

Caregivers' Knowledge, Risk Perception, Vaccine Confidence, and Preventive Practices for Diphtheria Among Under-five Children in Ibadan, Nigeria

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Abstract

Background

Africa is facing recurrent diphtheria outbreaks, with its reemergence in four African countries: Algeria, Guinea, Niger, and Nigeria. In Nigeria, diphtheria has been prevalent than many other countries around the world. Despite the availability of effective vaccines, suboptimal immunization coverage persists and under-five children in Nigeria are mostly vulnerable. This study assessed the interplay between caregivers' knowledge, risk perception, diphtheria vaccine confidence, and preventive practices to inform targeted interventions.

Methods

A community-based cross-sectional study of 642 caregivers of under-five children in three randomly selected local government areas of Ibadan. A multi-stage sampling technique was employed. Data were collected using a pre-tested, interviewer administered questionnaire. Variables included socio-demographics, knowledge, risk perception, vaccine confidence, and preventive practices. Scores were dichotomized into good/poor based on calculated means. Data were analyzed using IBM SPSS v23. Chi-square and binary logistic regression were used to identify factors associated with preventive practices at a 5% significance level.

Results

The mean age of caregivers was 27.4 ± 4.9 years; 95.5% were female. An average (54.2%) had good knowledge of diphtheria, 60.1% had good risk perception, and an overwhelming majority (94.9%) had good vaccine confidence. Overall, 92.5% demonstrated good preventive practices, including high rates of handwashing and social distancing. However, only 65.1% of children had received the third dose of pentavalent vaccine. In multivariate analysis, good knowledge (AOR = 5.89, 95% CI: 1.68–20.68, $p = 0.006$) and excellent vaccine confidence (AOR = 170.81, 95% CI: 38.71–753.79, $p < 0.001$) were strong, independent predictors of good preventive practices. Good risk perception was influenced good preventive practices (AOR = 0.16, 95% CI: 0.04–0.55, $p = 0.004$). Caregivers' education and occupation were also significantly associated with outcomes in the model.

Conclusion

While caregivers in Ibadan exhibit high confidence in the diphtheria vaccine and generally good preventive practices, critical gaps in vaccine completion and a disconnect between risk perception and action remain. Strengthening routine immunization systems and community-based education programs focused on vaccine completion are essential to curtail the ongoing outbreak and prevent future resurgence.

1.0 Introduction

Diphtheria, a life-threatening vaccine-preventable disease caused by the toxigenic strains of "*Corynebacterium diphtheriae*" has re-emerged as a critical public health threat in Nigeria [1]. Following a period of decline, a major outbreak beginning in 2022 has seen Nigeria account for over 90% of diphtheria cases in Africa, with a case fatality rate (CFR) of 5.6% [2]. Epidemiological, evidence gotten from data obtained showed that children and adolescents bear the highest burden of diphtheria, with the majority of confirmed cases occurring among those aged 1–14 years [3].

The resurgence of diphtheria is primarily attributed to suboptimal childhood immunization coverage. In Nigeria, the national coverage for the third dose of the diphtheria-tetanus-pertussis containing vaccine (DTP3) remains low at an estimated 57%, leaving a substantial immunity gap in the population [4]. While logistical challenges in vaccine supply and distribution are

significant barriers [5], the ultimate determinant of immunization uptake at the individual level is often caregiver acceptance and adherence to the vaccination schedule [6].

The Health Belief Model postulates that health-related behaviors, such as vaccine uptake, are influenced by an individual's perceived susceptibility to and severity of a disease, perceived benefits and barriers to action, and cues to action [7]. In the immunization realm, this translates to caregivers' knowledge of the disease, their perception of the risk it poses to their child, and their confidence in the recommended vaccine [8]. Studies in various settings have linked poor parental knowledge and negative risk perception to lower vaccination rates [9, 10]. Conversely, high vaccine confidence, including trust in safety, efficacy, and importance of vaccines, is a robust predictor of vaccine acceptance [11].

Despite the ongoing outbreak, there are few studies on the specific cognitive and perceptual factors influencing diphtheria prevention among caregivers in Nigeria. Existing studies have focused on general immunization coverage or knowledge of childhood vaccines, without a specific lens on diphtheria during an active outbreak period [12, 13]. Understanding the interplay between knowledge, risk perception, and, crucially, diphtheria-specific vaccine confidence is essential for designing effective, targeted interventions to curtail its spread.

This study, therefore, aimed to assess caregivers' knowledge, risk perception, and diphtheria-specific vaccine confidence, and to evaluate their preventive practices among caregivers of under-five children in Ibadan, Nigeria. Furthermore, it sought to identify the key factors associated with the adoption of preventive practices, providing evidence to bridge the gap between awareness and protective action in a high-risk urban setting.

