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MORALITY BEFORE KNOWLEDGE

Assessment of child and maternal immunization coverage among patients at medical college hospital: A hospital-based cross-sectional study

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ABSTRACT

Background: Immunization is thought to be a very successful and economical therapeutic strategy since it dramatically lowers death and disability from vaccine-preventable illnesses. The survey was carried out at Rangpur medical college hospital (RMCH), Rangpur Division, Bangladesh, with the aim of evaluating the vaccination makeup of kids and moms. **Methods:** During January and June 2025, systematic interviews and immunisation document checking served to gather information about 200 participants, comprising 120 mothers and 80 children. For the statistical assessment, both deductive and informative techniques were applied using SPSS version 25. **Findings:** According to the Expanded Programme on Immunisation (EPI) timeline, 65% of the children assessed (n = 80) did totally immunised, 25% did partly immunized, and 10% did none. 55% of mothers received tetanus toxoid (TT) boosters, 78% obtained TT2, and 90% obtained TT1. Mothers in the 20–30 age range showed the highest percentage of vaccination knowledge (65%), followed by those over 30 (55%) and under 20 (40%). Ignorance (42%), vaccine unavailability (28%), fear of complications (18%), and hospital proximity (12%) were the largest obstacles to complete immunization. Furthermore, compared to children from distant regions (45%), children from urban or semi-urban areas had higher full vaccination rates (72%) ($p = 0.012$). **Conclusion:** The results underscore the critical role of tailored community-based interventions and policy measures that address structural inequities, maternal empowerment, and healthcare accessibility. To increase equitable levels of vaccination throughout Bangladesh, the results emphasize the necessity of enhancing maternal welfare skills, ensuring that vaccines remain available, and integrating immunizations into routine healthcare for women and newborns. **Novelty/Originality of this article:** The study additionally explored the interplay of socioeconomic status, maternal education, and health system factors, providing a holistic understanding of immunization behavior and the underlying social determinants influencing vaccine uptake.

KEYWORDS: Bangladesh; child vaccination; cross-sectional study; immunization; maternal health.

1. Introduction

Immunization is thought to be one of the most economical and effective treatments that has been developed so far. Immunization is crucial in lowering the mortality and number of people with disabilities associated with a number of diseases, including cholera, poliomyelitis, pertussis, tetanus, diphtheria, hepatitis B, and tuberculosis (Lindstrand et al., 2021). According to estimations from the World Health Organization (WHO),

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immunizations prevent 4–5 million deaths annually, greatly enhancing advances in society and well-being assurance. Vaccines benefit patients and enhance their ability to recoup by preventing the spread of disease and safeguarding disadvantaged groups that may not always be ready to obtain them (Sáfadi, 2023). Beginning in Bangladesh about 1979, the entire System on Immunization aimed to make vaccines widely accessible to all women and children of reproductive age. Over decades, EPI has attained over 90% national makeup for vaccines such as Bacillus Calmette-Guérin (BCG), oral polio vaccine (OPV), diphtheria-pertussis-tetanus (DPT), and hepatitis. This success has had a key part in reducing the prevalence of childhood diseases, lowering infant and under-five mortality rates, and improving maternal health outcomes (Rahman, 2020). Inequalities still exist between towns and villages, people, social groupings, and areas notwithstanding such national successes. According to investigations, vaccination rates are considerably lower in the north, like in the Rangpur Division, where impoverishment, limited access to healthcare, and ignorance still affect vaccination uptake (Chowdhury & Ravi, 2022). Moreover, maternal education, cultural norms, and community perceptions play an equally significant role in vaccine acceptance. Women with limited exposure to formal schooling often rely on informal sources for health information, which may perpetuate misconceptions regarding vaccine safety. This demonstrates that immunization coverage is not only a matter of availability but is also heavily influenced by social determinants and behavioral patterns within households and communities. Understanding these multifactorial influences is crucial for developing interventions that are both effective and culturally sensitive. The Social Determinants of Health (SDH) framework provides an important theoretical basis for understanding these disparities, emphasizing that health outcomes are shaped by structural factors such as income, education, geography, and access to healthcare services rather than biomedical factors alone. In addition to the SDH framework, the Health Belief Model (HBM) provides an important behavioral lens for explaining vaccination uptake, particularly through constructs such as perceived susceptibility, perceived severity, perceived benefits, and perceived barriers that influence parental decision-making regarding immunization (Hassan et al., 2023).

A key component of comprehensive immunization regimens is providing double defense for mothers and infants via maternal immunization. Maternal and neonatal tetanus (MNT), a potentially fatal but avoidable illness that nevertheless kills thousands of people each year in developing nations, can be avoided by receiving tetanus toxoid (TT) vaccinations throughout pregnancy (Santilli et al., 2025). In order to preserve antibodies, the EPI in Bangladesh advises giving pregnant women two TT doses (TT1 and TT2), followed by an instant immunization. Although TT1 and TT2 coverage levels are rather high, often exceeding 80%, booster dosage availability remains variable, particularly in remote and rural areas. Inadequate follow-up, a lack of wellness credentials, and restricted opportunities for therapy are the main causes of the issue (Das & Hossain, 2021). The differentiation draws attention to the demand for greater oversight of maternity vaccinations and community education programs. In the same way, childhood immunizations continue to be a crucial component of pediatric preventative initiatives. The EPI's childhood vaccination schedule includes vaccines to prevent tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus, hepatitis B, Haemophilus influenza type B (Hib), and measles-rubella. Health efforts in Bangladesh are still hampered by inadequate or ignored vaccination, amid advances in general. According to facts, a sizable percentage of youngsters do not receive all recommended vaccinations, making them vulnerable to avoidable illnesses and antibody shortages (Shattock et al., 2024). Numerous reasons, such as familial disinterest, vaccine hesitation, anxiety about side effects, vaccine shortages, and the distance between homes and hospitals, contribute to poor results and inadequate immunizations. Furthermore, the problem is made worse by stereotypes, sexism, and deception about vaccinations (Cagnotta et al., 2025). The vaccination levels in Bangladesh also show regional differences. Downtown and, typically culturally, rural regions have higher vaccination rates due to improved healthcare services, higher educational attainment, and regular educational campaigns. Yet, transportation issues, the shortage of

efficient healthcare providers, and a lack of neighborhood mobilization are the main reasons why rural and isolated areas fail (Salahin et al., 2025). An excellent illustration of the problems is the Rangpur Division, which is mainly rural and has limited assets. Vaccine accessibility and awareness are still below par notwithstanding attempts by governmental and charity organizations; specific study is needed to pinpoint the roots and create tailored solutions (Meeting, 2022). However, existing literature still lacks sufficient facility-based evidence that simultaneously integrates maternal and child immunization outcomes with socioeconomic, behavioral, and health system determinants in tertiary care hospital settings in northern Bangladesh. Furthermore, immunization inequities are rarely analyzed within interdisciplinary sustainability and health equity frameworks, limiting understanding of how vaccination programs contribute to broader goals of social justice, equitable health systems, and sustainable development (Grand-Guillaume-Perrenoud et al., 2022; Park, 2026).

