Nigerian Medical Journal
NIGERIA MEDICAL ASSOCIATION
Print ISSN 0300-1652, E-ISSN 2229-774X

Original Research

Antimicrobial susceptibility pattern of pharyngeal isolates of children seen in a tertiary facility in Sokoto over three years (2022-2024)

***Khadijat O. Isezuo[1], Jibril Abubakar[2], Yahaya Mohammed[2], Usman Muhammad Sani[1], Usman Muhammad Waziri[1], Bilkisu Ilah Garba[1], Asmau Adamu[1], Fatima Bello Jiya[1], Amina Ibrahim[1], Khadija Muhammad Dada[2], Umar Muhammad Ango[3].**

[1]Department of Paediatrics, Usmanu Danfodiyo University Teaching Hospital, Sokoto, [2]Department of Clinical Microbiology, Usmanu Danfodiyo University Teaching Hospital, Sokoto. [3]Department of Community Health Usmanu Danfodiyo University, Sokoto

Abstract

Background: Acute pharyngitis is an inflammation of the pharynx and surrounding soft tissues caused by viral, bacterial, or fungal infectious agents. Only bacterial and fungal infections require antimicrobial therapy. Over-use of antibiotics can lead to anti-microbial resistance which is concerning. Antimicrobial susceptibility patterns of causative organisms are necessary to guide appropriate treatment. The study aims to retrospectively assess from laboratory records, the antimicrobial susceptibility pattern of pharyngeal isolates amongst children aged below 15 years managed at Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria.

Methodology: This was a three (3)-year descriptive retrospective review, from January 2022 to December 2024. A convenience sampling technique was used. A review of positive isolates and susceptibility patterns, which were categorized as sensitive, intermediate, and resistant was done. Information was extracted and entered in a study proforma sheet. Data was analyzed using SPSS version 23. A p-value of 0.05 was taken as significant.

Results: The total number of patients results reviewed was 305 comprising 160 males (52.5%) and 145 females. The majority 182 (59.7%) were below five (5) years and 109 (35.7%) had positive bacterial and fungal isolates including 50 (16.4%) Streptococcus pneumoniae, 17 (5.6%) Staphylococcus spp., 16 (5.2%) other Streptococcus spp., & 7 (2.3%) Pseudomonas spp. Sixteen (5.2%) had the fungal agent Candida isolated. Streptococcus pneumoniae demonstrated high sensitivity to ciprofloxacin (44%) followed by ceftriaxone (38%) and erythromycin (24%) likewise Staphylococcus spp but resistance to cefotaxime and amoxycillin-clavulanate. Other Streptococcus spp had high sensitivity to ceftriazone (37.5%) but also demonstrated resistance to ciprofloxacin (37.5%) and gentamicin (31.3%).

Conclusion: Streptococcus pneumonia, Staphylococcus spp, and other Streptococcus spp were the commonest bacterial pharyngeal isolates and demonstrated mixed sensitivity and resistance to quinolones and cephalosporins antibiotics amongst others. More effort on antimicrobial stewardship is key.

Keywords: Antimicrobial; Susceptibility; Pharyngeal; Isolates; Children.

***Correspondence:** Dr Isezuo KO. Department of Paediatrics, Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria.
Email: khadisez@yahoo.com

How to cite: Isezuo KO, Abubakar J, Mohammed Y, Sani UM, Waziri UM, Garba BI, Adamu A, Jiya FB, Ibrahim A, Dada KM, Ango UM. Antimicrobial susceptibility pattern of pharyngeal isolates of children seen in a tertiary facility in Sokoto over three years (2022-2024). Niger Med J 2025;66(2):586-597.https://doi.org/10.71480/nmj.v66i2.717.