2.0 Methods

2.1 Study Area

This study was conducted in Ibadan, Oyo State, located in the South-Western geopolitical zone of Nigeria. Ibadan is the capital of Oyo State and the third most populous city in Nigeria, with an estimated metropolitan population exceeding 6 million [14]. As a major commercial and administrative hub, Ibadan is characterized by rapid urbanization and is recognized as the second fastest-growing city in Africa [15]. Its diverse population and mix of urban, peri-urban and rural settlements make it an ideal setting for public health research, comprising 11 Local Government Areas (LGAs). The city's population is predominantly Yoruba, with Christianity and Islam as the main religions, and its economy is largely driven by trade, commerce, and a growing technology sector. This study was carried out in three randomly selected LGAs within Ibadan: Ibadan North, Akinyele, and Ibadan North-East. These LGAs were chosen due to their dense, rural, peri-urban to urban characteristics, which present a mix of socioeconomic profiles relevant to assessing barriers to childhood immunization. Specific communities within these LGAs; Inalende and Igosun (Ibadan North), Moniya and Olorisaoko (Akinyele), and Aremo and Aromolaran (Ibadan North-East) were selected as the primary study sites.

2.2 Study Design

A community-based, descriptive cross-sectional study of caregivers 15 years and above, of children under five years of age.

2.3 Study Population

The study population comprised all caregivers (parents, foster parents, or legal guardians) who were primarily responsible for the day-to-day care and health decisions of at least one child under the age of five years and had been residing in the selected study communities for a minimum of six months.

2.4 Eligibility Criteria

Caregivers were eligible for inclusion if they were aged 18 years or older, the primary decision-maker for a child under five years living in their household, had resided in the selected community for at least six months, and provided written informed consent to participate.

Caregivers were excluded if they were mentally or physically unable to provide coherent responses during the interview, had a significant hearing or speech impairment that precluded effective communication, or were unwilling to provide informed consent.

2.5 Sample Size Determination

Sample size was calculated using the formula for determining single proportion ($n = \frac{(Z)^2[P(1-P)]}{d^2}$) in which the p is the proportion of care givers whose index child had completed the three doses of Diptheria Tetanus Pertusis (DTP3) trivalent vaccine was 49.1% [16], including a design effect of 1.5 and the desired precision margin, d, was set at 0.05 while Z, the standard normal deviate was set at 1.96 and 95% confidence interval. The calculated value was adjusted for a 10% attrition rate to obtain a final sample size of 642.

2.6 Sampling Technique

A multi-stage sampling technique was employed to select study participants. In the first stage, three (3) out of the eleven (11) local government areas (LGAs) in Ibadan were selected by simple random sampling method using balloting without replacement. The selected LGAs are Ibadan North, Akinyele, and Ibadan North-East. In the second stage two wards were selected from each LGA to make a total of six wards. These wards are Ward 2 and Ward 4 (Ibadan North); Ward 8 and Ward 12 (Akinyele); and Ward 4 and Ward 12 (Ibadan North-East). In the third stage, a comprehensive list of all communities within each selected ward was compiled. Using simple random sampling, one community was selected from each ward, making a total of six (6) communities. The six (6) selected communities were: Inalende (Ward 2, Ibadan North), Igosun (Ward 4, Ibadan North), Moniya (Ward 8, Akinyele), Olorisaoko (Ward 12, Akinyele), Aremo (Ward 4, Ibadan North-East), and Aromolaran (Ward 12, Ibadan North-East). In stage 4, a modified cluster sampling technique was used to select households. In each community, the first household was identified by spinning a bottle at a central location to determine the initial direction. Subsequent households were selected consecutively along that direction until the allocated sample size for the community ($n = 107$) was achieved. In households with more than one eligible caregiver, one was randomly selected by balloting. In all, a total of 642 caregivers were recruited across the six communities.

2.7 Data Collection Instrument and Methods

Data were collected using a pretested, semi-structured, interviewer-administered questionnaire. The questionnaire was developed based on a thorough review of relevant literature and adapted from previous studies, written in English and translated into Yoruba (the local language). The questionnaire comprised five sections; Socio-demographic Characteristics of Caregivers and their Under-five Children (Age, sex, religion, marital status, educational level, occupation, average monthly income, and number of children under five). The knowledge was assessed using twenty-eight items covering the cause, symptoms, transmission, and prevention of diphtheria. The diphtheria risk perception was assessed using four items exploring caregivers' perceived susceptibility of their child to diphtheria and the perceived severity of the disease. Caregivers vaccine confidence was assessed using three items covering trust in the vaccine, acceptance of the importance of the vaccine, its safety, and effectiveness of the diphtheria-containing vaccine (Penta). Caregivers diphtheria preventive practices was assessed using six items on self-reported practices, including penta vaccine uptake for their child and other preventive behaviors.

