledge about the importance of immunization, its subsequent doses, the importance of completing the full course, and irregular holding of vaccination sessions caused low immunization coverage in urban areas of Bangladesh [10][11][12].

The latest Bangladesh EPI coverage evaluation report 2019 [4] showed that the highest number of invalid doses were for measles rubella (MR1) vaccine (7.8%) and the lowest numbers were for Pentavalent2 and Pentavalent3 vaccines at 1.0 %, which was higher in urban areas. Nationally, the highest percentage of invalid doses was recorded in Dhaka North City Corporation (DNCC), with the highest rate being for invalid Pentavalent3.

Various studies have been conducted regarding the invalid doses of immunization schedules even in the USA. One evaluation was conducted among US children where 10.5% of children received at least one invalid dose of vaccine, which cost approximately $10-18 million to repeat at least one invalid vaccine dose. This finding revealed that the cost of revaccinating these children was substantial and might have a negative impact on parents, physicians, and vaccine purchasers[13].

One study in India [14] found that the low rate of education of the mother, place of delivery, and high birth order had a positive association with low vaccination coverage. They recommended to conduct role plays, group talks; displaying posters, pamphlets, and arranging competitions in the community level to ensure immunization to be a “felt need” of the mothers for their children.

A study conducted in Malawi [15] found the existence of a significant number of invalid doses of Pentavalent1,2,3 and

measles in selected districts. However, the knowledge level of parents regarding the valid vaccination doses and the schedule was not assessed there; rather they suggested rigorous capacity building for service providers.

Another study [6] conducted to identify barriers to effective immunization in urban slums of Nigeria and found that attitudes of parents, poor understanding of the importance of immunization, insufficient information provided by service providers, and less engagement with community people are the key barriers to uptake of immunization in slum areas which were all linked to the inadequate information and education to beneficiaries of the vaccination program.

Another study [16] conducted in 41 Gavi-eligible countries found that universal coverage of the measles, rotavirus, and pneumococcal conjugate vaccines (PCV) could avert a significant portion of disastrous health expenditure.

In Bangladesh, some researchers [17] conducted a study to see the awareness among parents about the PCV under routine immunization program and showed that most parents were unaware of the PCV vaccination status of children.

Therefore, it is revealed that the existing rate of invalid doses need to be reduced to achieve the EPI target, and for doing so, the assessment of the parent's knowledge, attitude, and practice regarding the maintenance of the vaccine schedule is a prime concern. Although in Bangladesh, various studies have already been conducted to identify the reasons for dropout, left out, or partial vaccination, but no study has yet been conducted to assess the knowledge of parents regarding the valid doses. In order to fill up this knowledge gap, this study is being attempted to find out the following questions:

1. To what extent parents of children are informed about the vaccine schedule under the routine EPI?
2. To investigate why children are being provided invalid vaccine doses.

Therefore, the objectives of this study are to assess the level of knowledge, attitude, and practice of parents regarding vaccination schedules under the routine EPI program. Moreover, identify the reason for providing invalid vaccine doses to the children under the routine EPI program by the service providers.

Methodology

This cross-sectional, descriptive study used both quantitative and qualitative information to identify the underlying causes of the presence of invalid doses vaccination schedules in selected areas by assessing the knowledge, attitude, and practice (KAP) of parents regarding child immunization and service providers' perspectives.

The study site was selected as per the Census of Slum Areas and Floating Population 2014 report, where it was stated that the Dhaka division contains the largest proportion of the slum population at 48%, whereas DNCC contains 1,35,061 households in slums (23%), Dhaka South City Corporation contains 40,015 households in slums (7%). Therefore, DNCC had been chosen for conducting this study in a slum area by using simple random sampling technique.

A KAP survey was conducted at the household level in the selected slums of 30 no ward under Zone 5 of DNCC. The survey respondents (mothers) were selected based on the criteria of having a baby of 2 to 3 years old (24 to 36 months

aged child) as routine immunization schedule was completed within two years of age. Mothers were asked about their knowledge, attitude and practice regarding vaccination schedules of their last child. They were asked the number of each type of vaccination received (card validated) to avoid the recall bias issue as well as their satisfaction, perception, practice during that time.

