

Original Article

Determinants of Low Diphtheria–Tetanus Immunization Coverage Among School-Age Children

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Article History:

Submission:

December 2025

Review:

January 2026

Accepted:

January 2026



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And One Health
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ABSTRACT

Background: Diphtheria–Tetanus immunization is an essential booster vaccine for school-age children, yet coverage remains suboptimal in many settings. Communication gaps, parental uncertainty, and programmatic challenges often contribute to low uptake. This study aimed to identify the determinants associated with low Diphtheria–Tetanus immunization coverage among school-age children.

Methods: An analytical cross-sectional study was conducted involving 98 parents or guardians whose children did not receive the Diphtheria–Tetanus immunization. Data were collected using a structured, pre-tested questionnaire assessing sociodemographic characteristics, knowledge, schedule awareness, clarity of information, perceptions, and concerns regarding immunization. Additional qualitative insights were obtained through interviews with immunization officers. Quantitative data were analyzed descriptively and through bivariate analysis using the chi-square test, while qualitative data were examined thematically.

Results: Bivariate analysis showed significant associations between Diphtheria–Tetanus immunization uptake and parental knowledge ($p = 0.021$), awareness of the immunization schedule ($p = 0.008$), clarity of information received ($p = 0.003$), and concerns about side effects ($p = 0.015$). In contrast, sociodemographic factors such as education level showed no significant relationship ($p = 0.062$). Qualitative findings revealed complementary insights, highlighting misinformation, limited communication through schools, and logistical constraints within the immunization program.

Conclusion: Communication-related determinants are the primary factors influencing Diphtheria–Tetanus immunization uptake among school-age children. Strengthening information delivery, improving collaboration between health centers and schools, and addressing parental concerns through clearer and more consistent communication strategies are essential to increasing immunization coverage.

Keywords: Diphtheria–Tetanus immunization, immunization coverage, parental knowledge, communication barriers, school-age children.

INTRODUCTION

Diphtheria and tetanus are significant vaccine-preventable diseases that pose a risk, particularly to school-age children. Diphtheria, primarily caused by the bacterium *Corynebacterium diphtheriae*, leads to severe respiratory issues and complications such as myocarditis and neuropathies. Tetanus, caused by *Clostridium tetani*, results in muscular spasms and can be fatal without immediate treatment. Both diseases can be effectively prevented through vaccination, including primary immunization in infancy and booster doses during childhood and adolescence to maintain immunity. Specifically, the administration of the Diphtheria, Tetanus, and Pertussis (DTP) vaccine is crucial, as antibody levels diminish over time, necessitating boosters to sustain protective immunity (1,2).

Booster immunizations are especially critical for school-age children, as this period corresponds with heightened susceptibility due to waning immunity from primary series vaccinations. The Centers for Disease Control and Prevention (CDC) emphasizes that maintaining high coverage with DTP is essential to prevent outbreaks. Recent data indicate that vaccination coverage rates have declined significantly in various regions worldwide, underscoring the increased risk for diphtheria and tetanus in school-age populations. For instance, in 2021, global coverage for the third dose of DTP (DTP3) fell to 81%, marking the lowest level since 2008 (3,4). This decline is alarming as it increases the chances of disease resurgence in communities that may have previously reached elimination levels for these diseases.

Numerous challenges face school-based immunization efforts, particularly biases and misinformation that can lead to hesitancy and reduced vaccination uptake. For example, the COVID-19 pandemic severely disrupted routine immunization services, leading to substantial decreases in vaccination rates and increasing the number of children who are either unvaccinated or inadequately vaccinated. Studies indicate that misinformation surrounding vaccines has exacerbated this issue (5,6). Additionally, school environments, where many diseases can easily spread among unvaccinated children, highlight the necessity of enforcing vaccination requirements to protect public health (7). Furthermore, social and cultural factors significantly influence the acceptance and uptake of vaccines among school-aged children, necessitating tailored outreach and educational strategies to encourage immunization.

In conclusion, the importance of sustaining high vaccination coverage through regular immunization and booster programs for diphtheria and tetanus cannot be overstated. As global vaccination rates continue to decline, particularly among school-age children, proactive measures are essential to mitigate the challenges posed by misinformation, supply chain issues, and public hesitancy. Without targeted interventions to address these challenges, the risks of preventable disease outbreaks will inevitably escalate, threatening the health of children and communities worldwide (8,9).