A comprehensive strategy that tackles social and financial hurdles is needed to increase vaccination acceptance. From the standpoint of the consumer, vaccination compliance is significantly impacted by maternal education, civic engagement, and trust in medical professionals. Higher educated mothers have the ability to understand vaccination timings, recognize the benefits of immunizations, and finish the course of treatment (Ozawa et al., 2023). Continued improvement on the supplier end involves growing offering, retraining medical staff, improving climate oversight, and guaranteeing continuous vaccine supply. Including vaccinations in women's and children's an ordinary improves protection and attachment, particularly in low-income environments (Hu et al., 2023). Recent public health approaches such as digital tracking systems, SMS reminders, and community engagement programs have shown potential in improving immunization adherence and reducing dropout rates. Enhancing vaccination programs is crucial in light of Bangladesh's SDGs, particularly SDG 3, which is about ensuring every person's maximum fulfillment in life. Achieving uniform immunization rates improves the hospital sector's broader durability while also lowering maternal and newborn mortality. Continuous evaluations are required to track shortcomings and handle new issues, including vaccine hesitancy, wrong data, and entry inequities, even in the face of notable progress (Sultana et al., 2023). Bangladesh’s immunization program is also closely linked with the Sustainable Development Goals (SDGs), particularly SDG 3, which aims to ensure healthy lives and promote well-being for all at all ages. Within this framework, equitable access to vaccination services represents a key indicator of health system performance and social justice. Disparities in immunization coverage based on income, education, and geographic location reflect broader inequalities in social determinants of health and sustainability governance, especially in low-resource settings such as northern Bangladesh. Equitable immunization coverage directly contributes to SDG 3 (Good Health and Well-being), as disparities in vaccine uptake reflect broader inequities in income, education, and healthcare access.

In light of those considerations, this investigation aimed to assess the immunization practices of women and children who frequently visit RMCH, a significant healthcare center in the country's north. The purpose of this research is to produce medical data that accurately depicts current vaccination standards, pinpoint the variables affecting vaccination uptake, and identify locations requiring assistance. This study aims to provide a comprehensive assessment of vaccination gains in the area by concentrating on both maternal tetanus toxoid coverage and child immunization tolerance. Additionally, this study sought to examine the interconnectedness of maternal health education, socioeconomic status, and healthcare infrastructure in influencing immunization outcomes. By evaluating both maternal and child vaccination status concurrently, the research provides a dual perspective on the impact of systemic, social, and behavioral factors on overall community immunity. This dual focus enables policymakers and healthcare practitioners to design interventions that simultaneously strengthen maternal health services and child immunization initiatives. Recent developments in maternal and child immunization strategies emphasize the necessity of innovative outreach approaches and digital health solutions to address persistent gaps in vaccine coverage. The implementation of digital

tracking systems, mobile health notifications, and SMS reminders has shown promise in improving adherence to EPI schedules, particularly for TT boosters among pregnant women and follow-up doses for children. Seasonal challenges, including floods and climate-induced migration, frequently disrupt vaccine delivery and cold-chain management in northern Bangladesh, necessitating adaptive and flexible service provision. Furthermore, engagement of fathers, elder caregivers, and community leaders in vaccination education programs has demonstrated increased compliance, highlighting the role of family and community support in health-seeking behaviors. Addressing socio-economic barriers through strategies such as conditional cash transfers and localized vaccination centers can also incentivize participation and reduce disparities between urban and rural populations. The integration of these approaches with traditional healthcare delivery not only enhances overall coverage but also fosters sustainability by embedding vaccination awareness within community structures. Given these challenges and opportunities, targeted interventions combining technology, community mobilization, and context-sensitive planning are crucial for achieving equitable, comprehensive immunization, thereby contributing to national goals for maternal and child health, and advancing the broader public health agenda in Bangladesh. The objectives of this study are to determine the prevalence of full, partial, insufficient, and deficient vaccine coverage in children under five years old; analyze the findings of TT vaccines administered following birth, including boosters, TT1, and TT2; examine mothers' knowledge of vaccinations throughout age groups; identify significant obstacles and factors affecting parental and child vaccination compliance; and compare vaccination rates and outcomes in both urban and rural areas of Rangpur District. Through fulfilling this context, the study provides relevant information on the present immunization's deficits in addition to realistic suggestions to improve immunizations procedures in Bangladesh. The results are anticipated to help healthcare providers, programmer managers, and medical officials create beneficial measures targeted at attaining equity and long-term vaccination rates across the country.

2. Methods

2.1 Examine the atmosphere and design

In order to evaluate immunizations coverage among women and children visiting RMCH, a significant higher-education referring facility servicing the Rangpur Division in the north of the country, the current investigation used a descriptive, hospital-based representative structure. RMCH serves a sizable regional area that includes rural as well as urban dwellers from districts nearby, including Nilphamari, Kurigram, Lalmonirhat, and Gaibandha. The hospital is a perfect place to assess immunizations coverage in communities of mothers and children since it offers full medical treatments, encompassing prenatal, postnatal and pediatric treatment. The investigation was carried out from roughly January to June 2025, which is a period of over six months. The Outpatient Department (OPD), the Antenatal Care (ANC) unit, and the Pediatric Section were the 3 main RMCH locations from which information was obtained. These sections were chosen in particular because they serve children who qualify to receive the EPI and women of adulthood. In order to provide a balanced representation of the target population within the Rangpur Region, the schedule and location of gathering information had been established to include all urban and rural individuals who frequently look for treatment at the institution. Although the hospital-based design ensures access to a diverse clinical population, it may not fully represent community-level populations who do not seek healthcare services at tertiary facilities.

