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Public perception and health behaviours related to diphtheria risk in Northern Nigeria

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Abstract

Background Diphtheria, a vaccine-preventable disease, has re-emerged in Northern Nigeria with serious public health consequences. Understanding how awareness and risk perception shape health behaviours is critical for controlling outbreaks. This study assessed public awareness, risk perception, and associated socio-demographic factors among residents in selected high-burden states in northern Nigeria.

Methods A cross-sectional survey was conducted from December 2022 to December 2023 in ten northern states (Katsina, Kano, Jigawa, Zamfara, Kaduna, Bauchi, Borno, Yobe, Nasarawa, and the Federal Capital Territory). A multistage sampling technique selected respondents aged 18 years and above. Data were collected using a structured, interviewer-administered questionnaire adapted from the WHO Diphtheria Rapid Perception Survey Tool, translated into Hausa and back-translated. Descriptive and inferential statistics, including binary logistic regression, identified predictors of awareness and risk perception.

Results A total of 2,924 respondents participated (mean age: 34.6 ± 11.2 years; 58.2% female). Awareness of diphtheria was 63.4%, and 48.1% perceived the disease as highly dangerous. Radio was the predominant information source (62.9%). Higher education (aOR = 2.14, 95% CI: 1.56–2.92), prior knowledge of vaccination (aOR = 1.87, 95% CI: 1.29–2.70), and residence in urban areas (aOR = 1.66, 95% CI: 1.21–2.32) were significant predictors of awareness. Risk perception was higher among females (aOR = 1.42, 95% CI: 1.13–1.78), participants with formal education (aOR = 1.51, 95% CI: 1.20–1.92), and those citing radio as a major information source (aOR = 1.36, 95% CI: 1.03–1.80).

Conclusion Socio-demographic factors and information exposure significantly influence awareness and perception of diphtheria. Strengthened community engagement, social listening, behavioural intelligence, radio-based campaigns, and integration of diphtheria information into primary health education can enhance outbreak preparedness and vaccine uptake.

Keywords Diphtheria, Awareness, Risk perception, Northern Nigeria, Health belief model, Vaccine-preventable diseases

1 Introduction

Diphtheria is a serious bacterial infection caused by *Corynebacterium diphtheriae*, transmitted mainly through respiratory droplets [1]. Despite global control efforts, outbreaks continue to occur in low- and middle-income countries. In 2023, Nigeria recorded its largest diphtheria outbreak in recent decades, with over 5,898 suspected cases across 11 states, 99.4% of which occurred in six northern states [2]. This resurgence underscores persistent immunization gaps, suboptimal surveillance, and communication challenges in high-risk regions [3–4].

While existing studies have explored vaccination coverage and clinical outcomes, little is known about community awareness and behavioural responses to diphtheria outbreaks [3–6]. Public awareness and risk perception are critical in shaping preventive actions and vaccine acceptance, especially in contexts where misinformation and low trust in health authorities persist.

Guided by the Health Belief Model (HBM), this study posits that perceived susceptibility, severity, benefits, and barriers influence health-related decision-making. The model provides a framework to understand how individual beliefs shape preventive behaviours during epidemics [7].

Previous studies in Nigeria focused mainly on general immunization awareness and often lacked behavioural analysis, regression modelling, or geographically diverse samples [8–11]. This study addresses these gaps by assessing awareness, perception, and preventive behaviours regarding diphtheria across multiple northern states during an active outbreak.

Objective To assess awareness, risk perception, and preventive behaviours related to diphtheria among adults in northern Nigeria, and identify socio-demographic predictors influencing these outcomes.

2 Methods

2.1 Study design and setting

This was a cross-sectional descriptive survey conducted between December 2022 and December 2023 in ten northern states: Katsina, Kano, Jigawa, Zamfara, Kaduna, Bauchi, Borno, Yobe, Nasarawa, and the Federal Capital Territory (FCT) (Fig. 1). Data collection was conducted concurrently across all selected states between December 2022 and December 2023. These states were purposively selected based on high outbreak burden as reported by NCDC and WHO (2023–2024) [2, 12].