Content and face validity of the questionnaire were established through a critical review by the research supervisor. To assess reliability and clarity, a pre-test was conducted among 64 caregivers (10% of the sample size) in Ibadan North-West LGA, a neighboring area with similar demographic characteristics to the study sites. Feedback from the pre-test was used to identify problems with the instrument and necessary corrections were made before the final administration.

Preparatory to the data collection, six research assistants with prior experience in community-based health surveys were recruited and trained over two days. The training covered the study's objectives, ethical guidelines (including the informed consent process and principles of confidentiality), respondents. selection and questionnaire administration techniques.

Data collection was conducted through face-to-face interviews in the respondents' households using an electronic data collection tool (Kobo Collect). For participants who were literate, the English version of the questionnaire was administered while for those non literate the Yoruba version of the questionnaire was administered. Completed entries were reviewed daily by the principal investigator for completeness and consistency.

2.8 Data Management and Analysis

Data were analysed using IBM SPSS version 23. Descriptive statistics were computed for all variables. Categorical variables were summarized using frequencies and percentages, while continuous variables (e.g., age, knowledge scores) were summarized using means and standard deviations (SD). For the assessment of the knowledge of the participants, each of the 28 knowledge items was scored as 1 for a correct answer and 0 for an incorrect or "don't know" response. Total knowledge scores ranged from 0 to 28. For dichotomizing the categories of knowledge, the mean of the scores (14.0) was determined. Those caregivers scoring below 14 points were categorized as having poor knowledge, while those scoring at or above fourteen points were categorized as having good knowledge. Risk perception was assessed using four items with a 3-point Likert scale. Total scores ranged from 4 to 10. Using the mean score (7.0) as a cut-off, respondents were categorized as having poor (scores < 7) or good (scores $\geq$ 7) risk perception. Vaccine Confidence: Confidence in the diphtheria vaccine was assessed using three items on a 5-point Likert scale (Strongly Agree to Strongly Disagree). Total scores ranged from 3 to 15. Using the mean score (9.0) as a cut-off, respondents were categorized as having "low confidence" (scores < 9) or "high confidence" (scores $\geq$ 9). Preventive practices were assessed using six items. Total scores ranged from 0 to 11. The mean score (6.0) was used as the cut-off; caregivers scoring below the mean were categorized as having poor preventive practices, while those scoring at or above the mean were categorized as having good preventive practices. The Chi-square (χ^2) test was used to examine bivariate associations between categorical independent variables (e.g., socio-demographic factors, knowledge level, risk perception, vaccine confidence) and the primary outcome variable (preventive practices). Variables found to be significant in the bivariate analysis at a p-value < 0.05 were entered into a binary logistic regression model to identify independent predictors of good preventive practices. Adjusted odds ratios (AORs) with their 95% confidence intervals (CIs) were calculated. A p-value < 0.05 was considered statistically significant in the final model.

3.0 Results

Table 1 shows that more than half of the caregivers were female (95.5%), mothers (93.1%) and were married (93.1%). The majority of the caregivers attained at least secondary education (63.2%) and were mainly entrepreneurs (68.8%). Among under-five children, 53.4% were female, 46.9% aged 13–36 months, and 50% were first-borns. Christianity (49.4%) and Islam (50.6%) were almost equally represented among the respondents.

Table 2 shows that more than half of the caregivers (54.2%) demonstrated good knowledge of diphtheria. About 49.5% of the caregivers identified diphtheria as a cough disease that affect the throat of children. Most respondents (93.9%) knew the disease is preventable, a fatal disease (73.7%) and 85.8% identified vaccination as a preventive measure. Commonly recognized symptoms included pseudo membrane (69.2%) and swelling in the jaw (61.2%). However, knowledge of the correct timing for the first vaccine dose (18.8%) was low. Major identified risk factors were vaccine refusal (74.8%) and poor sanitary conditions (70.9%).

Table 3 shows that more than half of the caregivers (92.7%) perceived diphtheria as a severe disease, with 62.6% describing it as serious and 30.1% as very serious. Although 54.0% were unsure about their child's likelihood of contracting diphtheria, only 23.2% believed it was likely. Over half (57.2%) were not worried about infection. Overall, 60.1% demonstrated good risk perception toward diphtheria.

Table 4 About 94.9% of the caregivers demonstrated good confidence in the diphtheria vaccine, with 69.8% strongly agreeing on its importance, 66.8% on its effectiveness, and 65.6% on its safety.

Table 5 shows that most caregivers (92.5%) demonstrated good preventive practices toward diphtheria. Frequent preventive actions included hand washing after defecating (87.7%) and before feeding a child (84.9%). Social distancing was often practiced by 80.2%, while 50.0% frequently covered their noses when sneezing. However, consistent nose mask usage remained low at 18.7%. Vaccine uptake was high, with 86.4% having received at least one dose, but dropped for Penta 3 (65.1%). The main reasons for missed doses included tight schedules (5.3%), safety concerns (5.1%), and lack of awareness (4.5%), contributing to 34.3% incomplete uptake.