2.2 Analyze the sample method and demographic

Moms between the ages of eighteen and forty-five who attended ANC or postpartum treatments along with kids between the ages of 0 and 59 months who accompanied their mothers to pediatric or outpatient services made up both categories that participated in the

study. Using a non-probability convenience sampling technique, 200 people in total participated in the enquiries. This enabled the investigators to recruit individuals that were accessible and satisfied those requirements throughout the exploratory time. Time restrictions and the requirement for actual viability in a healthcare context led to the selection of this method of sampling. Of the total participants, 120 were mothers and 80 were children, representing the core groups under the study objectives. The ratio between maternal and child participants was determined to ensure adequate representation for both population segments. The use of convenience sampling, while practical in a tertiary hospital setting, limits the probability of random selection and may introduce selection bias. Compared with the broader Rangpur Division population, the sample is likely to over-represent healthcare-seeking, relatively more accessible households, while under-representing hard-to-reach rural and socioeconomically disadvantaged groups. This difference should be considered when interpreting the findings, particularly in relation to external validity and generalization beyond the hospital population. The study design is cross-sectional in nature, allowing assessment of immunization status and associated factors at a single point in time. The sample size (n = 200) was determined based on feasibility within the study period and availability of eligible participants in the selected hospital departments.

Inclusion Criteria: Mothers aged 18–45 years having an actual birth within the preceding 5 years. Children aged 0–59 months who were eligible for EPI vaccinations, with immunization information verified either through vaccination cards or maternal recall. Exclusion Criteria: Critically ill mothers or children who could not participate in the interview process. Respondents are unwilling to provide informed consent or share immunization details. Before collecting information, all eligible respondents have been made aware of the investigation's objectives, procedures, confidentiality, and voluntary nature. A formal authorization being acquired from each respondent following ethical approval from the Institutional Review Board (IRB) of Rangpur Medical College.

2.3 Methods, instruments for collecting information and ethical considerations

A previously validated, organized survey was used to gather information developed in English and translated into Bengali for ease of understanding. The instrument was designed based on WHO immunization coverage assessment guidelines and previous literature on maternal and child vaccination studies conducted in Bangladesh. The questionnaire showed great dependability along with excellent internal consistency with a Cronbach's alpha coefficient of 0.86. The 4 primary parts of the info-gathering device were as follows: Maternal age, education, occupation, household income, and residential status (rural or urban) were among the characteristics of society. Maternal immunisation background: Tetanus toxoid vaccine information, including TT1, TT2, and TT booster dosages, was discussed. Child immunization past: Recorded kid's vaccination status in accordance with the national EPI schedule, including BCG, DPT, OPV, Hepatitis B, Hib, and Measles-Rubella. Mothers' understanding of immunization advantages, timetables, and possible challenges like vaccine unavailability, side effects, and accessibility was measured using a 10-item understanding and mindset questionnaire.

Data Collection Procedure: Six nursing students with training had been hired to gather data from the ground. Participants attended a two-day instruction on interviewing methods, scientific procedures, and immunisation document validation before starting to gather information. Individual interviews using a planned survey were used to collect data, and when accessible, immunization records were then verified. 72% (n = 144) of the 200 people surveyed had immunization documents, while the remaining 28% supplied vaccination information according to mother recollection. During every day meetings, supervision (the primary experimenter and experienced nursing trainees) routinely checked the accuracy and reliability of the information provided. Every person involved was given a hidden identifying number to ensure complete privacy. To minimize recall bias, immunization cards were prioritized whenever available, and self-reported data were used only when

records were absent. Data collection was conducted in a private setting within hospital premises to ensure confidentiality and reduce response bias. The RMCH IRB gave the investigation ethical clearance. Before taking part, spoken explicit permission was collected, and individuals were made aware of the ability to withdraw at any moment free of incurring any penalties. Every piece of information gathered was safely maintained and utilized solely for scholarly study objectives.

2.4 Data processing, evaluation and study methodology flow

Upon collecting data, responses were coded and loaded into the Statistical Package for the Social Sciences (SPSS) version 25 for analysis and abnormalities. For the characteristics of society, vaccination coverage, and education extents, mathematical approaches such as indicators, percentages, rates, and variances were used to give a summary. Inferential statistics were applied to identify associations between categorical variables. The chi-square (χ^2) assessment conducted employed to examine connections involving immunization coverage then chose sociodemographic differences like maternal age, education, and residence. A p-value of less than 0.05 is its definition. Tables and illustrations were employed to efficiently and precisely communicate the results. All statistical analyses were performed at a 95% confidence interval to ensure robustness of findings. Data cleaning and validation were performed prior to analysis to remove inconsistencies and missing values.

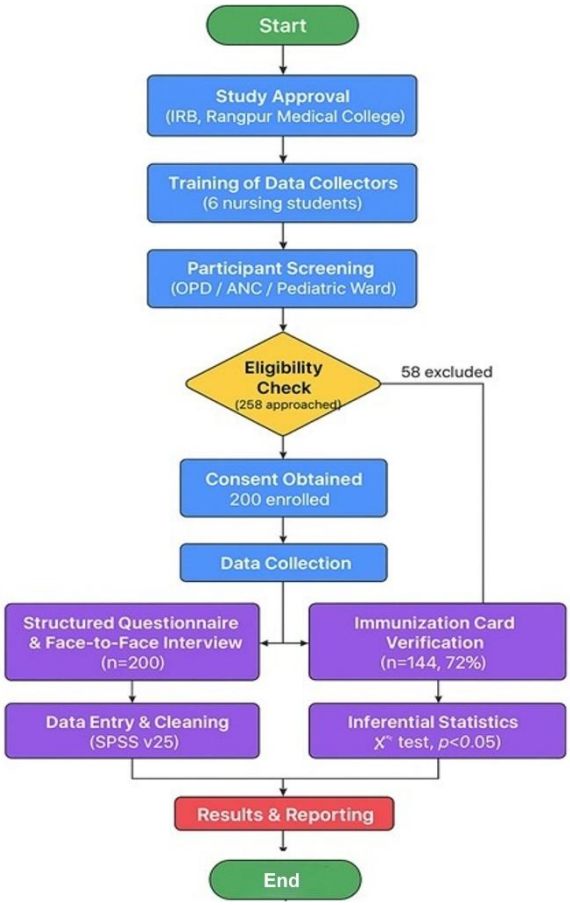

Fig. 1. Participant selection, data collection, and analysis procedures at RMCH, Bangladesh, with a flowchart of the investigation's approach.

The investigation's methodical procedure, from institutional approval to statistical evaluation, is shown in Fig. 1. 200 of the 258 candidates who had been evaluated and met the necessary requirements eventually got recruited. This article uses a qualitative study approach to Onil Secondhand Balikpapan, a secondhand clothing retailer. Of the many

sellers who might practice business ethics, Onil Secondhand was chosen for the following reasons: Onil Secondhand explicitly states that they sell clothing to address and practice Islamic values in urban areas. Data was collected through extensive literature and media searches, as well as interviews with consumers and vendors. All data collected was categorized, interpreted, and analyzed using a qualitative approach.