Quick Response Code:

Introduction

Acute pharyngitis is an inflammation of the pharynx and surrounding soft tissues that can be caused by viral, bacterial, or fungal infectious agents.[1] Pharyngitis, which refers to inflammation of the pharynx can also be caused by environmental exposures such as air pollutants, allergens, smoke; and from contact with hot fluids and caustic substances.[2]Out of the infectious agents, viruses are the most common accounting for about 80% of cases while the remaining are bacterial and, rarely, fungal infections.[3]Viruses predominate as infective causes of pharyngitis. It is usually spread by contact with oral and respiratory secretions and occurs commonly during dry seasons. Important viral causes include Influenza, parainfluenza, adenoviruses, coronaviruses, enteroviruses, rhinoviruses, respiratory syncytial virus (RSV), Ebstein-Barr virus, herpes simplex virus (HSV), human metapneumovirus (HMPV).[4] Most viral causes are mild except infectious mononucleosis. Bacterial causes include but are not limited to *Streptococcus pyogenes* (Group A *Streptococcus*), *Corynebacterium diphtheriae, Fusobacterium necrophorum, Mycoplasma pneumoniae, Neisseria gonorrhea,* and *Chlamydophilia pneumonia.*[5]Pharyngitis is relatively common, accounting for more than 5% of outpatient visits to primary care facilities for both children and adults.[6]The burden of acute pharyngitis varies with region, however global burden estimates between 0.006 episodes per 100 child-years to 1,290.2 per 100 child-years, with a pooled incidence rate of 82.2 episodes per 100 child years.[7]

Pharyngitis affects children of all age groups, however, viral pathogens commonly affect children five (5) years and below, while bacterial organisms affect usually children 5-15 years.[6] Acute infection of the pharynx also accounts for a substantial number of visits to paediatric emergency unit and many feature sore throat as a symptom or evidence of pharyngitis (erythema, edema, exudate, or an exanthem) on examination. [5]This is in addition to other symptoms such as fever, vomiting, diarrhoea which can result in complications like dehydration, febrile seizures, and sepsis.[7] Viral causes are often self-limiting in nature, while bacterial and fungal infections typically require antimicrobial therapy.[6] Out of the bacterial causes, pharyngitis caused by Group A Streptococci (GAS) is among the most concerning due to its associated severe complications necessitating appropriate diagnosis and targeted treatment. The usual clinical task is to distinguish important, potentially serious, and life-threatening causes of acute pharyngitis from those that are self-limiting and require no specific treatment. Distinguishing the different types of pharyngitis clinically may be challenging because there is a similarity in their presenting features and signs. Soreness of the throat, painful swallowing, and fever are the commonly associated features irrespective of the causative agent.[7]

However, there are some distinct features that have been associated with different causative agents which may be highly suggestive of the aetiology.[8] GAS pharyngitis (and tonsillitis) can progress to more severe infection, such as peritonsillar abscess or invasive infections; it can also result in post-infection sequelae including acute post-streptococcal glomerulonephritis, acute rheumatic fever (ARF), and rheumatic heart disease (RHD).[8] Proper identification of implicating bacterial organisms is therefore necessary by serological and microbiological studies in order to provide appropriate and adequate treatment and also to prevent antimicrobial resistance. Throat swab cultures and rapid antigen-detection tests (RADTs) are the diagnostic tests for GAS most available in routine clinical care. Throat culture plated on blood agar remains the gold standard for diagnosing streptococcal pharyngitis.[9] Scoring systems have been developed from these symptoms in combination with clinical examination of the pharynx to guide the decision-making process in prescribing antibiotics.[6] However, there is also an ever-present threat of overuse and misuse of antibiotics with the resultant development of antibiotic-resistant strains which has especially been attributed to the unwarranted treatment of viral infections with antibiotics.[3]Efforts to distinguish these infections by microbiological testing is essential. Many children are usually commenced on empirical antibiotics in the absence of rapid antigen tests and culture results. Often, they usually improve and are discharged without follow-up and establishing a particular aetiology (either viral or bacterial) even after a throat swab has been taken for microbiology and culture.[3]

In this study, we, therefore, reviewed the laboratory records of pharyngeal swabs taken from children with acute pharyngotonsillitis who were managed at Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, Nigeria over three (3) years. This is with a view to evaluating the common microbial causes of acute pharyngotonsillitis and the sensitivity pattern of antibiotics. This is with a view to guide the prescription of antibiotics in the management of these patients in line with anti-microbial stewardship. There has been concern about the overuse of antibiotics to treat pharyngitis which can contribute to antimicrobial resistance.[10] Antimicrobial susceptibility pattern of causative organisms is therefore necessary to guide appropriate treatment.[11]

Methodology

Study Population

The study population involves Cases of acute pharyngitis who presented to Paediatric clinics and wards of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria, who had throat swab microscopy, culture, and sensitivity results available in the laboratory.