2.2 Study population and sampling technique

A multistage sampling technique was used:

- *Stage 1* Purposive selection of outbreak-affected states.
- *Stage 2* Random selection of Local Government Areas (LGAs) within each state.
- *Stage 3* Systematic sampling of households using a fixed sampling interval of every 5th household.
- *Stage 4* Within each selected household, one eligible adult (≥ 18 years) was selected using a simple lottery method.

Sample size ($n = 2{,}924$) was proportionally allocated to each state based on population estimates. Only residents aged ≥ 18 years who consented were included.

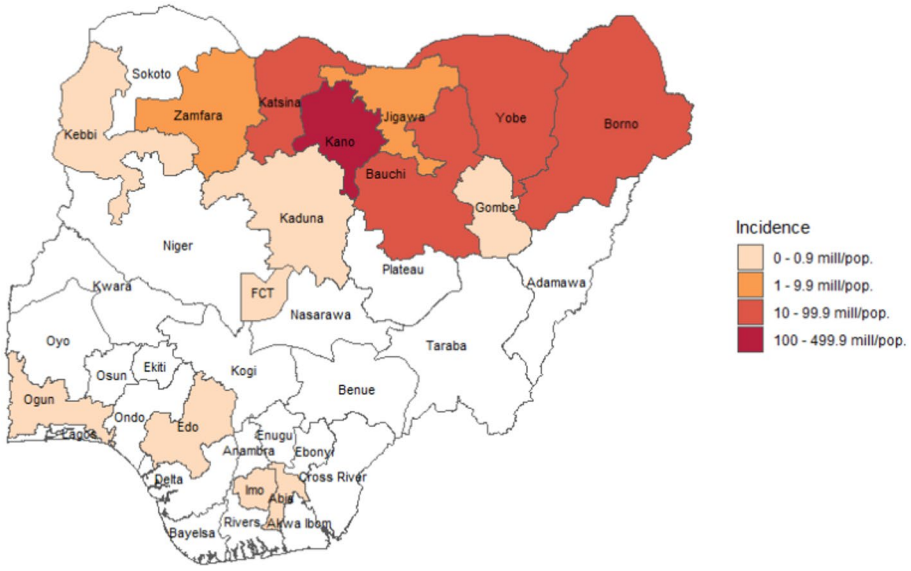

Fig. 1 Confirmed diphtheria case incidences per million population across Nigerian States. 2022 epi-week 19 to 2025 epi-week 11. Source: [2]

2.3 Data collection instrument

Data were obtained by means of a structured interview-based delivered questionnaire, formulated based on the Diphtheria Rapid Perception Survey Tool adapted from WHO guidelines [12], and previous KAP studies on vaccine-preventable diseases in Nigeria [3, 5, 7–11]. The instrument was translated into Hausa for ease of administration in local communities and back-translated into English to ensure accuracy. The tool had sections on socio-demographic characteristics, awareness and knowledge of diphtheria, sources of information, perceptions of diphtheria risk and severity, and preventive practices and healthcare-seeking behaviour. The instrument was pretested with 50 participants in a non-participating LGA, and minor adjustments were made. The reliability coefficient (Cronbach's $\alpha = 0.82$) confirmed internal consistency.

2.4 Training and quality control

Twenty trained field enumerators and five supervisors participated in a five-day training on ethical considerations, interviewing skills, and questionnaire administration. Supervisors reviewed forms daily for completeness, and 10% of responses were double-entered to verify data accuracy.

2.5 Data analysis

Data were analyzed using STATA 17. Descriptive statistics (frequencies, means, and proportions) summarized the variables. Bivariate associations were examined using Chi-square tests ($p < 0.05$). Variables with $p < 0.25$ were entered into a multivariate logistic regression model using backward elimination to identify independent predictors. Crude (COR) and adjusted odds ratios (aOR) with 95% confidence intervals (CI) were reported. Missing data were treated as a separate "Missing" category.

