Science World Journal Vol. 20(No 3) 2025 https://dx.doi.org/10.4314/swj.v20i3.34
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

ANTIBIOTIC MISUSE AND ITS IMPACT ON THE DEVELOPMENT OF ANTIMICROBIAL RESISTANCE (AMR) IN NORTH EASTERN NIGERIA

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ABSTRACT
Antimicrobial resistance (AMR) poses a critical global public health threat, particularly in low- and middle-income countries. This descriptive cross-sectional study investigated the patterns of antibiotic misuse and its association with demographic characteristics, knowledge, awareness, attitudes, and behaviors among 423 adults in North Eastern Nigeria. The findings reveal widespread inappropriate antibiotic use, including self-medication (52.2%), incomplete courses (49.4% reported not usually completing), and sharing of antibiotics (53.4%). Self-medication and incomplete antibiotic use were significantly more prevalent among individuals aged 25–64 years, males, urban residents, and those with tertiary education. Poor antibiotic knowledge and prevalent misconceptions, such as the belief that antibiotics cure viral infections (56% of respondents), were significantly associated with higher rates of misuse. A significant number of respondents (26.0%) believed antibiotics are effective for all illnesses and engaged in self-medication. Furthermore, belief in the acceptability of sharing antibiotics (23.4%) and the safety of self-medication (15.6%) were strongly linked to misuse behaviors. Logistic regression identified self-medication (OR = 0.273, 95% CI: 0.182–0.409, $p < 0.001$) and sharing of antibiotics (OR = 0.431, 95% CI: 0.290–0.639, $p < 0.001$) as significant predictors of treatment failure. These findings underscore an urgent need for targeted public health interventions, including tailored education campaigns, stricter regulation of antibiotic sales, and promotion of the One Health approach, to curb antibiotic misuse and mitigate AMR in North Eastern Nigeria.

Keywords: Misuse, Antibiotics, Resistance, Self-medication, Antimicrobials.

INTRODUCTION

Antimicrobial resistance (AMR) is one of the most pressing public health threats of the 21st century, with the potential to reverse decades of medical progress. AMR occurs when microorganisms such as bacteria, viruses, fungi, and parasites evolve to resist the effects of medications previously effective for treating infections. The World Health Organization (WHO) warns that if current trends continue, AMR could cause up to 10 million deaths annually by 2050 and result in global economic losses exceeding USD 100 trillion (Sekyere & Asante, 2018).

Antibiotics—critical tools in modern medicine—are among the most misused antimicrobial agents. Their misuse fuels the emergence of resistant pathogens, rendering once-treatable infections life-threatening. This crisis is especially alarming in low- and middle-income countries (LMICs) like Nigeria, where healthcare infrastructure is weak and public awareness of rational antibiotic use remains low (Chukwu *et al*., 2020; Irfan *et al*., 2022).

Northern Nigeria, including the North East region comprising states like Bauchi, Borno, Yobe, Adamawa, Taraba, and Gombe, is especially vulnerable to the threat of AMR due to a combination of systemic, behavioral, and environmental factors. The region is characterized by high poverty levels, widespread self-medication, limited healthcare access, and poorly regulated pharmaceutical markets (Magaji *et al*., 2025). These conditions provide a fertile ground for the development and spread of resistant pathogens.

The frequent empirical use of antibiotics—due to the lack of diagnostic facilities—combined with the availability of antibiotics without prescription, has made irrational antibiotic use a norm (Godman *et al*., 2022). Moreover, the conflict-driven humanitarian crisis in parts of North East Nigeria has further strained already fragile health systems, increasing the reliance on unregulated drug vendors and informal care (Alhassan & Utono, 2021).

Antibiotic misuse in the North East encompasses both overuse and underuse. Overuse includes self-medication, use of antibiotics for viral infections such as the common cold or malaria, and combining antibiotics with traditional remedies. Underuse is also common, with patients often purchasing incomplete courses of antibiotics due to financial constraints, or discontinuing treatment once symptoms subside (Lawal *et al*., 2025; Magaji *et al*., 2025).

Several misconceptions fuel this misuse. For instance, many individuals believe antibiotics are effective against all infections, including viral illnesses. Others use leftover antibiotics or

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www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
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medications prescribed for family members without consulting healthcare professionals (Klein *et al*., 2018; Belachew *et al*., 2021). Community drug outlets continue to dispense antibiotics without prescriptions, while online pharmacies remain largely unregulated. The digital divide in Northern Nigeria also means that misinformation spreads rapidly, especially via social media and informal networks. Digital health literacy remains low, especially among the rural and semi-literate populations, which impedes public understanding of the consequences of antibiotic misuse (Labrique *et al*., 2018).