Validated questionnaires and card verification were used for gathering information, to be then entered, cleaned, and analyzed. Data collection was conducted ethically and systematically: structured face-to-face interviews using a prevalidated questionnaire captured socio-demographic details, maternal knowledge, attitudes, and practices related to childhood immunization for all 200 enrolled participants. Simultaneously, immunization status was objectively verified by checking vaccination cards whenever available (n=144, 72%). This dual approach minimized recall bias and enhanced data accuracy. All data were double-entered into SPSS version 25 for quality control, followed by rigorous cleaning to identify and correct missing values, outliers, and inconsistencies. Descriptive statistics (frequencies, percentages, means, and standard deviations) summarized participant characteristics and immunization coverage. Inferential analysis employed the Chi-square (χ^2) test to examine associations between key variables (e.g., maternal education, antenatal care attendance, and complete immunization status), with statistical significance defined at $p < 0.05$. Results were presented in tables and figures, interpreted in the context of existing literature, and discussed with implications for public health policy and future interventions in similar low-resource settings. The study followed a sequential workflow including screening, enrollment, data collection, verification, analysis, and interpretation stages.

2.5 Statistical status of the participants

The majority of the moms lived in the countryside (58.3%) and belonged to the ages of 20 and 30 (58.3%), which is consistent with the demographic profile of the northern Bangladeshi population. With 58.3% having either no higher learning or merely elementary schooling, the graduation rate was relatively poor. A significant percentage of families (45.8%) made less than BDT 10,000 per month, highlighting financial constraints that may affect health-related behaviors, particularly vaccination compliance.

Table 1. Maternal and infant socioeconomic makeup (N = 200)

Characteristic	Mothers (n = 120)	Children (n = 80)
Age Group		
< 20 years	25 (20.8%)	-
20-30 years	70 (58.3%)	-
> 30 years	25 (20.8%)	-
Child Age		
0–11 months	-	30 (37.5%)
12–23 months	-	35 (43.8%)
24–59 months	-	15 (18.8%)
Residence		
Urban	50 (41.7%)	
Rural	70 (58.3%)	
Maternal Education		
No formal education	30 (25.0%)	-
Primary	40 (33.3%)	-
Secondary or Above	50 (41.7%)	-
Monthly Income (BDT		
<10,000	55 (45.8%)	-
10,000-20,000	45 (37.5%)	-
> 20,000	20 (16.7%)	-

Additionally, the demographic profile reflects the influence of social determinants such as education and income on healthcare behaviors, showing that low literacy and economic hardship correlate with lower awareness and utilization of immunization services. This

baseline characterization provides an important framework for interpreting vaccination uptake patterns and designing context-specific interventions.

3. Results and Discussion

The results of the evaluation of information of 200 respondents—120 mothers and 80 children attending RMCH—are presented in this subsection. The findings are arranged in accordance with the goals of the investigation, with particular attention paid to income differences, literacy impediments, maternal vaccination achievement, and immunisation completeness. Summary information is used to summarise the information, and when necessary, inference evaluation is included.

3.1 Child immunization status

According to the national EPI schedule, 65% (n = 52) of the 80 children evaluated in the present investigation had received all recommended vaccinations. Ten percent (n = 8) had no vaccinations at all, whereas a further twenty-five percent (n = 20) were only partly immunized due to missing one or more scheduled doses. This split shows that while most children got every necessary vaccine, a sizable percentage (35%) failed to receive any immunizations at all or only a few of them, which could jeopardize the development of local collective immunity. The above results indicate that targeted interventions are required to bridge the gap in partial or non-immunized children, particularly in rural areas where access, awareness, and parental education remain obstacles.

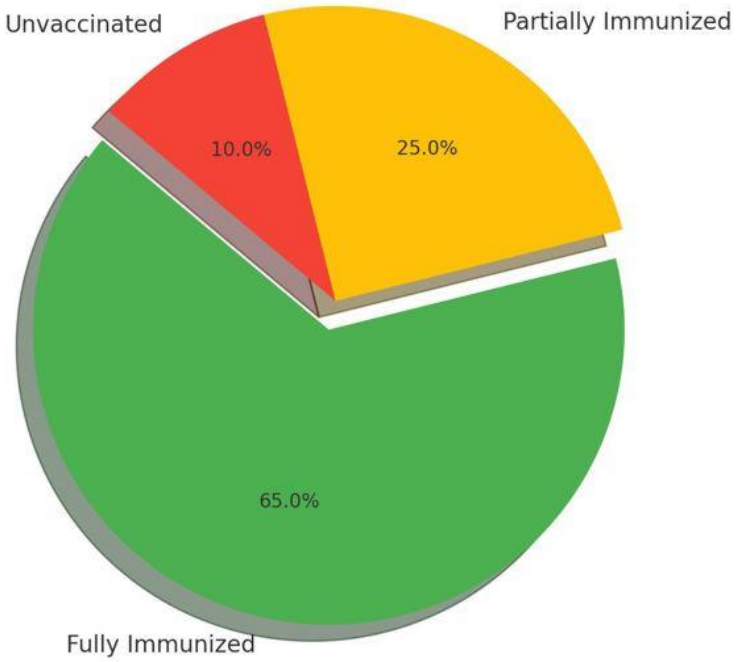

Fig. 2. Respondents' completion of child immunity (n = 80)

Fig. 2 shows child immunization status among children aged 0–59 months (n = 80) attending Rangpur Medical College Hospital, Bangladesh, showing proportions of fully immunized (65%), partially immunized (25%), and non-immunized (10%) according to the EPI schedule. The analysis underscores the need for combined strategies addressing social, economic, and logistical barriers to improve full vaccination rates. The above results are consistent with national immunization assessments conducted in Bangladesh that indicate that, notwithstanding generally good EPI availability, inadequate vaccination is a chronic problem. Household ignorance, availability problems, and vaccine shortages in faraway locations are among the causes. Nearly two-thirds of the kids got completely immunized,

according to a pie chart, indicating a reasonable level of achievement. But the other 35% of children, who are partly or not immunized, constitute a significant service deficit which might undermine vaccination limits, especially in rural regions with large populations. The results are consistent with national data in Bangladesh, which indicates that children with families with more money and cities with more educated moms are more likely to have received all recommended vaccinations (Kundu et al., 2023).