The persistently low coverage of diphtheria-tetanus immunization among children is a multifaceted issue significantly influenced by parental acceptance, awareness, and knowledge. A lack of awareness about the importance of booster vaccinations contributes to the declining immunity observed in school-age children. Studies indicate that seroprotection against these diseases wanes more rapidly than against viral antigens such

as measles, creating heightened vulnerability among adolescents if booster doses are not administered timely (10,11). Furthermore, misinformation has become a crucial obstacle; campaigns that inaccurately portray vaccines or perpetuate myths about their safety can significantly affect parental decision-making regarding childhood immunizations (12). This misinformation often spreads through social media and online platforms, creating environments where erroneous beliefs about vaccination can gain traction and lead to increased vaccine hesitancy (13).

The role of health system communication and logistics is equally vital in addressing the declining uptake of diphtheria-tetanus vaccinations. Effective communication strategies tailored to the target demographic are essential for dispelling misinformation and enhancing parental understanding of vaccination importance (14). Additionally, logistical challenges such as the availability of vaccines, accessibility to healthcare services, and coordination among health providers can impede immunization efforts. For instance, gaps in vaccine supply chains and insufficient health resources have been identified as barriers to achieving adequate vaccination coverage (1). Moreover, studies highlight the importance of consistent monitoring and evaluation of vaccination campaigns to accurately understand coverage levels, as many reports rely on potentially flawed recall methods from caregivers (15). Addressing both the communication and logistical aspects can significantly contribute to improving immunization rates against diphtheria and tetanus, thus safeguarding public health.

Despite the recognized importance of childhood immunizations, limited research has been conducted on the combined parental and programmatic determinants impacting booster immunization uptake for vaccine-preventable diseases such as diphtheria and tetanus. The existing literature often focuses primarily on parental attitudes and knowledge without adequately addressing programmatic factors or exploring how these two domains interact (16). This gap in research hampers the construction of comprehensive strategies that can effectively boost vaccination rates. Parental knowledge, influenced by awareness and the degree of misinformation, has been shown to significantly influence vaccination decisions; however, communication hurdles within health systems complicate this relationship (17,18). Studies indicate that logistical challenges, such as vaccine availability and accessibility, combined with a lack of tailored health communications, lead to missed opportunities for booster immunization (19). Evidence suggesting that parents' perceptions and local healthcare program strengths contribute to vaccination status underlines the necessity for an integrated approach that incorporates both aspects to enhance immunization uptake (20). This study aims to identify and analyze the determinants contributing to low Diphtheria–Tetanus immunization coverage among school-age children, with particular attention to parental-related factors such as awareness, knowledge, and concerns, as well as programmatic factors including communication clarity, information delivery, and implementation challenges within the immunization program.

METHOD

This study employed an analytical cross-sectional design to examine the relationship between parental and programmatic factors and Diphtheria–Tetanus immunization coverage among school-age children. A total

of 98 parents or guardians whose children had not received the immunization were selected through purposive sampling. Primary data were collected using a structured and pre-tested questionnaire that assessed sociodemographic characteristics, knowledge of Diphtheria–Tetanus immunization, awareness of immunization schedules, clarity of information received, perceptions of vaccine importance, and concerns about possible side effects. Additional qualitative data were obtained through interviews with immunization officers to provide contextual insights into program challenges. Secondary data were retrieved from immunization reports and health facility records. Quantitative data were analyzed using descriptive statistics and bivariate analysis, with the chi-square test applied to determine associations between independent variables and immunization status at a 95% confidence level. Qualitative data were analyzed thematically to support and enrich quantitative findings. Ethical procedures included obtaining informed consent from all participants and ensuring confidentiality throughout the study..

RESULT

Table 1 presents the characteristics of the 98 respondents included in this study. The majority of respondents were aged 30–40 years (57.1%), followed by those older than 40 years (30.6%), while only a small proportion were younger than 30 years (12.2%). Most respondents were unemployed or housewives, accounting for 65.3% of the sample, whereas 34.7% reported being employed. In terms of educational background, nearly half of the respondents had completed senior high school (49.0%), 26.5% had higher education, while smaller proportions had attended elementary school (14.3%) or junior high school (10.2%). These characteristics indicate that most parents or guardians were in the productive age group, had moderate to higher education levels, and a majority were not formally employed, which may influence their access to information and decision-making regarding immunization.