The study population also included selected service providers of the study areas from both government and NGO officials to know their perspective about the incidence of invalid vaccine doses.

Operational Definitions[1]

Invalid Dose: In EPI, the dose is considered an invalid dose when it doesn't meet the immunization schedule criteria (dose given before a minimum age or after a too short interval).

Invalid Penta1: If 1st dose of Penta is given before six weeks of age of a child

Invalid Penta2: 2nd dose of Penta is considered invalid if the interval between 1st dose and 2nd dose is less than four weeks

Invalid Penta3: 3rd dose of Penta is considered invalid if the interval between 2nd dose and 3rd dose is less than four weeks

Invalid MR 1st dose: If 1st dose of MR is given before 270 days or nine months of age of a child

Invalid MR 2nd dose: If 2nd dose of MR is given before 450 days or 15 months of age of a child

Fully vaccinated: A child is fully vaccinated if the child has received all recommended doses according to the national immunization schedule by 12 months of age.

Sample Size Estimation

By using the following sample size estimation formula, minimum 440 number of samples was selected, however, 456 interviews were conducted successfully.

The overall sample size, *n*, is determined as follows:

$$n = \frac{Z_{\alpha}^{2} p(1-p)(DEFF)}{d^{2}}$$

where,

- Z_{α}^{2} = 1.96 at 5% level of significance
- Estimate of the expected proportion, = 0. 5
- Desired level of absolute precision, d = 6%

- Estimated design effect, DEFF = 1.5

Data Collection Techniques

Data from quantitative part were collected by using a structured questionnaire during January 2020. Experienced and skilled interviewers about immunization activities collected data in their smart phone and after rechecking the data, they sent data online. Qualitative data was collected during November 2020 to February 2021 due to nation-wide Covid situation. The In-depth Investigation technique was used as key informant interview (KII) with nine (9) key personnel from the policy level to field level staff (health care providers from NGO and city corporation) who were involved in EPI activities in study area. Two experienced qualitative interviewers were recruited to assist the first author to conduct KII for taking notes and transcribing the recorded interviews. These interviews were conducted face to face with relevant service providers, lasting for 30 to 90 minutes, and digital audio recorders were used for recording the interviews.

Data Analysis Technique

Descriptive analysis technique was used to assess the demographic and socioeconomic status, immunization details and immunization coverage indicators (fully vaccinated, dropouts) based on the knowledge, attitudes, and practice of parents regarding child immunization, calculation of changes. Chi-square test statistic was employed to assess the relationship between respondent's socio-demographic and vaccination status using STATA 14 software and statistical significance based on 95% confidence intervals.

For qualitative part, 1st author analyzed the data manually using the content analysis procedure and identified the themes as the reason of providing invalid vaccine doses to the children by the service providers.

Ethical Consideration

All data were collected from both mothers and service providers with written informed consent that they voluntarily participated in this study. Confidentiality was strictly maintained as per the Declaration of Helsinki and all ethical principles outlined in the Bangladesh Medical Research Council guideline throughout the study.

Results

For this study, we conducted a household-level survey where 456 respondents participated and successfully completed the survey who were the mother of 2-3 years aged child. Some demographic and socioeconomic indicators showed in the following table (Table 1).