The misuse of antibiotics significantly contributes to the development of resistant bacterial strains. Infections that were once easily treatable with first-line antibiotics now require more toxic, expensive, or unavailable drugs. In North East Nigeria, resistance to commonly used antibiotics such as ampicillin, cotrimoxazole, tetracycline, and streptomycin has been widely reported (Iwalokun *et al*., 2019; Magaji *et al*., 2025).

The convergence of resistance patterns in both human and animal sectors further complicates the issue. Antibiotics used in veterinary medicine—especially in livestock—are often the same or structurally related to those used in humans. Their misuse in animal husbandry, often as growth promoters or for disease prevention, contributes to the development of resistant strains that can be transmitted to humans through food chains and environmental exposure (Ajayi *et al*., 2020; Okello *et al*., 2023).

Moreover, the presence of substandard and counterfeit antimicrobials in the region undermines treatment effectiveness and accelerates resistance. Weak regulatory frameworks and insufficient post-market surveillance allow poor-quality drugs to circulate widely, especially in rural and conflict-affected areas (Godman *et al*., 2022).

The implications of AMR in Northern Nigeria are dire. Increased morbidity and mortality are reported, particularly among vulnerable groups such as children, the elderly and immunocompromised individuals (Kariuki & Dougan, 2014; Ahmed *et al*., 2024). Infections last longer, become more difficult to treat, and often require hospitalization. The burden on already overstretched healthcare systems is immense (Kariuki & Dougan, 2014; Ahmed *et al*., 2024).

Furthermore, the rise in resistant infections compromises the success of medical procedures such as surgery, chemotherapy, and organ transplantation. With limited access to second- and third-line antibiotics, patients in the North East face significant risk of treatment failure and death (Magaji *et al*., 2025).

The economic cost is also severe. Longer hospital stays, increased need for diagnostic tests, and loss of productivity due to prolonged illness contribute to rising healthcare expenses and household poverty. Without urgent action, AMR could undermine efforts toward achieving universal health coverage and the Sustainable Development Goals (SDGs) in the region (Ahmed *et al*., 2024).

Adopting the One Health approach is also critical, integrating human, animal, and environmental health to address AMR holistically. This includes regulating veterinary drug use, improving water and sanitation, and minimizing environmental contamination from pharmaceutical waste (Okello *et al*., 2023; Uzoka *et al*., 2025).

Despite growing global concern over AMR, data on the specific factors driving antibiotic misuse in North Eastern Nigeria remains limited. Existing national surveys and studies tend to generalize trends across the broader Nigerian population without disaggregating data by region, socioeconomic status, or cultural context (Chukwu *et al*., 2020; Babatola *et al*., 2021). Consequently, there is insufficient evidence to inform region-specific strategies for antibiotic stewardship and AMR control in the North East. Moreover, while anecdotal and observational reports suggest widespread self-medication, irrational antibiotic use, and weak regulation in the region, few empirical studies have systematically examined these issues in the context of AMR. There is also a significant gap in understanding how public misconceptions, informal healthcare practices, and digital misinformation contribute to misuse. This study seeks to bridge this gap by providing evidence-based insights into antibiotic misuse in North Eastern Nigeria and its relationship with AMR. It explored the scope of inappropriate antibiotic practices, identified key risk factors, and highlighted opportunities for targeted public health interventions. By focusing on this under-researched region, the study contributes to a more equitable and effective national AMR response.

METHODOLOGY

Study Area

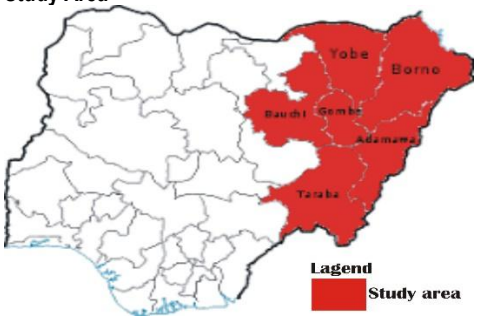

Figure1: Map of Nigeria showing the study area

This study was conducted in selected communities across the North Eastern region of Nigeria, a region with six states including Bauchi, Gombe, Yobe, Adamawa, Taraba and Borno, having diverse populations and healthcare challenges. The area comprises both urban and rural settings, where access to antibiotics is often unregulated and self-medication is common.

Study Design

A descriptive cross-sectional survey was employed to assess the extent of antibiotic misuse and its impact on the development of antimicrobial resistance (AMR) among residents in the region.