Study Area

The study was carried out at the Paediatrics and Microbiology Department of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. This is a tertiary health facility located within a metropolis. Sokoto state is in the dry Sahel region and is surrounded by sandy Savannah. The town lies between latitude 13^0 3'11.931' N east of the equator. The hospital serves as a referral centre for more than 10 million people in the States of Zamfara, Kebbi, Niger, and Katsina as well as countries like Niger in the West African sub-region.[12,13]

Study Design

The study was a descriptive, cross-sectional, and retrospective study. It was conducted over a three (3) year period (January 2022 to December 2024). A study proforma was used to record demographic data and results of throat swab microscopy, culture, and sensitivity. The method of data collection was by review of laboratory records in the microbiology laboratory, Sokoto state, Nigeria.

Sample Size Determination

A minimum sample size of 288 was calculated using the Fischer's formula with a Z-score for the confidence level set at 1.96 for a 95% confidence interval and prevalence set at 0.5 and margin of error of 0.05. Thereafter, finite correction was applied.[14]

Sampling Technique

A convenience sampling technique was used. Samples were selected from the existing Laboratory data.

Sample Processing

The processing of throat swab samples is detailed as follows. Firstly, **v**isible exudates or hyperemic areas on the tonsillar walls were swabbed with a sterile cotton swab, while the tongue was depressed by a wooden spatula when necessary. Usually, samples are collected using a sterile swab stick from the ward or clinic by the managing physician and transported immediately to the laboratory for analysis. A smear was made and Gram stained. The presence of pus cells, epithelial cells, and bacterial cells was noted, and this inferred the quality of the sample and choice of media. The sample was then inoculated on blood/chocolate agar and MacConkey agar.

Following overnight incubation at 37 °C, aerobically and at 5% CO2 for blood and MacConkey agar and chocolate agar respectively, the plates were observed for any visible growth, haemolysis, and colonial morphology. The isolate was further Gram stained and subjected to a biochemical test for final identification. Small, shiny, and translucent colonies surrounded by a zone of alpha hemolysis on Choc Agar, Gram-positive diplococci, catalase positive and susceptible to optochin were identified as *S. pneumoniae, S. aureus* isolates were identified as moderately sized colonies surrounded by zones of clear beta-hemolysis on BA, catalase, and coagulase-positive

The conduct of antimicrobial susceptibility testing (AST) depends on the type of organism isolated. A review of the pattern of positive isolates and susceptibility patterns categorized as sensitive, intermediate, and resistant was done and entered into the study proforma.

Ethical Approval

Ethical approval for the study was obtained from the Research and Ethics Committee of UDUTH, Sokoto, Nigeria. Confidentiality of data would be maintained by coding the identity of the results while entering proforma and keeping data safe by ensuring password entry into the database before access.

Data Analysis

All relevant data was entered into a proforma sheet and then analyzed using SPSS statistical software version 22. For quantitative data, continuous variables (e.g. age) were expressed as a median and inter-quartile range while categorical variables (e.g. age categories, gender, type of organism) were expressed as proportions. Tables, figures, and charts were used to display the results. Chi-square or where necessary, Fisher's Exact test, was used to test for statistical significance. A *p*-value of <0.05 will be considered statistically significant.

Results

The total number of children who had pharyngitis and throat swab samples sent for microscopy was 305 and all the results were reviewed. They comprised 160 males (52.5%) and 145 females (47.5%). One hundred and eighty-two (59.7%) were aged below five (5) years. They were not normally distributed by age with a slight positive skewness and using the Kolmogorov-Smirnov test of normality. The median age was 48 months with an IQR of 81 months. Females were older with a median age of 60 months (IQR:87 months) than males with a median age of 36 months (IQR:72 months) Figure 1.