Table 6 shows that caregivers' preventive practices were significantly associated with age, education, occupation, knowledge, risk perception, and vaccine confidence ($p < 0.01$). Those aged ≥ 30 years, with Diploma/First Degree/Post Graduate, and entrepreneurs demonstrated better practices. Good knowledge (AOR = 5.89, $p = 0.006$) and good vaccine confidence (AOR = 170.81, $p < 0.01$) strongly predicted preventive practices. Gender, religion, and marital status showed no significant association.

Table 7 shows that caregivers' knowledge has significant association with caregivers' age, education, occupation, and birth order ($p < 0.01$). Caregivers aged 15–19 years (AOR = 11.923, $p = 0.021$), and employed/entrepreneur caregivers (AOR = 1.960, $p = 0.028$) were more likely to have good knowledge. Those with secondary education (AOR = 0.553, $p = 0.009$), were less likely to have good knowledge compared to those with higher education. Gender, religion, marital status, relationship with child, and child's characteristics showed no significant association ($p > 0.05$).

Table 8 shows that caregivers' vaccine confidence was significantly associated with age, education, occupation, and knowledge ($p < 0.01$). Caregivers aged 15–19 years and those aged ≥ 30 years all reported 100% vaccine confidence. Higher education showed increased confidence, with 99.3% among those holding diplomas or higher ($p < 0.01$). Entrepreneurs (97.3%) also displayed strong confidence compared to the unemployed (84.0%). Notably, caregivers with good knowledge of diphtheria were over 13 times more likely (AOR = 13.089, $p = 0.001$) to have high vaccine confidence.

4.0 Discussion

This study provides a comprehensive assessment of factors influencing diphtheria prevention among caregivers of children under five in Ibadan, Nigeria, a critical public health focus given the disease's recent resurgence, which claimed young lives and elevated the national case fatality rate to 5.1% in 2025, with most cases occurring in children aged 1–14 years [3]. Our findings offer insights into caregivers' knowledge, risk perception, vaccine confidence, and preventive practices, revealing both enabling factors and unexpected behavioral contradictions that can inform targeted outbreak response and sustained immunization strategies. Caregivers in this study demonstrated a higher level of knowledge about diphtheria. This is out of the knowledge level range gotten from reports from similar settings in Enugu, Nigeria; Indonesia; and Yemen, where good knowledge ranged from 18.8% to 41% [12, 17, 18]. Key symptoms such as pseudo-membrane and swollen jaw were recognized by substantial proportions of respondents. This knowledge was significantly associated with caregivers' age, education, and occupation, aligning with studies that identify these sociodemographic factors as predictors of health knowledge [10, 18]. Importantly, good knowledge independently predicted improved preventive practices in the multivariate model, which contradicted earlier studies. For instance, in an Indonesian study conducted among parents/caregivers of under-five children, the investigators found no link between parental knowledge and outbreak immunization coverage [17], suggesting that, in this context, knowledge reinforcement remains a viable intervention pathway.

In terms of risk perception, sixty percent of caregivers perceived diphtheria as a significant threat to their children, which is in alignment with findings by Ossai and Fatiregun in study carried out in Kaduna and Enugu, Nigeria [10]. Contrary to the theory of Health Belief Model [7], heightened risk perception did not translate into better preventive behaviour. Rather, caregivers with good risk perception were very less likely to engage in diphtheria preventive practices, indicating a concerning cognitive dissonance between perceived threat and actionable response. This phenomenon is not unique to lay caregivers; even among health workers in Brazil, high risk perception (81.8%) coexisted with low diphtheria vaccine uptake [19]. Our analysis

found no significant association between sociodemographic factors and risk perception, suggesting that perceptions may be shaped more by community narratives, past outbreak experiences, or access barriers than by individual demographics.

Notably, vaccine confidence was exceptionally high, with 94.9% of caregivers expressing trust in the importance, effectiveness, and safety of the diphtheria vaccine. This is similar to findings from studies from Lagos and Ethiopia where the caregivers were found to have a high vaccine confidence level [13, 20]. Confidence emerged as the strongest predictor of preventive practice, underscoring its central role in vaccination uptake. This aligns with reports from recent Nigerian outbreaks where parental vaccine refusal was cited as a key driver of transmission. Confidence was significantly linked to knowledge but not to basic demographic variables, reinforcing the idea that trust in vaccines is more influenced by information sources and social networks than by socioeconomic status alone [21]. The persistence of vaccine confidence in this study is encouraging, though it remains vulnerable to misinformation, as demonstrated in settings where beliefs in alternatives to vaccination (e.g., prayer) eroded confidence in vaccine safety [21, 22].