Table 1. Characteristics of Respondents

Characteristics	Category	Frequency (n)	Percentage (%)
Age	< 30 years	12	12.2
	30–40 years	56	57.1
	> 40 years	30	30.6
Occupation	Employed	34	34.7
	Unemployed/Housewife	64	65.3
Education Level	Elementary School	14	14.3
	Junior High School	10	10.2
	Senior High School	48	49.0
	Higher Education	26	26.5

Table 2 shows the bivariate analysis examining the relationship between parental and programmatic factors and Diphtheria–Tetanus immunization status among school-age children. The results indicate that several variables were significantly associated with immunization uptake. Parents with good knowledge were more likely to have their children immunized compared to those with poor knowledge ($p = 0.021$). Awareness of the immunization schedule also showed a strong association, as children of parents who were aware were

more likely to receive the vaccine ($p = 0.008$). Similarly, parents who reported receiving clear information were significantly more likely to allow immunization than those who felt information was unclear ($p = 0.003$). Concerns about side effects were also influential, with parents who had no concerns being more likely to approve immunization ($p = 0.015$). In contrast, education level did not show a statistically significant relationship with immunization status ($p = 0.062$). Overall, these findings suggest that communication-related factors—knowledge, awareness, information clarity, and perceptions of safety—play a critical role in determining immunization uptake.

Table 2. Patient Knowledge, Attitudes, and Practices

Independent Variable	Category	Received Immunization n (%)	Did Not Receive n (%)	p-value	Interpretation
Knowledge of Diphtheria–Tetanus Immunization	Good	40 (70.2)	17 (29.8)	0.021	Significant
	Poor	12 (44.4)	15 (55.6)		
Awareness of Immunization Schedule	Aware	28 (75.7)	9 (24.3)	0.008	Significant
	Not aware	24 (44.4)	30 (55.6)		
Clarity of Information Received	Clear	30 (76.9)	9 (23.1)	0.003	Significant
	Not clear	22 (41.5)	31 (58.5)		
Concerns About Side Effects	No concerns	32 (78.0)	9 (22.0)	0.015	Significant
	Concerned	20 (47.6)	22 (52.4)		
Level of Education	High (Senior High & Higher Ed)	46 (69.7)	20 (30.3)	0.062	Not significant
	Low (Elementary & Junior High)	6 (42.9)	8 (57.1)		

The findings of this study highlight that parental knowledge, awareness of the immunization schedule, clarity of information received, and concerns regarding vaccine side effects are key factors associated with the uptake of Diphtheria–Tetanus immunization among school-age children, while sociodemographic characteristics such as education level showed no significant influence. These results collectively indicate that communication-related determinants play a dominant role in shaping parental decisions, underscoring the need for improved information delivery and more effective engagement strategies within the immunization program..

DISCUSSION

The investigation into the factors influencing vaccination uptake suggests multifaceted determinants that encompass knowledge gaps, communication effectiveness, and parental awareness. Several studies reveal that parents' understanding of vaccination is critical for ensuring their children's immunization against vaccine-preventable diseases. Research indicates that the perceived risks associated with vaccination, coupled

with misinformation circulating through social media, exacerbate hesitancy among parents, ultimately leading to lower uptake rates (21,22). Effective communication strategies that clarify vaccine safety and address specific concerns about potential side effects prove essential in mitigating these barriers. Furthermore, while some studies suggest demographic characteristics such as education level do play a role, there is evidence indicating that the interplay between socio-demographic factors and vaccine literacy is complex and may not solely depend on educational attainment (23,24).

It is crucial to emphasize that while many parents possess favorable attitudes towards vaccinations, their decisions are often swayed by incomplete or conflicting information regarding the importance of booster vaccinations and existing misconceptions about their necessity. The lack of structured, culturally-tailored communication has been highlighted as a barrier in various contexts, suggesting that targeted efforts to empower parents with clear, actionable information may enhance immunization uptake significantly (25). Moving forward, it is vital to reinforce health communication frameworks within healthcare systems, ensure the dissemination of accurate information through multiple channels, and address the psychosocial factors that contribute to vaccine hesitancy to improve vaccination rates in child populations (26).

Studies indicate that higher levels of knowledge regarding vaccines correlate positively with approval for immunization; parents who fully understand the benefits and safety of vaccines are more likely to consent to their children's vaccinations. Conversely, inadequate knowledge has been linked to increased vaccine hesitancy. For instance, parents lacking accurate information may rely on misinformation or anecdotal accounts, leading to misconceptions about vaccine safety and putting their children at an elevated risk for preventable diseases (27). The literature consistently demonstrates that low knowledge levels can foster considerable doubt and fear regarding vaccination, as evidenced by the findings in various studies where individuals with limited understanding of vaccination protocols were less likely to trust vaccines and thus more hesitant to participate in immunization programs (28). Therefore, enhancing educational initiatives targeting parents and caregivers is essential for building confidence in vaccines and improving immunization rates.