Study Population and Sample Size

The study population comprised adults aged 18 years and above residing in North Eastern Nigeria. A total of 423 respondents were selected through a multistage sampling technique to ensure representation across various demographic groups. Individuals who were unwilling to participate or below the age of 18 were excluded from the study.

Data Collection Instrument

A structured, pre-tested questionnaire was used to obtain relevant data from participants. The questionnaire was designed to assess socio-demographic characteristics, knowledge, attitudes, and practices regarding antibiotic use, as well as awareness of AMR. The instrument included both closed- and open-ended questions and was administered in English and local languages as appropriate.

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Ethical Considerations

Informed consent was obtained from all participants before data collection. Participants were assured of the confidentiality and anonymity of their responses. Ethical approval was obtained from an appropriate institutional ethics committee prior to the commencement of the study.

Data Analysis

Data collected were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 23. Descriptive statistics such as frequencies and percentages were used to summarize the data. Associations between variables were examined using chi-square tests, and logistic regression analysis was employed to identify predictors of antibiotic misuse. Statistical significance was set at $p < 0.05$.

RESULTS

Association between Demographic Characteristics and Antibiotic Misuse Behaviors

The current study assessed the Impact of Antibiotic Misuse on the Development of antimicrobial Resistance (AMR) in North Eastern Nigeria. The relationship between demographic variables and self-medication, completion of antibiotics, and sharing behaviors is presented in Tables 1a–1c.

This study revealed that, Self-medication with antibiotics was significantly associated with age, gender, educational level, and location. Out of 423 respondents, 52.2% (n=221) reported engaging in self-medication with antibiotics. Participants aged 25–64 years (46.8%) reported higher involvement in self-medication compared to those aged 18–24 years (5.4%) ($\chi^2 = 11.708$, $p = 0.001$). Males were more likely to self-medicate (46.8%) than females (5.4%) ($\chi^2 = 11.708$, $p = 0.001$). A significantly higher proportion of respondents with tertiary education engaged in self-medication (47.0%) compared to those with no formal education (2.6%) ($\chi^2 = 32.246$, $p < 0.001$). Urban dwellers (36.4%) were significantly more likely to self-medicate than those in rural areas (0%) ($\chi^2 = 13.840$, $p = 0.001$) (Table 1a)..

Table 1a: Association between self-medication and demography of the respondents

Variables		Self-medication Involved (%)	Not-involved (%)	Total (%)	χ^2	df	*P* value
Age							
	18-24 years	23(5.44)	49(11.58)	72(17.02)	11.708	2	0.001*
	25-64 years	198(46.81)	153(36.17)	351(82.98)			
	65 years and above	0(0.00)	0(0.00)	0(0.00)			
Gender							
	Male	198(46.81)	154(36.41)	352(83.22)	11.708	1	0.001*
	Female	23(5.44)	48(11.35)	71(16.78)			
Educational level							
	No formal education	11(2.60)	2(0.47)	13(3.07)	32.246	3	0.000*
	Primary	0(0.00)	11(2.60)	11(2.60)			
	Secondary	11(2.60)	3(0.71)	14(3.31)			
	Tertiary	199(47.04)	186(43.97)	385(91.02)			
Location							
	Urban	154(36.41)	121(28.61)	275(65.01)	13.840	2	0.001*
	Semi-urban	67(15.84)	65(15.37)	132(31.21)			
	Rural	0(0.00)	16(3.78)	16(3.78)			

"χ^2" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

Exactly 50.6% (n=214) reported completing prescribed antibiotics. Usual completion of antibiotics was significantly associated with age ($\chi^2 = 8.708$, $p = 0.003$), gender ($\chi^2 = 8.708$, $p = 0.003$), education ($\chi^2 = 33.314$, $p < 0.001$), and location ($\chi^2 = 11.440$, $p = 0.003$). Among those who usually completed their antibiotics, the majority was males (43.9%) and aged between 25–64 years (38.8%). Participants with tertiary education (46.6%) were more likely to complete antibiotics compared to those with no formal education (2.6%), and urban dwellers (31.21%) than rural (2.60%) (Table 1b).