2.6 Ethical considerations

Ethical approval for this study was gotten from the National Health Research Ethics Committee (NHREC Ref. NHREC/01/01/2007-19/07/2022). Verbal consent was obtained due to low literacy levels in some communities. Participants were informed of their rights to decline participation, and all data were anonymized to protect confidentiality.

3 Results

3.1 Socio-demographic characteristics

A total of 2,924 respondents participated in the survey. The mean age was 34.6 ± 11.2 years, and 58.2% were female. The majority were married (68.4%), had secondary education (37.1%), and resided in urban areas (54.8%) (Table 1).

3.2 Awareness and information sources

Overall, 63.4% of respondents had heard of diphtheria. Awareness was highest among respondents with tertiary education and those aged 25–44 years. The leading sources of information were radio (62.9%) and community health workers (28.4%). Other notable sources included friends/family (20.9%), television (17.8%), and social media (12.9%) (Table 2; Fig. 2).

Awareness was significantly associated with education, occupation, and state of residence ($p < 0.001$).

3.3 Risk perception of diphtheria

Almost half (48.1%) of respondents perceived diphtheria as *very dangerous*, while 35.3% considered it *somewhat dangerous*. A majority (84.2%) expressed willingness to seek care if symptoms developed (Table 3).

Table 1 Socio-demographic characteristics of respondents ($N = 2,924$)

Variable	Category	Frequency (*n*)	Percentage (%)
Age group (years)	18–24	456	15.6
	25–34	922	31.5
	35–44	738	25.2
	45 +	808	27.7
Sex	Male	1,222	41.8
	Female	1,702	58.2
Marital status	Single	760	26.0
	Married	1,998	68.4
	Divorced/Widowed	166	5.6
Education level	None	524	17.9
	Primary	692	23.7
	Secondary	1,086	37.1
	Tertiary	622	21.3
Occupation	Unemployed	362	12.4
	Trader/Artisan	972	33.2
	Civil servant	786	26.9
	Student	566	19.4
	Others	238	8.1
Residence	Urban	1,603	54.8
	Rural	1,321	45.2

Table 2 Awareness of diphtheria and information sources (*N* = 2,924)

Variable	Category	*n* (%)
Heard of diphtheria	Yes	1,855 (63.4)
	No	1,069 (36.6)
Primary source of information about diphtheria*	Radio	1,838 (62.9)
	Community health worker	831 (28.4)
	Television	519 (17.8)
	Friends / family	612 (20.9)
	Social media	376 (12.9)
	Religious leader	281 (9.6)
	Others	147 (5.0)