3.2 Prevalence of maternal tetanus toxoid (TT) vaccinations

For 90% (n = 108) of the 120 participating mothers received the first dosage (TT1) of tetanus toxoid, whereas 78% (n = 94) got the next dose (TT2), according to the assessment of maternity immunizations state. Yet, just over half (n = 66) of the booster dose was completed. Sustaining vaccination continuation over subsequent pregnancies or reproductive years is hampered through behavioral and physical obstacles, as evidenced by the gradual decline between TT1 and the TT booster. Although few moms mentioned sporadic prenatal checkups and lack of vaccines as causes for inadequate regimens, others noted confusion about the need for booster doses.

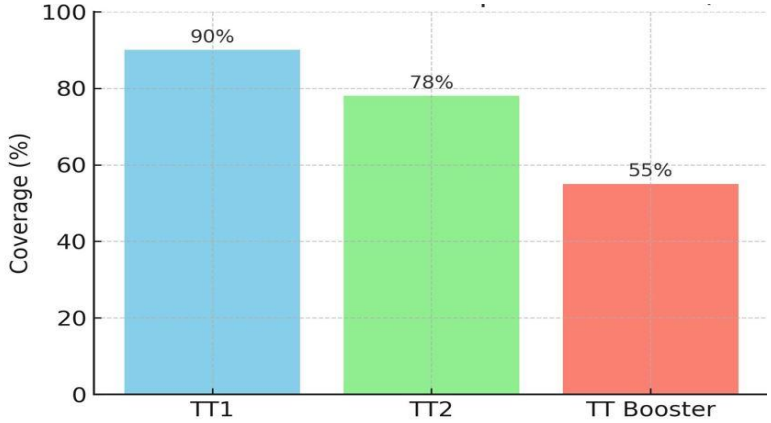

Fig. 3. TT vaccine outcomes for mothers (n = 120)

Fig. 3 shows maternal tetanus toxoid (TT) vaccination coverage among mothers (n = 120), indicating uptake of TT1 (90%), TT2 (78%), and TT booster dose (55%) during pregnancy and reproductive age group.

These findings emphasize the need for consistent counseling and follow-up mechanisms to ensure that mothers complete the entire TT vaccine schedule, particularly in communities with low literacy or limited access to health facilities. TT1 (90%) consistently declines to TT2 (78%) and TT booster (55%), according to a vertical bar chart. In order to guarantee that women receive the entire TT vaccine series throughout their periods, this pattern highlights the necessity of improved monitoring procedures, community outreach, and educational initiatives. The reported decrease in TT1 to TT booster is in accordance with research in Bangladesh that found women having greater degrees of education and better living conditions showed far greater rates of tetanus toxoid vaccination (Islam et al., 2022).

3.3 Age-specific maternal vaccination knowledge

Mother's age and understanding of the significance of vaccinations were found to be significantly correlated in the present investigation (p = 0.021). Moms between the ages of 20 and 30 had a greater degree of knowledge (65%) than moms over the age of 30 (55%) and moms under the age of 20 (40%). This chronological variation is in accordance with current statistics in Bangladesh's rural and semi-urban areas, that newer mothers—especially teenagers—show noticeably less knowledge of vaccination schedules and

benefits as a result of premature marriages, lack of higher learning, and decreased use of prenatal healthcare amenities.

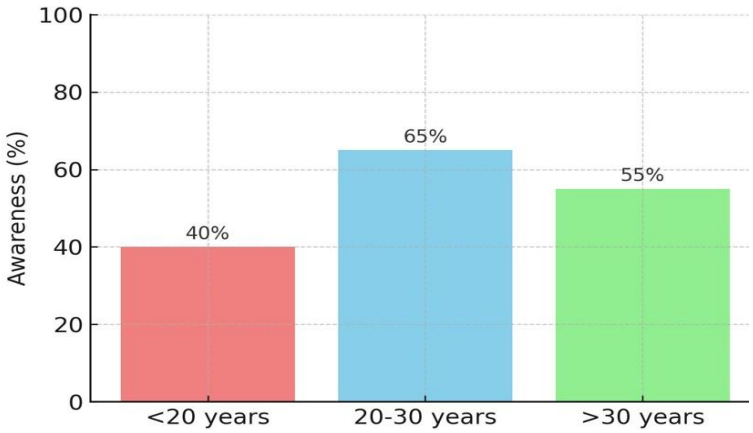

Fig. 4. Mother immunization knowledge by adults

Fig. 4 shows age-wise distribution of maternal knowledge regarding immunization, showing higher awareness among mothers aged 20–30 years (65%) compared to younger and older age groups. A distinct increased trend in awareness with age and maturity can be seen in this grouped bar diagram. Moms below the age of 20 showed a poor comprehension of vaccination times, suggesting that early-life health education initiatives might be crucial in enhancing later maternity immunization practices. The age-related slope is constant; recent data in Bangladesh indicates younger mothers (moms under the age of 20–24) and those with limited access to maternity care have lower awareness and fewer perceptions of earlier vaccinations (Roy et al., 2024).

3.4 Barriers to immunization

Out of the 200 responders, 48 people (24%) provided a range of justifications for their own or their incomplete or neglected vaccines. The following were the main challenges identified: Ignorance (42%), Vaccine unavailability or stockouts (28%), Fear of side effects or vaccine hesitancy (18%), Distance to health facilities (12%). These findings highlight that both knowledge-related and system-related factors contribute significantly to under-immunization.

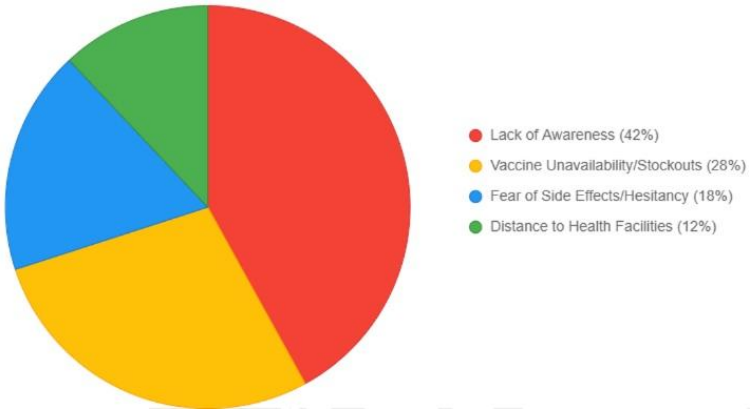

Fig. 5. Causes of missing or partial vaccinations (n = 48)

Addressing supply-chain limitations alongside comprehensive community education can bridge these gaps. These findings highlight that both knowledge-related and system-related factors contribute significantly to under-immunization. Problems with technology underscore the importance of supporting the frozen food supply or healthcare area, and the generality of knowledge indicates the need for further neighborhood sensitization efforts.