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Table 1b: Association between usual completion of antibiotics medication and demography of the respondents

Variables		Completing medication		Total (%)	χ^2	df	P value
		Usually (%)	Not-usually (%)				
Age							
	18-24 years	44(10.40)	28(6.62)	72(17.02)	8.708	2	0.003*
	25-64 years	164(38.77)	187(44.21)	351(82.98)			
	65 years and above	0(0.00)	0(0.00)	0(0.00)			
Gender							
	Male	186(43.97)	166(39.24)	352(83.22)	8.708	1	0.003*
	Female	22(5.20)	49(11.58)	71(16.78)			
Educational level							
	No formal education	11(2.60)	2(0.47)	13(3.07)	33.314	3	0.000*
	Primary	0(0.00)	11(2.60)	11(2.60)			
	Secondary	0(0.00)	14(3.31)	14(3.31)			
	Tertiary	197(46.57)	188(44.44)	385(91.02)			
Location							
	Urban	132(31.21)	143(33.81)	275(65.01)	11.440	2	0.003*
	Semi-urban	65(15.37)	67(15.84)	132(31.21)			
	Rural	11(2.60)	5(1.18)	16(3.78)			

"χ^2" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

About 53.4% (n=226) admitted to sharing antibiotics with others. Sharing of antibiotics was not significantly associated with age (χ^2 = 0.218, p = 0.641), but it was significantly associated with gender (χ^2 = 11.708, p = 0.001), education (χ^2 = 32.246, p < 0.001), and location (χ^2 = 13.840, p = 0.001). Males (46.8%) and those with tertiary education (44.2%) were more likely to engage in sharing antibiotics. Sharing was also more common among urban dwellers (36.4%) compared to rural dwellers (0%) (Table 1c).

Table 1c: Association between the habit of sharing antibiotics and demography of the respondents

Variables		Sharing antibiotics (%)		Total (%)	χ^2	df	P value
		Involved	Not-involved				
Age							
	18-24 years	33(7.80)	39(9.22)	72(17.02)	0.218	1	0.641
	25-64 years	187(44.21)	164(38.77)	351(82.98)			
	65 years and above	0(0.00)	0(0.00)	0(0.00)			
Gender							
	Male	198(46.81)	154(36.41)	352(83.22)	11.708	1	0.001*
	Female	22(5.20)	49(11.58)	71(16.78)			
Educational level							
	No formal education	11(2.60)	2(0.47)	13(3.07)	32.246	3	0.000*
	Primary	11(2.60)	0(0.00)	11(2.60)			
	Secondary	11(2.60)	3(0.71)	14(3.31)			
	Tertiary	187(44.21)	198(46.81)	385(91.02)			
Location							
	Urban	154(36.41)	121(28.61)	275(65.01)	13.840	2	0.001*
	Semi-urban	66(15.60)	66(15.60)	132(31.21)			
	Rural	0(0.00)	16(3.78)	16(3.78)			

"χ^2" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

Association between Knowledge and Awareness of Antibiotics and Misuse Behaviors

Tables 2a–2c present the association between respondents' knowledge and awareness of antibiotics and their misuse behaviors.

Self-medication was significantly associated with having heard of antibiotics (χ^2 = 5.352, p = 0.021), incorrect belief that antibiotics cure viral infections (χ^2 = 17.810, p < 0.001), lack of formal education on antibiotic use (χ^2 = 24.022, p < 0.001), and poor understanding of antibiotic purpose and AMR (χ^2 = 12.553, p < 0.001). Most respondents (92.2%) had heard of antibiotics, but misconceptions were common. A majority (56%) believed antibiotics cure viral infections (Table 2a).

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www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
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Table 2a: Association between self-medication and Knowledge and Awareness of Antibiotics

Variables	Self-medication (%)		Total (%)	χ^2	df	P value
	Involved	Not-involved				
Have you ever heard of antibiotics?						
Yes	209(49.41)	181(42.79)	390(92.20)	5.352	1	0.021*
No	11(2.60)	22(5.20)	33(7.80)			
Can antibiotics cure viral infections (e.g., cold, flu)?						
Yes	143(33.81)	94(22.22)	237(56.03)	17.810	1	0.000*
No	77(18.20)	109(25.77)	186(43.97)			
Are you aware that overuse of antibiotics can lead to resistance?						
Yes	176(41.61)	164(38.77)	340(80.38)	0.771	1	0.380
No	44(10.40)	39(9.22)	83(19.62)			
Have you been educated on correct antibiotic use?						
Yes	121(28.61)	159(37.59)	280(66.19)	24.022	1	0.000*
No	99(23.40)	44(10.40)	143(33.81)			
Do you know what antibiotics are used for?						
Yes	274(64.78)	138(32.62)	412(97.40)	12.553	1	0.000*
No	0(0.00)	11(2.60)	11(2.60)			
What does AMR means to you?						
The body becomes resistant to antibiotics	98(23.17)	62(14.66)	160(37.83)	32.876	2	0.000*
Bacteria no longer respond to antibiotics	153(36.17)	66(15.60)	219(51.77)			
Not sure	33(7.80)	11(2.60)	44(10.40)			