Table 1. Demographic and Socioeconomic Status of Respondents

Socio-demographic indicators	Percentage/Proportion (n=456)		Mean	Mode
	Father	Mother		
Age				
15-30	-	396 (86.84)		
31-45	-	58 (12.72)	25.77	
46-60	-	2 (0.44)		
Education				
Illiterate/others	24 (5.26)	8 (1.75)		Primary (206) for mothers; Primary (166) & Secondary (165) for fathers.
Can read and write	69 (15.13)	70 (15.35)		
Primary	166 (36.4)	206 (45.18)		
Secondary	165 (36.2)	151 (33.11)		
Higher secondary	24 (5.26)	14 (3.07)		
Graduate	4 (0.88)	6 (1.32)		
Post-graduate	4 (0.88)	1 (0.22)		
Occupation				
Government service	2 (0.44)	1 (0.22)		Housewife (397) for mothers; Daily wage (254) for fathers.
Private service	83 (18.2)	10 (2.19)		
Business/Small business	87 (19.08)	6 (1.32)		
Housemaid /Daily wage	254 (55.7)	29 (6.36)		
Unemployed/Housewife	3 (0.66)	397 (87.06)		
Garments worker	27 (5.92)	13 (2.85)		
Average no. of children			02	
Average income of the Respondents			17357.02	
Average expenditure of the Respondents			15050.44	
Media exposure (Radio/Television/Newspaper)		78.07%		

Source: Field Survey, 2020. Note 2: 1USD = 84.65 BDT in 2020[18].

Parents' Knowledge of Routine Immunization Program

Among 456 respondents about 98% respondents claimed that they knew about the immunization program, but only 31.36% of respondents have knowledge about the number of vaccinations in the Government immunization programs (Table 2). In addition, only 4% of respondents claimed that they have knowledge regarding when a vaccination dose becomes invalid; even less than 4% of respondents said that they were acquainted with the term "invalid dose" of the vaccine schedule and informed about the invalid doses.

Table 2. Immunization Details of Children

Details	n=456 (Percentage)
Knowledge about Government Immunization Program	
Yes	447 (98.03)
No	9 (1.97)
Knowledge about the number of vaccinations in Government Immunization Program	
Yes	143 (31.36)
No	313 (68.64)
Know when the vaccination dose become invalid	
Yes	19 (4.17)
No	437 (95.84)
Informed about the invalid dose	
Yes	15 (3.29)
No	441 (96.71)
Child is vaccinated under EPI	
Yes	453 (99.34)
No	3 (0.66)
Condition of child's vaccine card	
Card was given and still available	368 (81.24)
Card was given but not available	85 (18.76)
Vaccination card is available	
Yes	325 (71.74)
No	128 (28.26)
Ever back from the vaccination center without doses	
Yes	25 (5.52)
No	428 (94.48)
Service providers talked about the subsequent dose	
Yes	389 (85.87)
No	64 (14.13)
Paid for the vaccine	
Yes	314 (69.32)
No	139 (30.68)

Source: Field Survey, 2020.

Table 3 represented the detailed knowledge level of the respondents about the vaccination procedures.

Table 3. Detail knowledge of vaccination procedures (n=456)

Types of Vaccine	For which	Where	When	How	No. of Doses
BCG	12.06%	-	59.65%	-	-
Pentavalent	0%	-	27.85%	-	29.39%
PCV	0.66%	26.54%	23.03%	-	23.9%
IPV	37.28%	-	0.22%	1.32%	0.66%
OPV	-	-	-	95.39%	34.65%
MR1	-	-	64.47%	-	-
MR2	-	-	55.26%	-	-

Source: Field Survey, 2020.

The majority of respondents did not know the reason for providing Polio vaccine to their children. About 37% of respondents knew that the IPV was given to their child to avoid disability. About 55% of respondents had knowledge about the timing when their child was required to get the second dose of Measles.

Parental Attitudes Towards the Vaccination program

About 96% of respondents showed a positive perception about the Government routine immunization program. According to them, these vaccines helped their children to increase their immunity and to become healthy. All respondents agreed that the Government's routine immunization program is required for the disease prevention of their children (Table 4).

Table 4. Parental Attitudes Towards Vaccination program

Immunization Details	n=456 (Percentage)
Perception of Government Routine Immunization Program	
Very good	19 (4.17)
Good	437 (95.83)
Routine Immunization is required for disease prevention	
Yes	456 (100)
No	0
Child received vaccine under the Routine Immunization	
Yes	453 (99.34)
No	3 (0.66)

Source: Field Survey, 2020.