Percentages exceed 100% because multiple responses were allowed

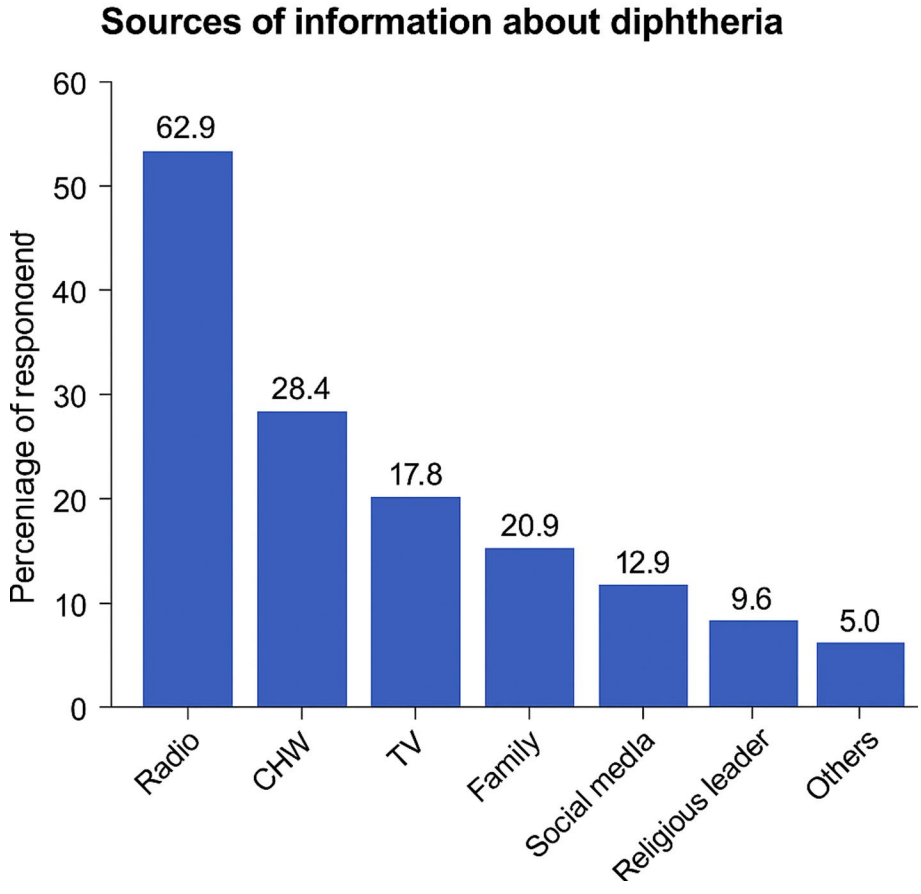

Fig. 2 Sources of information about diphtheria

Table 3 Risk perception of diphtheria (*N* = 2,924)

Variable	Category	*n* (%)
Perceived danger of diphtheria	Very dangerous	1,407 (48.1)
	Somewhat dangerous	1,032 (35.3)
	Not dangerous	485 (16.6)
Willing to seek care if symptoms develop	Yes	2,462 (84.2)
	No	462 (15.8)

Table 4 Association between risk perception and socio-demographic characteristics

Variable	Category	High risk perception *n* (%)	χ^2 (df)	*p*-value
Sex	Male	526 (43.0)	9.75 (1)	0.002
	Female	881 (51.8)		
Education	None	156 (29.8)	87.6 (3)	< 0.001
	Primary	297 (42.9)		
	Secondary	574 (52.9)		
	Tertiary	380 (61.1)		
Residence	Urban	867 (54.1)	29.8 (1)	< 0.001
	Rural	540 (40.9)		

Percentages represent row proportions. High risk perception refers to respondents who perceived diphtheria as "very dangerous."

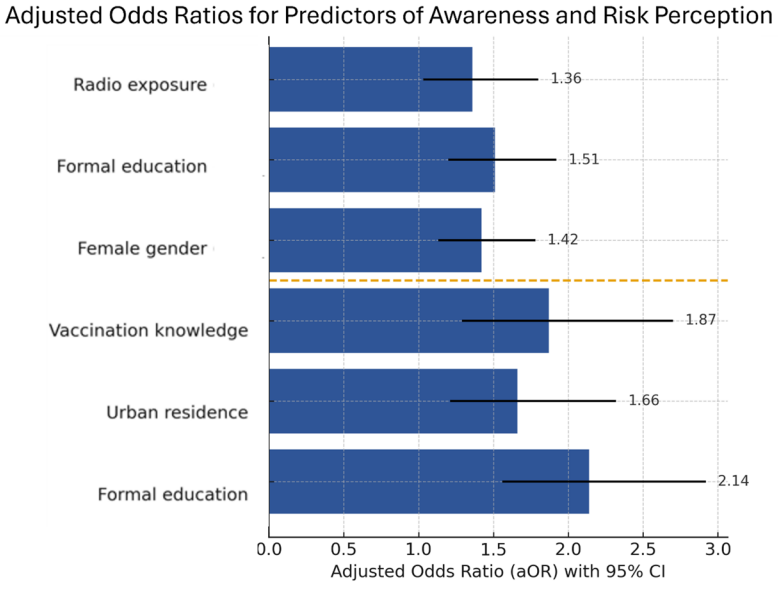

Fig. 3 Adjusted predictors of **A** awareness of diphtheria and **B** high risk perception of diphtheria among respondents

3.4 Association between risk perception and socio-demographic characteristics

Risk perception differed significantly across education, gender, and residence (Table 4). Risk perception was higher among females, those with formal education, and urban dwellers ($p < 0.05$). These findings suggest that educational attainment and gender-related roles may influence how individuals interpret and internalize outbreak risk messages (Fig 3).