"χ^2" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

Usual completion of antibiotics was associated with awareness of antibiotics ($\chi^2 = 3.981$, $p = 0.046$), correct understanding of viral infections ($\chi^2 = 10.538$, $p = 0.001$), awareness of AMR ($\chi^2 = 14.143$, $p < 0.001$), and prior education on proper use of antibiotics ($\chi^2 = 11.297$, $p < 0.001$). Respondents who had been educated on antibiotics were more likely to complete treatment (38.8%) than those who had not (10.4%), and those with correct knowledge of the antibiotic use (49.17%) than those without (0.00%), (Table 2b).

Table 2b: Association between usual completion of antibiotics medication, and Knowledge and Awareness of Antibiotics

Variables	Completing medication (%)		Total (%)	χ^2	df	*P* value
	Usually	Not-usually				
Have you ever heard of antibiotics?						
Yes	197(46.57)	193(45.63)	390(92.20)	3.981	1	0.046*
No	11(2.60)	22(5.20)	33(7.80)			
Can antibiotics cure viral infections (e.g., cold, flu)?						
Yes	99(23.40)	132(31.21)	231(54.61)	10.538	1	0.001*
No	109(25.77)	83(19.62)	192(45.39)			
Are you aware that overuse of antibiotics can lead to resistance?						
Yes	166(39.24)	180(42.55)	346(81.80)	17.336	1	0.000*
No	22(5.20)	55(13.00)	77(18.20)			
Have you been educated on correct antibiotic use?						
Yes	164(38.77)	116(27.42)	280(66.19)	32.154	1	0.000*
No	44(10.40)	99(23.40)	143(33.81)			
Do you know what antibiotics are used for?						
Yes	208(49.17)	204(48.23)	412(97.40)	11.297	1	0.001*
No	0(0.00)	11(2.60)	11(2.60)			

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What does AMR means to you?							
The body becomes resistant to	antibiotics	88(20.80)	72(17.02)	160(37.83)	14.143	2	0.001*
Bacteria no longer respond to	antibiotics	109(25.77)	110(26.00)	219(51.77)			
Not sure		11(2.60)	33(7.80)	44(10.40)			

"χ²" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

Respondents who believed antibiotics treat viral infections (36.4%) were more likely to share antibiotics ($\chi^2 = 40.798$, $p < 0.001$). Additionally, prior education on proper use of antibiotics ($\chi^2 = 51.446$, $p < 0.000$) and accurate understanding of antibiotic functions ($\chi^2 = 12.553$, $p < 0.001$) significantly influenced sharing behavior (Table 2c).

Table 2c: Association between the habit of sharing antibiotics, and Knowledge and Awareness of Antibiotics

Variables	Sharing antibiotics (%)		Total (%)	X2	df	*P* value
	Involved	Not-involved				
Have you ever heard of antibiotics?						
Yes	209(49.41)	181(42.79)	390(92.20)	5.352	1	0.021*
No	11(2.60)	22(5.20)	33(7.80)			
Can antibiotics cure viral infections (e.g., cold, flu)?						
Yes	154(36.41)	83(19.62)	237(56.03)	40.798	1	0.000*
No	66(15.60)	120(28.37)	186(43.97)			
Are you aware that overuse of antibiotics can lead to resistance?						
Yes	187(44.21)	159(37.59)	346(81.80)	3.617	1	0.057
No	33(7.80)	44(10.40)	77(18.20)			
Have you been educated on correct antibiotic use?						
Yes	110(26.00)	170(40.19)	280(66.19)	51.446	1	0.000*
No	110(26.00)	33(7.80)	143(33.81)			
Do you know what antibiotics are used for?						
Yes	220(52.01)	192(45.39)	412(97.40)	12.553	1	0.000*
No	0(0.00)	11(2.60)	11(2.60)			
What does AMR means to you?						
The body becomes resistant to antibiotics	88(20.80)	68(16.08)	156(36.88)	1.990	2	0.370
Bacteria no longer respond to antibiotics	110(26.00)	112(26.48)	222(52.48)			
Not sure	22(5.20)	23(5.44)	45(10.64)			

"χ²" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

Association between Attitudes and Behaviors toward Antibiotic Use and Misuse Practices

Self-medication was significantly influenced by the respondents' attitudes. A significant number of those who believed antibiotics are effective for all illnesses (26.0%) engaged in self-medication ($\chi^2 = 34.557$, $p < 0.001$). Those who approved of sharing antibiotics (23.4%) or believed self-medication is safe (15.6%) were also more likely to self-medicate ($p < 0.001$ for both). Concern about AMR was significantly associated with self-medication ($\chi^2 = 52.521$, $p < 0.001$), and a significant association was found between self-medication and stopping antibiotics once symptoms improve ($\chi^2 = 5.204$, $p = 0.023$) (Table 3a).