Regarding preventive practices, several demographic factors including religion, education, and birth order showed significant associations in univariate analysis but lost predictive power in the multivariate model when knowledge and confidence were accounted for. This suggests that the influence of factors such as maternal education, widely documented in studies from Malawi and Kenya [23, 24], may be mediated through improved knowledge and confidence rather than acting independently. The loss of significance in multivariate analysis points to confounding and underscores the complex interplay between sociodemographic characteristics and cognitive factors.

Conclusion

The study's findings carry important implications for public health action. First, while knowledge and Penta vaccine confidence are strong enablers of prevention, risk perception alone may not drive behavior and may even correlate with inaction if not paired with clear guidance and accessible services. Communication strategies should therefore move beyond fear-based messages and instead focus on reinforcing vaccine confidence, addressing specific misconceptions, and facilitating easy access to immunization services. Second, interventions should prioritize vulnerable subgroups such as older caregivers, those with lower education, and unemployed caregivers for tailored health education, as these groups demonstrated lower knowledge in this study. Finally, maintaining high vaccine confidence requires proactive engagement with trusted community and healthcare sources to counter misinformation, especially through social and religious networks where rumors may originate.

Limitations

The cross-sectional design used in this study precludes causal inference, and the potential for social desirability bias in self-reported practices and confidence. Nevertheless, the findings robustly address the study's objectives and highlight that effective diphtheria prevention requires an integrated strategy that builds actionable knowledge, safeguards vaccine confidence, and transforms risk awareness into facilitated action. Such an approach is essential not only for curtailing the current outbreak but also for sustaining immunity and preventing future resurgence among vulnerable under-five populations in Ibadan and similar settings.

Declarations

Ethical approval:

Ethical approval was obtained from the Oyo State Ministry of Health. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee and with the 1964 Declaration of Helsinki and its subsequent amendments.

Consent to participate:

Written voluntary informed consent was obtained for all caregivers who participated in this study. Participants who wish to exit/withdraw from the study for any reason or other were granted the right to withdraw with no consequences or punishment. All information provided by the participants was handled with strict confidentiality. All procedures involving human participants were conducted in accordance with the ethical standards of the institutional review committee and with the 1964 Declaration of Helsinki and its subsequent amendments.

Consent to publish:

The data collected for this manuscript does not include any information that leads to the identification of the participants. However, intention to publish was made known to the participants, and they gave consent.

Clinical Trial Number

Clinical Trial Number not applicable

Conflict of Interest:

The authors declare no conflict of interest.

Funding Declaration

No funding was secured for this study, all expensive was incurred by the authors.

Author Contribution

MDD was responsible for the concept and design of the study, directed the data collection and analysis, and reviewed the first draft of the manuscript, while AAA and DRO wrote the literature review and collected the data. MDD and AAA wrote and reviewed the manuscript. All authors approved of the final manuscript and agreed for it to be submitted for publication.

Data Availability

The datasets generated and analyzed for this study are available from the corresponding author upon reasonable request

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Tables

Table 1 Socio-demographic Characteristics of caregiver and children (N=642)

Variables	Frequency (N)	Percent (%)
Gender		
Male	29	4.5
Female	613	95.5
Age (Yrs) Mean 27.4±4.9		
15-19	13	2.0
20-24	183	28.5
25-29	252	39.3
≥30	194	30.2
Religion		
Christianity	317	49.4
Islam	325	50.6
Marital Status		
Single	18	2.8
Married	598	93.1
Separated/Divorced/Widowed	26	4.0
Highest Educational Level Attained		
No Formal Education		
Primary	17	2.6
Secondary	83	12.9
Diploma/First Degree/Post Graduate	406	63.2
	136	21.2
Occupation		
Student	11	1.7
Employed	114	17.8
Entrepreneur	442	68.8
Unemployed	75	11.7
Relationship with the child		
Father	24	3.7
Mother	598	93.1
Others	20	3.1

Table 1 Socio-demographic Characteristics of the under-five Children (N=642)

Gender		
Male	299	46.6
Female	343	53.4
Age (Month)		
0-12	187	29.1
13-36	301	46.9
≥37	154	24.0
Birth order		
1	321	50.0
2	185	28.8
≥3	136	21.2

Table 2 Caregivers' Knowledge of Diphtheria Symptoms, Causes, Transmission, Risk Factors, Fatality, and Prevention (N=642)