3.5 Predictors of awareness and risk perception

After adjustment for potential confounders, respondents with formal education were more than twice as likely to be aware of diphtheria compared to those with no formal education (aOR = 2.14, 95% CI: 1.56–2.92). Urban residents also demonstrated significantly higher awareness compared to rural residents (aOR = 1.66, 95% CI: 1.21–2.32). Prior knowledge of vaccination remained a strong predictor of awareness (aOR = 1.87, 95% CI: 1.29–2.70) (Table 5).

Regarding risk perception, female respondents had 42% higher odds of perceiving diphtheria as very dangerous compared to males (aOR = 1.42, 95% CI: 1.13–1.78).

Table 5 Predictors of awareness of diphtheria (binary logistic regression)

Variable	COR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Female vs. male	1.30 (1.10–1.55)	0.002	1.21 (0.97–1.50)	0.085
Formal education (primary and above)vs none	2.98 (2.36–3.77)	< 0.001	2.14 (1.56–2.92)	< 0.001
Urban vs. rural residence	1.82 (1.51–2.20)	< 0.001	1.66 (1.21–2.32)	0.001
Heard of vaccination	2.24 (1.67–3.01)	< 0.001	1.87 (1.29–2.70)	0.001
Age ≥ 45 vs. < 25	0.82 (0.64–1.05)	0.117	0.88 (0.66–1.18)	0.378

Table 6 Predictors of perceiving diphtheria as very dangerous among respondents (binary logistic regression)

Variable	COR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
Female vs. Male	1.48 (1.23–1.78)	< 0.001	1.42 (1.13–1.78)	0.002
Formal education (Primary and above) vs. none	1.72 (1.39–2.12)	< 0.001	1.51 (1.20–1.92)	0.001
Radio as main information source	1.40 (1.08–1.82)	0.010	1.36 (1.03–1.80)	0.028
Urban vs. rural residence	1.49 (1.22–1.83)	< 0.001	1.23 (0.98–1.55)	0.071

Individuals with formal education were significantly more likely to report high risk perception than those with no formal education (aOR = 1.51, 95% CI: 1.20–1.92). Exposure to radio as a primary source of information was also independently associated with higher risk perception (aOR = 1.36, 95% CI: 1.03–1.80) (Table 6).

4 Discussion

This study examined awareness, risk perception, and preventive behaviours related to diphtheria among adults across ten northern Nigerian states during an active outbreak. The findings reveal moderate awareness (63.4%) and suboptimal risk perception (48.1%), despite intense national response efforts. These results highlight persistent gaps in risk communication and community engagement that could hinder outbreak containment and vaccine uptake.

Awareness and Communication Pathways Awareness levels in this study are higher than those reported during earlier outbreaks of vaccine-preventable diseases such as measles and meningitis in northern Nigeria [13–15], but remain below the thresholds expected during an active public health emergency. The dominant role of radio (62.9%) and community health workers (28.4%) as primary information sources underscores the enduring importance of traditional media and interpersonal communication in low-literacy communities. Similar findings have been reported in Bangladesh and Ethiopia [16, 17], where radio continues to serve as a trusted medium for risk communication. However, the relatively low influence of social media (12.9%) and religious leaders (9.6%) reflect missed opportunities for tailored engagement in an era where misinformation often spreads online. Integrating verified digital content into radio and community programming may enhance both reach and credibility of public health messages.

Predictors of Awareness The predictors of awareness, education, urban residence, and vaccination knowledge, align with the Health Belief Model (HBM), which posits that individual awareness is shaped by exposure to information (cues to action) and perceived benefits. Participants with higher education were more than twice as likely to be aware of diphtheria compared to those without formal education. This relationship reinforces previous findings from India and Indonesia showing education as a consistent determinant of epidemic awareness [17–18]. Urban residents also demonstrated significantly higher awareness, reflecting greater access to mass media and health campaigns.