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ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
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Table 3a: Association between self-medication and Attitudes and behavior of the respondents towards antibiotic use

Variables	Self-medication (%)		Total (%)	χ^2	df	*P* value
	Involved	Not-involved				
Do you believe resistance can spread from person to person?						
Yes	99(23.40)	83(19.62)	182(43.03)	1.597	1	0.206
No	121(28.61)	120(28.37)	241(56.97)			
How concerned are you about AMR?						
Very concerned	99(23.40)	120(28.37)	219(51.77)	52.521	4	0.000*
Somewhat unconcerned	89(21.04)	44(10.40)	133(31.44)			
Unconcerned	11(2.60)	22(5.20)	33(7.80)			
Neither concerned nor unconcerned	22(5.20)	16(3.78)	38(8.98)			
Do you believe antibiotics are effective for all illnesses?						
Yes	110(26.00)	127(30.02)	237(56.03)	34.557	1	0.000*
No	110(26.00)	76(17.97)	186(43.97)			
Is sharing antibiotics with others acceptable?						
Yes	99(23.40)	56(13.24)	155(36.64)	39.347	1	0.000*
No	121(28.61)	147(34.75)	268(63.36)			
Do you think self-medication with antibiotics is safe?						
Yes	66(15.60)	160(37.83)	226(53.43)	13.284	1	0.000*
No	11(2.60)	186(43.97)	197(46.57)			
Is it okay to stop antibiotics once symptoms improve?						
Yes	110(26.00)	127(30.02)	237(56.03)	5.204	1	0.023*
No	110(26.00)	76(17.97)	186(43.97)			

"χ^2" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

The attitude of concern toward AMR showed significant association with completion behavior ($\chi^2 = 27.133$, $p < 0.001$). Those who disagreed with sharing antibiotics were more likely to complete treatment ($\chi^2 = 4.976$, $p = 0.026$). However, no significant associations were found with belief in antibiotic universality ($\chi^2 = 0.000$, $p = 1.000$), perception of self-medication safety ($\chi^2 = 1.576$, $p = 0.209$), or early discontinuation once symptoms improved ($\chi^2 = 1.171$, $p = 0.279$) (Table 3b).

Table 3b: Association between usual completion of antibiotics medication, and Attitudes and behavior of the respondents towards antibiotic use

Variables	Completing medication (%)		Total (%)	χ^2	df	*P* value
	Usually	Not-usually				
Do you believe resistance can spread from person to person?						
Yes	88(20.80)	94(22.22)	182(43.03)	0.000	1	1.000
No	120(28.37)	121(28.61)	241(56.97)			
How concerned are you about AMR?						
Very concerned	131(30.97)	105(24.82)	236(55.79)	27.133	4	0.000*
Somewhat unconcerned	53(12.53)	77(18.20)	130(30.73)			
Unconcerned	13(3.07)	11(2.60)	24(5.67)			
Neither concerned nor unconcerned	11(2.60)	22(5.20)	33(7.80)			
Do you believe antibiotics are effective for all illnesses?						
Yes	70(16.55)	89(21.04)	159(37.59)	0.000	1	1.000
No	132(31.21)	132(31.21)	264(62.41)			
Is sharing antibiotics with others acceptable?						
Yes	66(15.60)	94(22.22)	160(37.83)	4.976	1	0.026*

Science World Journal Vol. 20(No 3) 2025 https://dx.doi.org/10.4314/swj.v20i3.34
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

No	142(33.57)	121(28.61)	263(62.17)			
Do you think self-medication with antibiotics is safe?						
Yes	39(9.22)	44(10.40)	83(19.62)	1.576	1	0.209
No	175(41.37)	165(39.01)	340(80.38)			
Is it okay to stop antibiotics once symptoms improve?						
Yes	110(26.00)	127(30.02)	237(56.03)	1.171	1	0.279
No	98(23.17)	88(20.80)	186(43.97)			

"χ^2" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

Significant associations were observed between antibiotic sharing and beliefs about sharing acceptability ($\chi^2 = 65.810$, $p < 0.001$), perception of self-medication safety ($\chi^2 = 39.347$, $p < 0.001$), and early discontinuation of treatment ($\chi^2 = 17.810$, $p < 0.001$). Additionally, concern about AMR was significantly associated with sharing behavior ($\chi^2 = 52.521$, $p < 0.001$) (Table 3c).