Variables	Frequency (N)	Percent (%)
Description of diphtheria		
Cough disease that affects the throat of children	318	49.5
Cough disease	114	17.8
Sore throat disease	122	19.0
I don't know	88	13.7
Symptoms of diphtheria		
Difficulty in breathing	218	34.0
Fever	356	55.5
Swelling in the jaw	393	61.2
Pseudo membrane	444	69.2
Causes of diphtheria		
Hereditary	68	10.6
Microorganism	256	39.9
Attack	116	18.1
Mode of Transmission		
Open air Sneezing and coughing	267	41.6
Contact with infected individual	269	41.9
Contaminated surfaces or materials	257	40.0
Contaminated food and drinks	307	47.8
Risk Factor		
Overcrowding	251	39.1
Poor sanitary condition	455	70.9
Malnutrition	318	49.5
Poor nose mask usage	189	29.4
Vaccine refusal	480	74.8
Fatality		
Fatal disease	473	73.7
Prevention		
Preventable	603	93.9
Up-to-date vaccination	551	85.8
Hand wash after defecating	541	84.3
Hand wash before feeding a child	552	86.0
Social distancing	326	50.8
Adequate child feeding	395	61.5
Avoiding epidemic areas	297	46.3

Week of Penta 1	121	18.8
Number of Penta vaccine dose	381	59.3
Grading of Caregivers' knowledge of diphtheria		
Good (≥ 14.00)	348	54.2
Poor (< 14.00)	294	45.8

Table 3 Caregivers' Risk Perception of diphtheria among Under-five Children in Ibadan (N=642)

Variables	Frequency (N)	Percent (%)
Severe disease	595	92.7
Perceived severity of diphtheria		
Not serious at all	47	7.3
Serious	402	62.6
Very Serious	193	30.1
Perceived Likelihood of child contracting diphtheria		
Very unlikely		
Not sure	146	22.7
Likely	347	54.0
	149	23.2
Perceived Worry about child contracting diphtheria		
Not worried at all		
Worried	367	57.2
Very worried	221	34.4
	54	8.4
Grading Caregivers' Risk Perception		
Good (≥ 7.00)	386	60.1
Poor (< 7.00)	256	39.9

Table 4: Caregivers' Diphtheria vaccine confidence (N=642)

Variables	Frequency(N)	Percent (%)
Diphtheria vaccine importance		
Strongly agree	448	69.8
Agree	148	23.1
Unsure	27	4.2
Disagree	14	2.2
Strongly disagree	5	0.8
Diphtheria vaccine effectiveness		
Strongly agree	429	66.8
Agree	158	24.6
Unsure	29	4.5
Disagree	19	3.0
Strongly disagree	7	1.1
Diphtheria vaccine safety		
Strongly agree	421	65.6
Agree	160	24.9
Unsure	36	5.6
Disagree	21	3.3
Strongly disagree	4	0.6
Grading of Caregivers' Diphtheria Vaccine Confidence		
Good (≥ 9.00)	609	94.9
Poor (< 9.00)	33	5.1

Table 5: Caregivers' Preventive Practices (N=642)

Variables		Frequency(N)	Percent (%)
Diphtheria Vaccine uptake of at least one dose	Yes	555	86.4
	No	87	13.6
Nose covering when sneezing	Never	26	4.0
	Sometimes	295	46.0
	Often	321	50.0
Nose mask usage	Never	36	5.6
	Sometime	486	75.7
	Often	120	18.7
Social distancing	Never	35	5.5
	Sometimes	92	14.3
	Often	515	80.2
Hand wash after defecating	Never	18	2.8
	Sometimes	61	9.5
	Often	563	87.7
Hand wash before feeding a child	Never	25	3.9
	Sometimes	72	11.2
	Often	545	84.9
Diphtheria Vaccine Uptake	Penta 1 Uptake	555	86.4
	Penta 2 Uptake	508	79.1
	Penta 3 Uptake	418	65.1
Reasons for missing a dose of Penta vaccine	Lack of awareness of diphtheria vaccine	29	4.5
	Diphtheria vaccine safety	33	5.1
	Far distance from the hospital	24	3.7
	Unavailability of diphtheria vaccine	19	3.0
	Side effect of the first dose	15	2.3
	Discouragement after hearing about the side effect of diphtheria vaccine	22	3.4
	Culture	1	0.2
	Tight schedule	34	5.3
	Transport fare	26	4.0
	Rudeness of the hospital	4	0.6
	Payment at the hospital	1	0.2

Grading of Caregivers' Preventive Practices	Good (≥ 6)	594	92.5
	Poor (< 6)	48	7.5

Table 6: Factors Associated with Caregivers Preventive Practices against diphtheria among under-five Children (N=642)