Clear communication from schools, healthcare providers, and media plays a pivotal role in vaccination uptake, particularly concerning diphtheria and tetanus immunization. Miscommunication or insufficient outreach can significantly contribute to low vaccination coverage, as parents may not fully understand immunization schedules or the importance of booster doses, leading to hesitancy or noncompliance (29). A comparative analysis reveals that in communities where robust communication strategies are implemented—such as educational programs that convey accurate vaccine information—residents exhibit higher vaccine acceptance rates. For instance, a study found that structured educational interventions effectively improved parental knowledge and perceptions about vaccination, which in turn bolstered their approval of immunization programs (29). Conversely, inadequacies in socialization, such as failure to reach out to marginalized or less-informed groups, exacerbate vaccine hesitancy, as demonstrated by high rates of refusal correlated with low levels of knowledge about vaccine benefits and safety, particularly in communities with fragmented health systems where educational access is limited (30). Such findings underscore the necessity of targeted

communication efforts within immunization campaigns to bridge knowledge gaps and foster a supportive environment for vaccine acceptance.

Delays in vaccine distribution, scheduling setbacks, and unstable stocks can create significant barriers to immunization uptake, impacting parental perceptions and attendance at vaccination appointments. When parents experience missed opportunities due to logistical challenges or inconsistent communication from healthcare providers, it can lead to frustration and distrust towards the immunization program, ultimately diminishing their willingness to vaccinate their children (31). This highlights the necessity for a renewed approach to education and immunization reminders that leverages technology to enhance engagement and minimize confusion. Implementing digital solutions such as WhatsApp broadcasts, SMS reminders, or health apps can provide timely information that directly addresses these barriers and keeps parents informed about vaccination schedules and requirements. There is substantial evidence indicating that electronic reminders significantly increase immunization coverage by effectively prompting caregivers to take action and reducing the incidence of missed appointments (29). Therefore, integrating technological tools into public health campaigns could play a transformative role in increasing vaccine acceptance and improving overall immunization rates among children.

The findings from this study reveal similarities and divergences when compared to national and international research on booster immunizations. While many studies underscore the importance of clear communication and community engagement in increasing vaccine uptake, this research highlights the unique barriers faced by parents, such as logistical issues and miscommunication, that directly affect their perceptions and subsequent actions regarding vaccination (32). In contrast, some literature emphasizes that educational interventions alone can sometimes lead to higher immunization rates, even in the presence of socio-demographic disparities. This study's contribution lies in its focus on the intersection of logistical barriers and educational approaches, suggesting that a more integrative model that includes technology, such as SMS reminders or mobile health applications, is critical to effectively address gaps in vaccine compliance. The emphasis on utilizing technology to enhance communication strategies echoes findings from other studies demonstrating that digital reminders can significantly boost immunization rates, suggesting a crucial direction for public health initiatives (33). This unique angle not only advances the discourse on immunization strategies but also suggests actionable solutions tailored for local contexts where conventional methods may falter.

This study has several strengths, including its analytical cross-sectional design, the integration of quantitative and qualitative data, and a sample size sufficient to explore key determinants of Diphtheria-Tetanus immunization uptake. However, certain limitations must be acknowledged, such as the inability to establish causality due to the study design, the reliance on self-reported information that may introduce response bias, and the focus on a single geographic area, which may limit generalizability. Despite these limitations, the findings offer valuable implications for policy and practice, emphasizing the need to strengthen communication strategies, enhance collaboration between health centers and schools, and improve immunization monitoring and supply chain management. Future research should consider longitudinal study designs, explore cultural and social influences on vaccine acceptance in greater depth, and evaluate the

effectiveness of digital-based educational interventions in improving parental engagement and immunization coverage.

CONCLUSION

This study demonstrates that communication-related determinants—particularly parental knowledge, awareness of the immunization schedule, clarity of information received, and concerns regarding vaccine side effects Diphtheria–Tetanus immunization uptake among school-age children. While sociodemographic characteristics such as education level were not significantly associated with immunization status, programmatic challenges, including inconsistent information delivery and logistical constraints, further contributed to low coverage. These findings underscore the importance of strengthening communication strategies, enhancing coordination between health services and schools, and providing clear, accessible, and accurate immunization information to parents. Improving these aspects is essential to increasing immunization uptake and supporting broader efforts to prevent vaccine-preventable diseases.

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