Table 3c: Association between the habit of sharing antibiotics, and Attitudes and behavior of the respondents towards antibiotic use

Variables	**Sharing antibiotics (%)**		**Total (%)**	**χ^2**	**df**	***p* value**
	Involved	**Not-involved**				
Do you believe resistance can spread from person to person?						
Yes	99(23.40)	83(19.62)	182(43.03)	1.597	1	0.206
No	121(28.61)	120(28.37)	241(56.97)			
How concerned are you about AMR?						
Very concerned	99(23.40)	164(38.77)	263(62.17)	52.521	4	0.000*
Somewhat unconcerned	66(15.60)	27(6.38)	93(21.99)			
Unconcerned	11(2.60)	18(4.26)	29(6.86)			
Neither concerned nor unconcerned	27(6.38)	11(2.60)	38(8.98)			
Do you believe antibiotics are effective for all illnesses?						
Yes	220(52.01)	192(45.39)	412(97.40)	0.677	1	0.411
No	0(0.00)	11(2.60)	11(2.60)			
Is sharing antibiotics with others acceptable?						
Yes	121(28.61)	39(9.22)	160(37.83)	65.810	1	0.000*
No	99(23.40)	164(38.77)	263(62.17)			
Do you think self-medication with antibiotics is safe?						
Yes	66(15.60)	160(37.83)	226(53.43)	39.347	1	0.000*
No	11(2.60)	186(43.97)	197(46.57)			
Is it okay to stop antibiotics once symptoms improve?						
Yes	143(33.81)	94(22.22)	237(56.03)	17.810	1	0.000*
No	77(18.20)	109(25.77)	186(43.97)			

"χ^2" = Chi-square
"df" = degree of freedom
"*" = Significant at $p < 0.05$

Factors Associated with Antibiotic Treatment Failure

Logistic regression identified self-medication and sharing of antibiotics as significant predictors of treatment failure. Self-medication was associated with a 73% reduction in odds of successful treatment (OR = 0.273, 95% CI: 0.182–0.409, p < 0.001), while sharing antibiotics also significantly increased the likelihood of treatment failure (OR = 0.431, 95% CI: 0.290–0.639, p < 0.001). Completion of medication was not a significant predictor (p = 0.279) (Table 4).

Science World Journal Vol. 20(No 3) 2025 https://dx.doi.org/10.4314/swj.v20i3.34
www.scienceworldjournal.org
ISSN: 1597-6343 (Online), ISSN: 2756-391X (Print)
Published by Faculty of Science, Kaduna State University

Table 4: Logistics regression analysis for the variables associated with the antibiotic treatment failure

Variables	Treatment failure (%)		Total (%)	*P* value	OR	95% CI	
	Experienced	Not-experienced				Lower	Upper
Self-medication							
Involved	154(36.41)	67(15.84)	221(52.25)	0.000*	0.273	0.182	0.409
Not-involved	76(17.97)	126(29.79)	202(47.75)				
Completing medication							
Usually	109(25.77)	105(24.82)	214(50.59)	0.279	1.237	0.841	1.821
Not-usually	121(28.61)	88(20.80)	209(49.41)				
Sharing antibiotics							
Involved	143(33.81)	83(19.62)	226(53.43)	0.000*	0.431	0.290	0.639
Not-involved	87(20.57)	110(26.00)	197(46.57)				

"OR" = Odds ratio
"CI" = confidence interval
"*" = significant at p<0.05

DISCUSSION

This study investigated the patterns of antibiotic misuse and its association with demographic characteristics, knowledge, awareness, attitudes, and behaviors among individuals in North East Nigeria. The findings revealed widespread inappropriate use of antibiotics, including self-medication, failure to complete prescribed courses, and sharing of antibiotics—all of which significantly contribute to the growing threat of antimicrobial resistance (AMR) in the region.

Self-medication and incomplete antibiotic use were significantly more common among individuals aged 25–64 years, males, urban residents, and those with tertiary education. These findings are in line with previous study, which suggests that individuals with higher education levels may feel more confident in self-prescribing or relying on prior experience (Chukwu *et al*., 2020). Urban dwellers may also have easier access to antibiotics without prescription due to weak regulatory enforcement (Godman *et al*., 2022; Elijah *et al*., 2024). The low prevalence of misuse among elderly participants could be due to their greater reliance on formal healthcare systems or less frequent unsupervised drug use.