Fig. 5 shows reported barriers to child and maternal immunization (n = 48), highlighting ignorance (42%), vaccine unavailability (28%), fear of side effects (18%), and distance to health facilities (12%). The obstacles influencing vaccination compliance are ranked graphically in the above image. The primary reason for this was found to be ignorance, which was followed by problems with logistics and anxiety about negative consequences. These trends are consistent with results from the Bangladesh Demographic and Health Survey (BDHS) in 2022, which found that rural and semi-urban communities had comparable factors that contributed to inadequate immunization. These trends are consistent with global research demonstrating that supply-side limitations (e.g., vaccine stock-outs, length to institution) and consumer barriers (e.g., lack of knowledge, fear of side effects) are important causes of missing or partial immunization (Jelle et al., 2023).

3.5 Urban–rural disparities in immunization coverage

Immunization rates for children showed a significant gap between urban and rural areas. A mere 45 per cent of children in rural areas are being completely immunized, as opposed to 72 per cent of children in urban and semi-urban areas. It proved that there was indeed a strong correlation between immunization state and the location of living (χ^2 test, p = 0.012). While rural households deal with issues including significant fare, sporadic engagement events, and low knowledge, urban people enjoy more proximity to medical care, frequent immunization programs, and greater mother reading

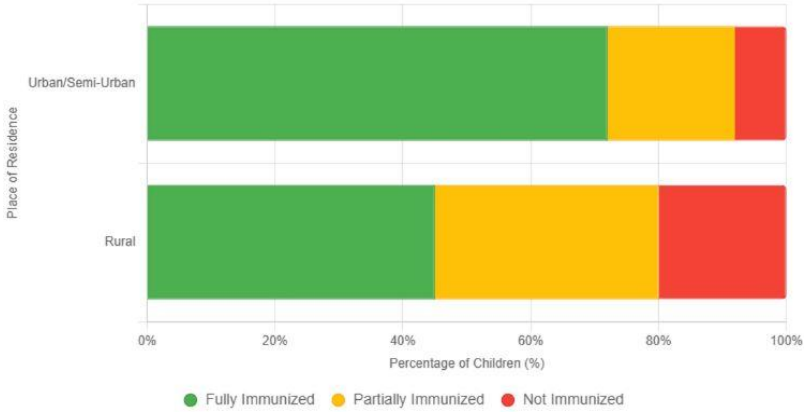

Fig. 6. Complete vaccination of children by place of residency

Urban and rural populations vary significantly, as shown by the layered bar chart. The percentage of fully immunized children is greater in urban areas, whereas the percentage of partially and non-immunized infants is higher in rural areas. The discrepancy draws attention to the structural unfairness in the delivery of healthcare in different Rangpur Division areas. These results are in line with prior research from Bangladesh showing that kids living in city ghettos or isolated rural areas are disproportionately malnourished even when nursing and pregnant women are taken into account (Jannat et al., 2024). Fig. 6 shows urban–rural comparison of full immunization coverage among children, demonstrating higher coverage in urban/semi-urban areas (72%) compared to rural areas (45%), with statistically significant difference (p = 0.012).

3.6 The relationship between parenthood and TT boosters

The study looked into the relationship between the completion of TT booster dosages and the mother's knowledge rates. The results demonstrated that education had a substantial impact on TT supplement usage (p = 0.034). Completing the TT booster course was considerably greater among moms with greater degrees of schooling. Women who have received training are more confident when engaging with cares, have a better understanding of preventive healthcare, and are mindful of immunizations protocols.

Table 2. Maternal education level and TT booster uptake among mothers

Maternal Education	Received TT Booster (n = 66)	Did Not Receive (n = 54)	p-value
No Formal Education	12 (40%)	18 (60%)	
Primary	20 (50%)	20 (50%)	0.034*
Secondary or Higher	34 (68%)	16 (32%)	

Note. $p < 0.05$ indicates statistical significance (χ^2 test)

It supports the idea that better maternal and child health outcomes are correlated with female education. The observed association between maternal education and TT booster completion is consistent with evidence from Bangladesh showing that women with higher education and better living standards had significantly higher tetanus-toxoid immunization coverage. Our findings that mothers with secondary or higher education had significantly greater TT-booster uptake (68% vs 40%) are consistent with evidence from Bangladesh showing educated mothers had ~47% higher odds of TT immunizations, as well as studies from Ethiopia/Eritrea and Benin where higher maternal education was a strong predictor of TT vaccine uptake (Bizuneh & Mustofa, 2024)). These findings highlight the critical role of maternal education in increasing TT booster compliance, reflecting the broader impact of literacy on health-seeking behavior and preventive care utilization.

3.7 Child vaccination status by monthly household income

Socioeconomic status was another determinant of immunization adherence. As shown in Table 3, vaccination completion rates increased proportionally with monthly household income. Hildren from low-income households were more likely to be partially or not immunized, according to the information, which clearly shows a socioeconomic difference.

Table 3. Correlation between respondents' child immunization history and their financial security

Monthly Income (BDT)	Fully Immunized	Partially Immunized	Not Immunized
< 10,000	18 (32.7%)	12 (60%)	5 (62.5%)
10,000–20,000	25 (48.1%)	6 (30%)	2 (25%)
> 20,000	9 (17.3%)	2 (10%)	1 (12.5%)

Caccess to healthcare facilities, transportation, and knowledge possibilities are sometimes restricted by economic hardship, particularly in rural populations. The findings indicate that targeted social protection and outreach programmes are necessary to ensure equitable vaccination makeup regardless of disparities in income. Our result that total immunizations increases with greater finances is consistent with the most recent investigation conducted in Bangladesh, which demonstrates that financial status is a significant driver of total childhood vaccination. Parallel to the findings that total immunizations rises depending on incomes at home, a new study in Bangladesh found that children of parents with increasingly raised hardship rankings were nearly 27% less likely to receive full immunizations (Acharya et al., 2022). This demonstrates that income disparities directly affect vaccination coverage. Targeted financial support, outreach, and educational interventions are necessary to ensure equitable access to immunization services.