Parental Practice on Routine Immunization Program

The respondents who showed their child's vaccination card (n=325) opined that their children received vaccination

services from the government's routine immunization program.

Table 5. Vaccination coverage

Types of Vaccine	Received (frequency)	Received (%)
BCG	325	100
Penta1	323	99.38
Penta2	309	95.08
Penta3	300	92.31
PCV1	323	99.38
PCV2	309	95.08
PCV3	295	90.77
IPV1	182	56
IPV2	143	44
OPV1	323	99.38
OPV2	307	94.46
OPV3	299	92
MR1	276	84.92
MR2	227	69.85

Source: Field Survey, 2020.

On assessing the immunization coverage of individual vaccines (Table 5), the coverage of birth dose of BCG was found to be the highest (100%). Though the study participants did not have any significant knowledge of the names of diseases that secure prevention from any specific vaccines, substantial percentages of respondents were quite aware of the vaccine schedule of their child.

For immunization knowledge and practice, access to media revealed a significant association. This finding indicated that media access might be a powerful tool to deal with the ignorance issue of invalid doses in immunization schedules in society. Individually, the mother's education had a significant impact on immunization knowledge, whereas the mother's age and the number of living children had a significant impact on immunization practice (Table 6). Parents' education and access to media had an association with immunization knowledge. The findings also revealed that in spite of having poor knowledge of the vaccination schedule, their vaccine-receiving (practice) proportion was high, and attitudes towards vaccination programs were quite positive. It also revealed that mothers' age, number of living children, and access to media had an association with immunization practice. The prevalence of immunization practice among young mothers (age below 30), mothers with an only child as well as mothers who are regularly exposed to media was comparatively high.

Table 6. Relationship between respondent's socio-demographic condition and vaccination status

Socio-demographic Indicators	Immunization knowledge (Percentage)	p-value	Immunization practice (Percentage)	p-value
Mother's age				
15-30	388 (85.09)	0.969	395 (86.62)	0.019*
31-45	57 (12.5)		56 (12.28)	
46-60	2(0.44)		2(0.44)	
Number of living children				
1	353 (77.41)	0.463	359 (78.73)	0.001*
2	81 (17.76)		81 (17.76)	
3	13 (2.85)		13 (2.85)	
Access to media				
Yes	355 (77.85)	0.014*	355 (77.85)	0.060†
No	98 (21.49)		98 (21.49)	
Mother's education				
Illiterate/others	7 (1.54)	0.042*	8 (1.75)	0.711
Can read and write	70 (15.35)		69 (15.13)	
Primary	199 (43.64)		204 (44.74)	
Secondary	150 (32.89)		151 (33.11)	
Higher secondary and above	21 (4.61)		21 (4.61)	
Economic Status				
0-15,000	246 (53.95)	0.590	251 (55.04)	0.977
15,000-30,000	188 (41.23)		189 (41.45)	
30,000-45,000	7 (1.54)		7 (1.54)	
45,000-60,000	6 (1.32)		6 (1.32)	

*Note: Percentage value in parentheses. P-value of Chi-square statistic is determined, where *Significance at 5% level and †Significance at 10% level. Source: Field Survey, 2020.*

Reasons for Providing Invalid Vaccine Doses: Service Providers' Perspective

From the service providers' interview, it was revealed that the occurrence of invalid doses in routine immunization programs was not a new. Though most of the respondents opined that service providers themselves play the most important role in providing valid vaccine doses, however, some programmatic aspects were also there behind this (Figure 1).

The service charge was one of the important factors, playing for providing invalid doses in an urban area as NGOs run this activity with their own finance. Therefore, business competition regarding service charge collection was another important factor in urban areas among the NGOs. However, awareness regarding vaccination was increasing day by day and people wanted to complete the vaccination schedule, but failed due to the service charges at NGO run health care centers. They changed their vaccination center to avoid service charges, but no health facility (except government facility) allowed them

and finally lost interest in completing the vaccination schedule of their children. Moreover, some of the NGOs working in urban areas had their own target and to meet this criterion, they gave vaccine doses to the children before the date of vaccination as they did not want to lose any single client each day.