Significant associations were found between poor antibiotic knowledge and higher rates of misuse. Misconceptions—such as the belief that antibiotics are effective against viral infections—were prevalent among respondents, consistent with findings by Lawal *et al*. (2025) and Chukwu *et al*. (2020), who noted alarmingly low levels of AMR knowledge in Nigeria. Respondents who had never received formal education about antibiotic use were more likely to self-medicate, share antibiotics, or discontinue treatment prematurely. This supports previous assertions that public health campaigns and educational interventions are vital in curbing misuse (Babatola *et al*., 2021; Irfan *et al*., 2022).

Furthermore, a high proportion of respondents believed antibiotics should be shared or used until symptoms resolve, a behavior that creates selection pressure for resistant bacteria. This trend underscores the need for community-level awareness initiatives to address both knowledge deficits and cultural habits that sustain misuse (Belachew *et al*., 2021).

The study also showed a clear link between negative attitudes toward antibiotics and risky behaviors. Many respondents held the belief that antibiotics are effective for all illnesses or that it is acceptable to stop medication once symptoms improve. These behaviors were significantly associated with self-medication, non-completion of prescribed doses, and sharing antibiotics.

Similar behavioral patterns have been observed across Sub-Saharan Africa, where access to antibiotics without prescription, low digital health literacy, and the use of informal health information contribute to inappropriate antibiotic use (Klein *et al*., 2018; Lawal *et al*., 2025). The findings affirm that improving awareness alone is insufficient—there is a need for interventions that reshape attitudes and correct misperceptions about antibiotics and resistance.

The current study also identified self-medication and sharing of antibiotics as significant predictors of treatment failure. Self-medication was associated with a 73% reduction in odds of successful treatment, while sharing antibiotics also significantly increased the likelihood of treatment failure. However, the study revealed that, completion of medication was not a significant predictor.

This study's findings align with the broader regional analysis by Magaji *et al*. (2025), which identified irrational antibiotic use, poor regulation, substandard drugs, and weak surveillance as key drivers of AMR in Northern Nigeria. The widespread misuse observed in this study is both a symptom and a cause of these systemic weaknesses.

Additionally, the economic hardship faced by many individuals in the region compounded by limited access to healthcare, encourages behaviors such as sharing antibiotics and buying incomplete doses, practices that directly accelerate resistance development (Irfan *et al*., 2022; Godman *et al*., 2022). These findings underscore the importance of addressing AMR through a multisectoral approach, targeting not just healthcare but also economic and regulatory systems.

The findings highlight an urgent need for coordinated action to address antibiotic misuse in Northern Nigeria. Effective interventions should include; public education campaigns tailored to local languages and cultural contexts, stricter regulation of antibiotic sales, especially in informal drug markets, integration of AMR and stewardship training into school curricula and healthcare institutions, and promotion of the One Health approach, addressing antibiotic misuse across human, animal, and environmental health domains. Efforts must also prioritize improving access to affordable and quality healthcare in rural and underserved communities to reduce dependence on informal antibiotic sources.

Conclusion

This study provides compelling evidence of widespread antibiotic misuse in North Eastern Nigeria, characterized by high rates of self-medication, incomplete treatment courses, and the sharing of antibiotics. These inappropriate practices are significantly driven by demographic factors such as age, gender, educational attainment, and urban residency, as well as critical gaps in public knowledge, pervasive misconceptions, and permissive attitudes towards antibiotic use. Specifically, beliefs that antibiotics are effective against all illnesses, including viral infections, and the acceptability of sharing or prematurely discontinuing antibiotics, are major contributors to misuse. The study also unequivocally identifies self-medication and sharing of antibiotics as significant predictors of treatment failure, highlighting the direct negative consequences of these behaviors on patient outcomes and the exacerbation of AMR. These findings are consistent with broader concerns about weak healthcare infrastructure, unregulated pharmaceutical markets, and low public awareness in low- and middle-income countries. Addressing the growing threat of AMR in North Eastern Nigeria requires a comprehensive, multi-faceted approach. This includes culturally sensitive public education campaigns, stringent regulatory enforcement over antibiotic sales, integration of AMR stewardship into educational and healthcare systems, and the robust implementation of a One Health framework to tackle misuse across human, animal, and environmental sectors. Prioritizing improved access to affordable and quality healthcare in underserved communities is also crucial to reduce reliance on informal and often harmful antibiotic practices. Without urgent and coordinated action, the gains made in medical progress will continue to be eroded, leading to increased morbidity, mortality, and economic burden in the region.

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