3.8 Overview of the main conclusions

According to the survey, 35% of children had been somewhat or not immunised, and 65% of children were fully immunised. Maternal TT attendance decreased from TT1 (90%) to booster doses (55%), and vaccination expertise was significantly correlated with moms' age ($p = 0.021$). Lack of knowledge (42%) and actual hurdles (28%) were the main obstacles. Urban and rural areas had greatly varying total immunisation rates ($p = 0.012$), with increased earnings and schooling having a beneficial effect on the end. Social

economics and regional disparities persist despite Bangladesh's usually effective national immunization programs, highlighting the significance of programs focused on healthcare access, education, and awareness. These findings highlight that despite national immunization programs, structural, socioeconomic, and educational factors continue to influence maternal and child vaccination coverage in northern Bangladesh. The results highlight the urgent need for multifaceted strategies to improve immunization coverage, especially among vulnerable populations in rural and low-income communities. Strengthening healthcare infrastructure, ensuring consistent vaccine supply, and improving cold-chain logistics can directly address system-related barriers. Simultaneously, targeted community education programs are crucial to reduce misinformation, alleviate fears about side effects, and raise awareness about the benefits of completing the full immunization schedule. Engaging local leaders, schoolteachers, and community health volunteers can enhance trust and encourage participation in vaccination programs. In addition, innovative solutions such as mobile health campaigns, SMS reminders, and home-based record tracking can improve follow-up for TT booster doses and childhood vaccines, particularly in remote areas. Social protection initiatives, including conditional cash transfers or transport subsidies, can mitigate economic barriers that hinder access to healthcare facilities. Finally, ongoing monitoring and evaluation, including disaggregated data by region, income, and maternal education, are essential to identify gaps promptly and adapt interventions accordingly. By combining these systemic, educational, and technological approaches, policymakers and health practitioners can ensure more equitable immunization coverage, strengthen herd immunity, and contribute to achieving national and global targets for maternal and child health. These strategies align with Bangladesh's commitment to SDG 3 and sustainable healthcare development.

3.9 Discussion

This investigation offers hospital-level data on the vaccination rate among mothers and children in Bangladesh's north, providing crucial information on vaccine compliance, influences, and obstacles. The results show that vaccination rates among mothers and children are generally average, with significant variations linked to the mother's level of education, income level, and place of residence. Children in this poll showed a full immunization level of 65%, as opposed to almost 80% observed in the Bangladesh Demographic and Health Report (National Institute of Population Research and Training (NIPORT;, 2017)). Such lower rates are in line with other research in both northern and distant Bangladesh, which found that community awareness, transportation challenges, and medical expenses are obstacles to vaccination adoption. Delay during preliminary and last doses remains a major problem, as seen by the 25% inadequate immunization rate compared to the 10% absence from vaccination rate. Especially in remote locations featuring thick people, inadequate immunization reduces local collective immunity and raises susceptibility to diseases that may be avoided. These findings emphasize the need for targeted interventions to improve coverage among underserved populations (Akter & Kabir, 2023). This indicates that immunization outcomes are not only dependent on individual behavior but are strongly influenced by structural health system factors such as service delivery efficiency, governance quality, and accessibility of care, highlighting the importance of a systems-based approach to improving vaccine equity.

A usual amount of TT2 (78%), a significant absorption of TT1 (90%), and a significantly reduced addition to dosage rates (55%) were all demonstrated by mother TT uptake. The slow transition from TT1 to booster doses is consistent with research from nearby nations such as India and Nepal, where similar delays in maternal vaccination schedules have been seen. The findings draw attention to shortcomings in methods of monitoring and hospital consistency for a greater number of infants. Weak direction, missing prenatal visits, and gaps in health worker outreach programs are probably the main causes of low mother vaccinations. Improving monitoring programs, documentation, and alerts could promote adherence to additional dosages and lower the risk of tetanus in women and newborns

(Naha et a., 2025). It has been proved that parental education significantly affects both mothers' and children's immunization rates. Parents that completed the TT inoculation regimen and made sure their children had all required vaccinations were substantially more likely to have a college degree or higher. This result is consistent with global research findings that highlight the role that female users play in encouraging healthy actions such as scheduling compliance, asking for help, and vaccination uptake. Studying improves knowledge of infection prevention, confidence in navigating healthcare facilities, and understanding of the advantages of vaccinations. Parents with excellent knowledge levels, on the other hand, showed poorer vaccination compliance, underscoring the necessity of focused health education in undereducated areas (Vikram et al., 2020). These findings suggest that education alone is not sufficient to ensure optimal immunization uptake unless it is supported by targeted health communication strategies, community engagement, and strengthened service delivery systems that together address both awareness and access barriers.

One of the main obstacles found in this survey is an absence of fluency and understanding, with 42% of respondents attributing this problem to their insufficient vaccination. 18% of respondents said that their reluctance is made worse by the dread of negative consequences. These difficulties highlight the importance of tailored advice, steady assistance, and efficient medical interaction when interacting with moms and kids. Periodic consulting throughout pregnancies and after delivery enhances immunization uptake and reduces vaccine phobia, according to surveys conducted in Bangladesh and South Asia. She showed the lowest awareness levels (in the age group of less than 20 years), and categories, societal engagement, and helpful messages could close the literacy deficit, especially for adolescents and newlyweds (Jose et al., 2016). There were significant differences between rural and urban settings; kids living in towns and cities had complete immunization rates of 72%, compared to 45% in rural areas ($p = 0.012$). This disparity is a result of variations in outreach access, travel, quality of services, and health facilities. Extended commutes to hospitals, erratic vaccination supplies, and a shortage of qualified medical staff are common problems for rural communities. As a result, these kids are more vulnerable to VPDs and have a higher chance of receiving insufficient vaccinations. To provide free contact immunization efforts in rural regions, they must be strengthened, and infrastructure injustices must be addressed (Crocker-Buque et al., 2017). These rural–urban differences reflect not only geographic inequality but also deeper structural inequities in health system distribution and resource allocation, suggesting the need for equity-focused immunization strategies that prioritize underserved and hard-to-reach populations. The observed 65% full child immunization coverage in this hospital-based sample is notably lower than the self-reported figures in nationally representative surveys, which may reflect recall bias or selection effects in community-based data collection. Hospital attendees in tertiary facilities like RMCH often include more complicated cases or families from remote upazilas who travel long distances only when facing serious illness, potentially skewing the sample toward lower immunization status. This ascertainment bias highlights the value of facility-based studies in uncovering hidden inequities that population surveys sometimes miss. Furthermore, the partial immunization rate of 25% signals a significant dropout problem, commonly occurring after the first few doses when parental motivation wanes due to perceived low risk or competing household priorities. Behavioral economics approaches, such as small nudges via SMS reminders or community incentives, have shown promise in similar settings to reduce such dropouts.