Table 7: Factors Associated with Caregivers Knowledge of diphtheria

		Caregivers' Preventive Practices					
	Variables	Good n (%)	Poor n (%)	χ^2	p-value	AOR (95% CI)	p-value
Gender	Male	29 (100.0)	0 (0.0)	2.454 ^a	0.117		
	Female	565 (92.2)	48 (7.8)				
Age (Yrs)	15-19	13 (100.0)	0 (0.0)	19.393 ^a	<0.01	9226331.998373 (0.00)	0.999
	20-24						0.842
	25-29	158 (86.3)	25 (13.7)			0.834 (0.140-4.958)	0.458
	≥30	233 (92.5)	19 (7.5)			0.542 (0.108-2.727)	
		190 (97.9)	4 (2.1)			1(ref)	
Religion	Christianity	293 (92.4)	24 (7.6)	0.008 ^a	0.928		
	Islam	301 (92.6)	24 (7.4)				
Marital Status	Single	17 (94.4)	1 (5.6)	0.100 ^a	0.951		
	Married	553 (92.5)	45 (7.5)				
	Separated/Divorced/Widowed	24 (92.3)	2 (7.7)				
Highest Educational Level Attained	No Formal Education	15 (88.2)	2 (11.8)	22.861 ^a	<0.01	0.111 (0.001-11.513)	0.354
	Primary	68 (81.9)	15 (18.1)			0.025 (0.001-1.088)	0.055
	Secondary	376 (92.6)	30 (7.4)			0.034 (0.001-1.311)	0.070
	Diploma/First Degree/Post Graduate	135 (99.3)	1 (0.7)			1(ref)	
Occupation	Student	11 (100.0)	0 (0.0)	52.119 ^a	<0.01	53019397.489879 (0.000)	0.999
	Employed	93 (81.6)	21 (18.4)			0.233 (0.057-0.952)	0.042
	Entrepreneur	430 (97.3)	12 (2.7)			5.857 (1.328-25.829)	0.020
	Unemployed	60 (80.0)	15 (20.0)			1(ref)	
Relationship with the child	Father	24 (100.0)	0 (0.0)	3.817 ^a	0.148		
	Mother	550 (92.0)	48 (8.0)				
	Others						

		20 (100.0)	0 (0.0)				
Child's Gender	Male	270 (90.9)	27 (9.1)	2.082	0.149		
	Female		21 (6.1)				
		324(93.9)					
Child's Age (Month)	0-12	171 (91.4)	16 (8.6)	0.542 ^a	0.762		
	13-36						
	37 and above	279 (92.7)	22 (7.3)				
		144 (93.5)	10 (6.5)				
Birth order	1	294 (91.6)	27 (8.4)	7.225 ^a	0.027	1.594 (0.211-12.054)	0.898
	2	167 (90.3)	18 (9.7)			1.131 (0.173-7.390)	0.652
	≥3	133 (97.8)	3 (2.2)			1(ref)	
Overall Caregivers' knowledge of diphtheria among under-five	Good (≥14.00)	344 (98.9)	4 (1.1)	43.978 ^a	<0.01	5.894 (1.680-20.679)	0.006
	Poor (<14.00)	250 (85.0)	44 (15.0)			1(ref)	
Overall Caregivers' diphtheria risk perception	Good (≥7.00)			13.842 ^a	<0.01		
	Poor (<7.00)						
		345 (89.4)	41 (10.6)			0.155 (0.044-0.554)	0.004
		249 (97.3)	7 (2.7)			1(ref)	
Overall Caregivers' diphtheria vaccine confidence	Good (≥9.00)	589 (96.7)	20 (3.3)	301.051 ^a	<0.01	170.814 (38.708-753.785)	<0.01
	Poor (<9.00)	5 (5.2)	28 (84.8)			1(ref)	

Characteristics		Caregivers' Knowledge of diphtheria among under-five				AOR (95%CI)	p-Value
		Good n (%)	Poor n (%)	χ^2	p-Value		
Gender	Male	17 (58.6)	12 (41.4)	0.239 ^a	0.625		
	Female	331 (54.0)	282 (46.0)				
Age (Yrs)	15-19	12 (92.3)	1 (7.7)	34.237 ^a	<0.01	11.923 (1.450-98.067)	0.021
	20-24	76 (41.5)	107 (58.5)				0.199
	25-29	129 (51.2)	123 (48.8)			0.705 (0.414-1.202)	0.042
	≥30	131 (67.5)	63 (32.5)			0.624 (0.396-0.082)	
						1(ref)	
Religion	Christianity	184 (58.0)	133 (42.0)	3.717 ^a	0.054		
	Islam	164 (50.5)	161 (49.5)				
Marital Status	Single		11 (61.1)	1.757 ^a	0.415		
	Married	7 (38.9)	271 (45.3)				
	Separated/Divorced/	327 (54.7)	12 (46.2)				
	Widowed	14 (53.8)					
Highest Educational Level Attained	No Formal Education	7 (41.2)	10 (58.8)	37.261 ^a	<0.01	0.470 (0.150-1.474)	0.196
	Primary	24 (28.9)	59 (71.8)				0.160
	Secondary	221 (54.4)	185 (45.6)			0.221 (0.114-0.427)	0.009
	Diploma/First Degree/	96 (70.6)	40 (29.4)			0.553 (0.355-0.862)	
	Post Graduate					1(ref)	
Occupation	Employed	8 (72.7)	3 (27.3)	22.276 ^a	<0.01	5.776 (1.272-26.230)	0.023
Student	Entrepreneur	64 (56.1)	50 (43.9)				0.091
	Unemployed	254 (57.5)	188 (42.5)			1.812 (0.909-3.613)	0.028
		22 (29.3)	53 (70.7)			1.960 (1.074-3.578)	
						1(ref)	