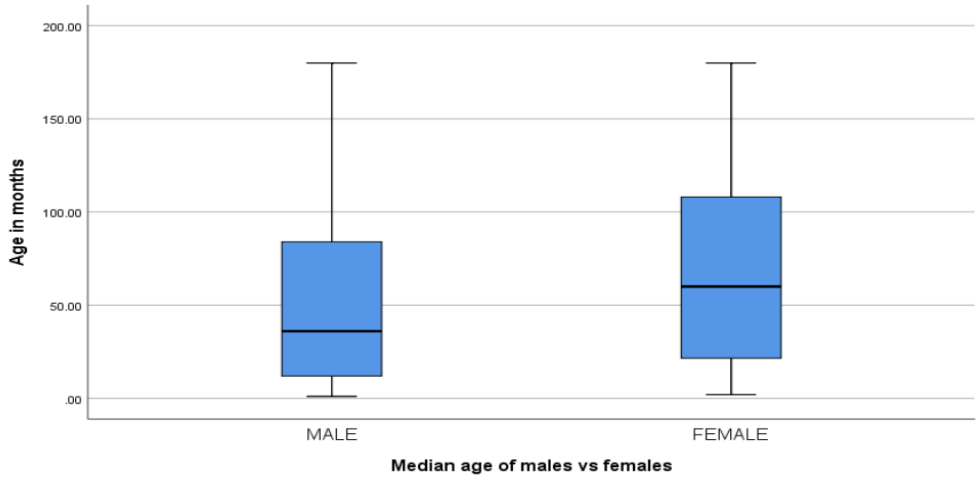

Figure 1: **Box plot showing the median age of male's vs females**

More males were aged under five (5) years as depicted in Table 1 which was statistically significant (p = 0.014).

Table 1: Age and gender distribution of the population

Age	Gender		
	Male	**Female**	**Total**
< 5 years	106 (58.2%)	76 (41.8%)	182 (59.7%)
> 5 years	54 (43.9%)	69 (56.1%)	123 (40.3%)
Total	160 (52.5%)	145 (47.5%)	305(100.0%)
$X^2 = 6.1$, $p = 0.014$			

Patterns of positive isolates from throat culture: The prevalence of positive isolates was 109 (35.7%). There were mainly Gram-positive organisms accounting for 83 (76.1%) and 10 Gram negatives accounting for 9.2%. Sixteen samples (14.7%) had fungal agent *Candida* isolated. There was no mixed infection.

Table 2 shows specific organisms isolated from pharyngeal swabs which were *Streptococcus pneumoniae* in 50 cases (45.9%), followed by *Staphylococcus spp, Streptococcus spp,* and Candida and Gram-negative organisms.

Table 2: Showing Organisms Isolated from pharyngeal swabs (n=109)

Pharyngeal Isolates	N	Percentage
Streptococcus pneumonia	50	45.9
Staphylococcus spp	17	15.6
Streptococcus spp	16	14.7
Candida spp	16	14.7
Pseudomonas spp	7	6.4
Escherichia coli	2	1.8
Klebsiella	1	0.9
Total	**109**	**100.0**

There was no significant difference in the gender distribution of the isolates as shown in Table 3. However, *Streptococcus spp* and Candida were more in males.

Table 3: Showing Gender Distribution of Isolates

Isolates	Male	Female	Total
Streptococcus pneumonia	23 (46.0%)	27 (54.0%)	50 (45.9%)
Staphylococcus spp	8 (47.1%)	9 (52.1%)	17 (15.6%)
Streptococcus spp	12 (75.0%)	4 (25.0%)	16 (14.7%)
Candida spp	9 (56.3%)	7 (43.8%)	16 (14.7%)
Pseudomonas spp	3 (42.9%)	4 (57.1%)	7 (6.4%)
Escherichia coli	1 (50.0%)	1 (50.0%)	2 (1.8%)
Klebsiella	1 (100.0%)	0 (0.0%)	1 (0.9%)
Total	**57 (52.3%)**	52 (47.7%)	109 (100.0%)
X^2= 5.6, p= 0.5			

There was no significant difference in the age distribution of isolates as shown in Table 4. However, *Streptococcus pneumoniae* and *Pseudomonas* were more among under-fives. While *Staphylococcus spp, Streptococcus spp, and* Candida were more among those above five (5) years though not statistically significant.