The significant effect of prior vaccination knowledge suggests that exposure to immunization messages, whether through healthcare providers or campaigns, contributes to broader epidemic awareness. This underscores the value of integrating outbreak information into existing vaccination programs and maternal-child health services.

Risk Perception and Behavioural Determinants Despite relatively high awareness, fewer than half of respondents perceived diphtheria as "very dangerous." This awareness–perception gap mirrors findings from previous infectious disease studies in Nigeria, including those on COVID-19 and Lassa fever [13–14]. Gender and educational differences in risk perception suggest that women and educated individuals are more responsive to health warnings, possibly due to their caregiving roles and greater access to credible information sources. Furthermore, the association between radio exposure and higher risk perception indicates that consistent and culturally adapted radio messaging remains one of the most cost-effective strategies for outbreak communication in low-literacy populations. However, passive information flow is insufficient. The persistence of low perceived severity among rural residents points to the need for interactive and participatory community engagement, particularly through local influencers, health workers, and traditional leaders who can contextualize scientific information.

4.1 Implications for risk communication and infodemic management

The study's findings have practical implications for risk communication, community engagement, and infodemic management. First, leveraging radio and community health workers should remain central to outbreak communication strategies in Nigeria, but messages must evolve from awareness creation to perception shaping and action prompting. Second, social listening systems should be integrated into ongoing public health surveillance to detect rumours early and adapt messaging based on community feedback. Third, interventions should employ gender-sensitive and literacy-appropriate communication materials, ensuring that both men and women can access, interpret, and act on accurate information.

Compared with findings from similar outbreaks in South Asia and East Africa, awareness and perceived risk levels in this study are moderate but consistent with settings characterized by limited health literacy and misinformation. In Pakistan, only 46% of respondents were aware of diphtheria prevention during the 2018 outbreak [18, 19], while a Tanzanian study reported 58% awareness of measles vaccination campaigns [19]. These parallels highlight the regional challenge of translating public health messaging into behaviour change, especially during multi-state epidemics.

4.2 Limitations and strengths

The cross-sectional design restricts causal inference, and self-reported measures may be subject to recall or social desirability bias. Verbal consent, though ethically justified in low-literacy settings, might limit data verification. Nonetheless, the study's large multi-state sample, use of a validated WHO tool, and inclusion of both quantitative and behavioural dimensions provide valuable insights into public understanding of diphtheria during an ongoing outbreak.

4.3 Recommendations

Based on these findings, three key actions are proposed:

1. *Strengthen community-based radio programming* that integrates participatory discussions, local dialects, and storytelling to improve perceived risk and self-efficacy.
2. *Embed social and community listening* mechanisms within state-level disease surveillance systems to track rumours and misinformation in real time.
3. *Implement targeted risk communication interventions* for low-literacy and rural populations using visual and interpersonal communication approaches.

5 Conclusion

The study highlights that while awareness of diphtheria is moderate, risk perception and behavioural readiness remain low in northern Nigeria. Addressing educational disparities, enhancing communication access, and integrating behavioural insights into outbreak response will be essential for strengthening public health preparedness and vaccine uptake. Applying behavioural insights from the Health Belief Model can enhance the design and delivery of diphtheria risk communication, improve vaccine acceptance, and strengthen public trust in health authorities.

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Author contributions
Abara A. Erim conceived the study and led design, analysis, and manuscript drafting.Ukamaka G. Okafor contributed to design and interpretation.Martin Z. Pam supported data analysis.Okechi Nzedibe contributed to literature review and methods.Other co-authors supported data processing, field supervision, and manuscript editing.All authors reviewed and approved the final version.

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Data availability
Data are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This study was approved by the National Health Research Ethics Committee (NHREC Ref. NHREC/01/01/2007-19/07/2022), and all procedures were conducted in accordance with the ethical standards of the committee and the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from all individual participants prior to their inclusion in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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