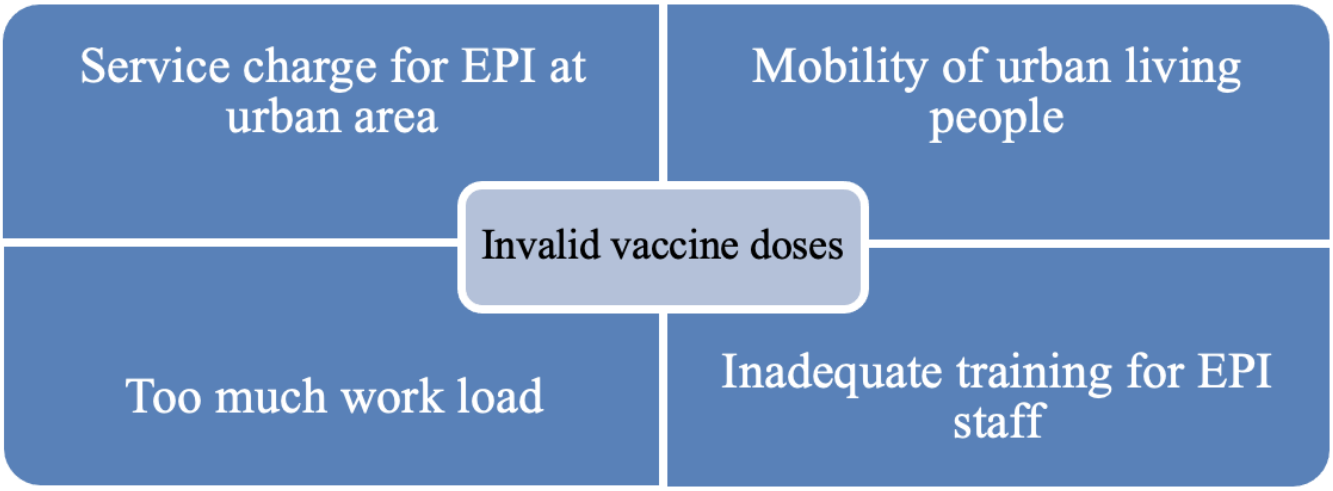

Figure 1. Reasons for providing invalid vaccine doses

Source: Author's depiction

Frequent mobility from one place to another was identified as another reason, which was related to the vaccination card retention practice. The urban living mobile population lost their child's immunization card during the house shifting. Most of them did not have any knowledge regarding the importance of the vaccination card, and it was difficult for the service provider to vaccinate a child with a valid dose without the vaccination card. Moreover, parents were not fully aware of the child's birth date, and they failed to provide the exact birth date to the service provider.

Inadequate workforce/resource person to conduct training and high turnover in the NGO sector was also a common picture. City Corporation officials were overburdened with their existing job responsibility and were not able to conduct any awareness program for mothers/caregivers. Inter-personal communication during vaccination was not possible due to the severe workload.

There was training related problem among the EPI staff as the authority arranged nationwide training at a time, which was not suitable for all types of organizations to comply with this schedule. Moreover, field staff of NGOs had to perform several responsibilities other than EPI; which reserved their ability to participate in the training program on time. Therefore, all NGO service providers did not get the basic EPI training in due time. Moreover, the concerned authority curtailed the training duration due to budget shortage.

Adequate knowledge and training were required for NGO-level staff to reduce the incidences of invalid vaccine doses. All respondents (service providers) opined that there was no alternative of basic EPI training for the service providers and two-day basic EPI training was not adequate for them. The lack of adequate workforce was another reason for providing invalid doses for which they seek some voluntary support from the community. They also shared their feelings that at least

4-day training was required to be informed about the newly introduced vaccine in the routine EPI as well as vaccine management procedures, such as cold chain management, infection prevention system, correct disposal of used needles and syringes, etc.