Urban-rural divides in immunization are not unique to Rangpur but mirror broader patterns across Bangladesh and other South Asian nations. In India’s Bihar and Uttar Pradesh states, similar gradients have been documented, with rural coverage lagging by 20–30 percentage points due to weaker frontline worker density and poorer road connectivity. In Rangpur, the predominance of agricultural livelihoods means that peak farming seasons coincide with immunization outreach schedules, leading to missed opportunities. Strengthening routine immunization micro-planning at the union level, coupled with engagement of agricultural extension workers to disseminate health messages during

seasonal gatherings, could help synchronize health service delivery with local livelihood patterns. Additionally, empowering female community health volunteers (often called Shasthya Shebikas in BRAC-supported programs) with performance-based incentives has proven effective in sustaining outreach in hard-to-reach char and haor areas of northern Bangladesh. The interplay between maternal education, household income, and immunization uptake underscores the multidimensional nature of vaccine hesitancy and access barriers. While education empowers women with health literacy and decision-making autonomy within households, poverty constrains physical access and opportunity costs associated with clinic visits. In low-resource contexts, conditional cash transfers linked to immunization completion — successfully piloted in Pakistan and parts of India — could be adapted for Bangladesh to address both demand- and supply-side constraints simultaneously. Moreover, addressing gender norms that limit women's mobility and decision-making power requires engaging male partners and elders through targeted sensitization sessions. Such family-centered approaches have been shown to increase TT booster uptake by nearly 30% in comparable rural South Asian settings. These inequalities further highlight systemic weaknesses in equitable healthcare delivery, where geographic and socioeconomic factors continue to shape access to essential preventive services. The persistence of such gaps suggests that current immunization strategies may not be sufficiently adaptive to address context-specific barriers in rural and low-income populations.

The investigation also identifies lost chances for coordinated counselling on child and mother vaccinations throughout standard medical appointments. There is an assistance provision deficit since numerous mothers visiting ANC or pediatric OPD visits were not completely informed about immunization regimens or the significance of TT booster doses. Women's and kids' coverage level can be increased by utilizing every patient interaction for concurrent counselling, counselling, and immunization. Notification platforms, portable vaccination centers, and coordinated community outreach are examples of combined family health initiatives that are expected to increase compliance and lower the rate of drop (Shah et al., 2024). A further factor influencing vaccination coverage included the family's wealth and socioeconomic position. Parents and kids from families with few resources were more likely to be partially or not vaccinated. Financial fragility may restrict awareness-raising efforts, restrict chances to make frequent trips to the clinic, and restrict utilization of transportation. These obstacles can be lessened, and fair immunization can be encouraged by social safeguards, including neighborhood immunization schemes, subsidized medical travel, and contingent payments (Vardavas et al., 2023). Strengthening local health committees and empowering community health volunteers can increase adherence and follow-up rates. Introducing routine maternal and child vaccination audits at hospital and union levels can help identify coverage gaps early. Collaborating with schools and community organizations for adolescent health education may increase awareness before first pregnancies. These disparities also have important implications within the Sustainable Development Goals framework, particularly SDG 3, which emphasizes equitable access to essential healthcare services. The observed inequalities in immunization coverage across rural–urban, educational, and income groups reflect persistent gaps in social justice and health equity. From a sustainability perspective, strengthening immunization systems contributes not only to improved health outcomes but also to long-term social stability and reduced vulnerability among disadvantaged populations. Overall, the findings emphasize the need for a shift from descriptive program evaluation to a more systems-oriented approach that addresses underlying structural determinants of immunization inequities. This calls for integrated policy interventions that combine health system strengthening, community engagement, and adaptive delivery models to ensure sustainable and equitable immunization coverage. In conclusion, the results of this research highlight the need for a variety of strategies to achieve broad vaccinations in Bangladesh's northern region. Optimizing family vaccination testing protocols, removing practical obstacles, lowering regional inequities, and increasing public awareness, health education, and maternal literacy are important tactics. Lawmakers, developers, and physicians that wish to improve

immunization results will find this study advice to be helpful. The national objective of attaining equitable vaccination rates and lowering vaccinated illnesses and deaths can be successfully accomplished by addressing structural, educational, and awareness-related deficiencies (Joarder et al., 2023).

4. Conclusions

According to the investigation, immunization rates for women and kids at RMCH are still close to ideal, pointing to enduring disparities in economic status, residency, and ability. The effectiveness of TT additions and the whole EPI timeline is still poor, especially in rural regions, given the comparatively strong adoption of previous doses such as TT1 and early childhood vaccinations. It gets shown that the primary determinants of vaccination refusal are Mom's sensibility and education, highlighting the critical role that well-informed choices have in averting disease. Yet, obstacles including a lack of education, a shortage of vaccines, concerns about unfavorable effects, and lengthy travel times for medical care impede global immunization advancements. Raising awareness of maternal wellness, improving vaccine supply chains, and developing local initiatives thus become crucial.

Vaccination recommendations are incorporated into standard pregnancy, postpartum, and pediatric treatments to guarantee medicine durability and lower prescription abandonment. Medical professionals, legislators, and residents must work together to achieve equal vaccination rates in northern Bangladesh. In order to enhance mother and child health outcomes and advance national immunisation targets, specific measures focusing on psychological and economic variables can close current cracks. Monitoring maternal and child health indicators regularly can provide data to adjust policies dynamically. Engaging fathers and family members in awareness programs can improve household support for vaccinations. Leveraging digital tools for vaccination tracking and reminders can reduce dropouts and missed doses. However, this study is limited by its hospital-based design and convenience sampling method, which may restrict generalizability to the broader Rangpur Division population. Additionally, reliance on partial maternal recall for vaccination history may introduce recall bias, despite partial verification through vaccination cards. From a policy perspective, the findings suggest that immunization strategies in northern Bangladesh should move beyond service provision to include equity-focused planning, strengthened primary healthcare outreach, and community-centered behavioral interventions tailored to rural and low-income populations. In relation to Sustainable Development Goal 3 (Good Health and Well-being), the observed disparities in immunization coverage reflect broader challenges in achieving universal health coverage and equitable access to essential healthcare services. Strengthening immunization systems therefore contributes directly not only to child and maternal survival but also to long-term health system resilience, social equity, and sustainable development outcomes in Bangladesh.

Recommendations: Enhance awareness programs targeting young and less-educated mothers through community campaigns and media. Integrate immunization counseling into every antenatal and postnatal care session. Deploy mobile health teams and SMS reminders for TT and EPI schedule tracking. Establish satellite vaccination centers in a underserved rural unions. Provide conditional incentives for completing TT boosters and child EPI schedules. Train healthcare workers to counter vaccine hesitancy and misinformation. Strengthen community health volunteer programs to follow up with mothers and children. Introduce routine vaccination audits and feedback systems at hospital and local levels. Include adolescent and pre-marital health education in schools to improve early awareness. Promote male and family engagement in a maternal and child vaccination programs. Develop digital tracking platforms for maternal and child immunization schedules.

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