Relationship with the child	Father	13 (54.2)	11 (45.8)	0.970 ^a	0.61		
	Mother	322 (53.8)	276 (46.2)				
	Others	13 (65.0)	7 (35.0)				
Child's Gender	Male	164(55.2)	133 (44.8)	4.111	0.63		
	Female	184 (53.3)	161 (46.7)				
Child's Age (Month)	0-12	112 (59.9)	75 (40.1)	0.229 ^a	0.12		
	13-36	152 (50.5)	149 (49.5)				
	37 and above	84 (54.5)	70 (45.5)				
Birth order	1	149 (46.4)	172 (53.6)	16.817 ^a	<0.01	0.672 (0.403-1.120)	0.127 0.948
	2	110 (59.5)	75 (40.5)				
	≥3	89 (65.4)	47 (34.6)				
1(ref)							

Table 8: Factors Associated with Caregivers' diphtheria Vaccine Confidence.

		Caregivers' Vaccine Confidence					
Characteristics		Good n (%)	Poor n (%)	χ^2	p-Value		
Gender	Male	28 (96.6)	1 (3.4)	0.178 ^a	0.673		
	Female	581 (94.8)	32 (5.2)				
Age (Yrs)	15-19	13 (100.0)	0 (0.0)	29.301 ^a	<0.01	0.227 (0.000)	1.000
	20-24	161 (88.0)	22 (12.0)			0.000 (0.000)	0.994
	25-29	241 (95.6)	11 (4.4)			0.000 (0.000)	0.994
	≥30	194 (100.0)	0 (0.0)			1(ref)	
Religion	Christianity	301 (95.0)	16 (5.0)	0.011 ^a	0.916		
	Islam	308 (94.8)	17 (5.2)				
Marital Status	Single	18 (100.0)	0 (0.0)	1.325 ^a	0.516		
	Married	567 (94.8)	31 (5.2)				
	Separated/Divorced/	24 (92.3)	2 (7.7)				
	Widowed						
Highest Educational Level Attained	No Formal Education	15 (88.2)	2 (11.8)	18.332 ^a	<0.01	0.282 (0.018-4.392)	0.366
	Primary	72 (86.7)	11 (13.3)			0.236 (0.023-2.374)	0.220
	Secondary	387 (95.3)	19 (4.7)			0.411 (0.048-3.479)	0.414
	Diploma/First Degree/	135 (99.3)	1 (0.7)			1(ref)	
	Post Graduate						
Occupation	Student	11 (100.0)	0 (0.0)	25.842 ^a	<0.01	29758627.217091(0)	0.999
	Employed	105 (92.1)	9 (7.9)			0.608 (0.194-1.905)	0.393
	Entrepreneur	430 (97.3)	12 (2.7)			2.204 (0.792-6.135)	0.130
	Unemployed	63 (84.0)	12 (16.0)			1(ref)	

Relationship with the child	Father	24 (100.0)	0 (0.0)	2.560 ^a	0.278		
	Mother	565 (94.5)	33 (5.5)				
	Others	20 (100.0)	0 (0.0)				
Child's Gender	Male	280(94.3)	17 (5.7)	0.386 ^a	0.534		
	Female	329 (93.9)	16 (6.1)				
Child's Age (Month)	0-12	172 (92.0)	15 (8.0)	4.494 ^a	0.106		
	13-36	289 (96.0)	12 (4.0)				
	≥37	148 (96.1)	6 (3.9)				
Birth order	1	302 (94.1)	19 (5.9)	7.162 ^a	0.028	1.142 (0.131-9.952)	0.905
	2	172 (93.0)	13 (7.0)			0.267 (0.031-2.320)	0.231
	≥3	135 (99.3)	1 (0.7)			1(ref)	
Caregivers' knowledge about diphtheria	Good (≥14.00)	346 (99.4)	2 (0.6)	32.485 ^a	<0.01	13.089 (2.946-58.160)	0.001
	Poor (<14.00)	263 (89.5)	31 (10.5)			1(ref)	
Caregivers' Risk Perception of diphtheria	Good (≥7.00)	360 (93.3)	26 (6.7)	5.054 ^a	0.025	0.507 (0.203-1.269)	0.147
	Poor (<7.00)	249 (97.3)	7 (2.7)			1(ref)	