Discussion

The level of knowledge, attitude, and practice of parents regarding vaccination schedules under the routine EPI program of Bangladesh had been assessed in this study. It was revealed that almost all respondents (98%) informed about the routine vaccination program in Bangladesh. However, only 31% of our population knew the exact number of vaccinations against each disease. Even people were not aware of the vaccination schedule; they were fully dependent on the service providers. They all knew that the first vaccine was given to a child in the left hand, but they did not know the name of the disease for which the BCG vaccine is given to their children. Whereas, the Bangladesh EPI coverage evaluation survey report mentioned that BCG coverage rate was almost a hundred per cent in the country [4]. The same scenario was also seen in the case of the pentavalent vaccine. Bangladesh EPI initially introduced this vaccine in DPT form when three vaccines were given to a child at a time to protect them from three diseases, such as Diphtheria, Pertussis, and Tetanus. But later on, in 2009, Bangladesh EPI started providing pentavalent vaccines against five diseases, including the Hib vaccine against pneumonia and hepatitis B vaccine, along with the previous three vaccines. However, our study findings revealed that none of the respondents knew the name of the diseases for which the pentavalent vaccine was provided to their child. This finding clearly indicated that respondents were not properly informed about the current number and doses of vaccine schedules as well as they were never informed about the invalid vaccine doses by the service providers, which was similar to the findings of some researchers globally [6][19][20][21][22].

But interestingly, it was revealed that almost 24% of respondents correctly answered the number of doses of the PCV vaccine. This finding is interesting as the PCV vaccine was introduced in Bangladesh routine EPI in 2015, and quite new in the routine vaccination program [17][23]. Even 23% knew the exact vaccination schedule for PCV; 27% remembered correctly that the PCV vaccine was given to their child on the right thigh. In case of polio vaccine, Bangladesh achieved the status of ‘Polio free’ status since 2014, which is a great achievement for health sector [2][3]. But proper knowledge regarding this vaccine was quite low. Only 37% of respondents knew that the polio vaccine was given to their children to protect them from disability. However, the IPV vaccine, which was a polio vaccine in injectable form, is introduced in routine immunization program in 2015. This was a single-dose vaccine, but later it was converted into a two-dose vaccine and called the fractional dose of IPV. This IPV vaccine also faced a global shortage, and the supply was interrupted [24][25][26]; therefore, some children were not vaccinated for IPV during that time.

This study had some limitations as child vaccination data was from the mothers who showed their child’s immunization cards to the study personnel. Only the mothers’ perception was treated as their attitudes towards the vaccination process. Moreover, this study only focused on the impact analysis of behavioural aspects (knowledge, attitude, and practice) of valid vaccine doses in routine EPI but analysis of financial loss or economic aspects of invalid vaccine doses could be the focus of future research.

Conclusion and Recommendation

Child vaccination is the most appropriate and cost-effective health intervention throughout the world. The study contributes to identifying the possible reasons for providing invalid vaccine doses to children by the service providers as well as assessing parents' knowledge, attitudes, and practices regarding vaccination schedules under the routine EPI of Bangladesh. This study findings revealed that parental knowledge of invalid vaccine doses is very limited though parents are aware of the importance of vaccination. Even most parents do not know which types of disease or number of diseases are prevented through this vaccination program. Another important thing is slum living people mostly receive vaccination-related information from the service providers, but are never informed about the invalid vaccine doses. Therefore, this is very important to keep informed the slum people about valid vaccine doses by involving slum authorities in EPI activity as suggested by service providers. The slum authority/slum manager can play a vital role in mobilizing EPI-related information to the slum living people. Therefore, it may contribute to designing appropriate interventions for reducing the rate of invalid doses of vaccination schedule in this country and help to achieve the desired target of 90% coverage.

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Author's Contribution

TS designed, implemented, conducted data analysis, and prepared the manuscript. MM implemented the study at the field level and review the manuscript. SRD performed the statistical analysis.

Footnotes

[1] Definitions are directly taken from Bangladesh EPI coverage evaluation survey report 2020[4].

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