Table 4: Showing Age Distribution of Isolates

Isolates	Male	Female	Total
Streptococcus pneumonia	32 (64.0%)	18 (36.0%)	50 (45.9%)
Staphylococcus spp	5 (29.4%)	12 **(**70.6%)	17 (15.6%)
Streptococcus spp	7 (43.8%)	9 (56.3%)	16 (14.7%)
Candida spp	6 (37.5%)	10 (62.5%)	16 (14.7%)
Pseudomonas spp	5 (71.4%)	2 (28.6%)	7 (6.4%)
Escherichia coli	1 (50.0%)	1 (50.0%)	2 (1.8%)
Klebsiella	1 (100.0%)	0 (0.0%)	1 (0.9%)
Total	57 (52.3%)	52 (47.7%)	109 (100.0%)
X^2= 10.1, p = 0.11			

In Table 5, the sensitivity of the various isolates to the antibiotics tested is shown. Out of the 50 isolates of *S. pneumoniae,* the highest sensitivity was to ciprofloxacin (44%) followed by ceftriaxone (38%) and erythromycin (24%). For the 17 *Staphylococcus spp, the* highest sensitivity was to ciprofloxacin (41.2%), followed by erythromycin (29.4%) and imipenem (23.5%). For the 16 other *Streptococcus spp,* they were highly sensitive to ceftriazone (37.5%), clindamycin (18.8%). Of the 7 *Pseudomonas spp,* levofloxacin

and gentamycin were sensitive, in 42.9% of cases each. The two *E. coli* strains were sensitive to ofloxacin and amikacin. *Klebsiella* was not sensitive to any antibiotics.

Table 5: Showing Isolates that were Highly Sensitive

Antibiotic	***S. pneum n=50*** ***n (%)***	***Staph. spp n=17*** ***n (%)***	***Strept spp n=16*** ***n (%)***	***Pseud n=7*** ***n (%)***	***E.Coli n=2*** ***n (%)***	***Kleb n=1*** ***n (%)***
Penicillin	1 (2.0)		-	-	-	-
Amoxicillin	3 (6.0)	1 (5.9)	1 (6.3)	-	-	-
Amoxyclav	3 (6.0)	-	-	-	-	-
Erythromycin	12 (24.0)	5 (29.4)	-	-	-	-
Ceftriazone	19 (38.0)	3 (17.6)	6 (37.5)	-	-	-
Cefotaxim	3 (6.0)	1 (5.9)	2 (12.5)	-	-	-
Ceftazidime	1 (2.0)	-	-	-	-	-
Cefepim	2 (4.0)	-	-	1 (14.3)	-	-
Vancomycin	3 (6.0)	2 (11.8)	1 (6.3)	-	-	-
Ciprofloxacin	22 (44.0)	7 (41.2)	3 (18.8)	2 (28.5)	-	-
Ofloxacin	1 (2.0)	2 (11.8)	-	2 (28.5)	1 (50.0)	-
Moxifloxacin	1 (2.0)	-	-	-	-	-
Levofloxacin	8 (16.0)	-	-	3 (42.9)	-	-
Gentamycin	6 (12.0)	2 (11.8)	1 (6.3)	3 (42.9)	-	-
Amikacin	2 (4.0)	1 (5.9)	-	2 (28.5)	1 (50.0)	-
Imipenem	4 (8.0)	4 (23.5)	1 (6.3)	2 (28.5)	-	-
Piperacillin-Tazobactam	-	-	1 (6.3)	1 (14.3)	-	-
Azithromycin	9 (18.0)	2 (11.8)	2 (12.5)	-	-	-
Clindamycin	3 (6.0)	-	3 (18.8)	-	-	-

In Table 6, the isolates with intermediate sensitivity to various antibiotics tested are shown. For *S. pneumoniae,* intermediate sensitivity was demonstrated to ceftriaxone, erythromycin and quinolones. While for *Staphylococcus spp.,* intermediate sensitivity was high with ceftriaxone, erythromycin and ciprofloxacin. For the other *Streptococcus spp.,* intermediate sensitivity was high with erythromycin, ciprofloxacin and penicillin.

Table 6: Showing Isolates That Demonstrate Intermediate/ Low Sensitivity

Antibiotic	*S. pneum n=50*	*Staph spp n=17*	*Strept spp n=16*	*Pseud n=7*	*E. coli n=2*	*Kleb n=1*
Penicillin	-	-	3 (18.8)	-	-	-
Amoxycillin	-	1 (5.9)	-	-	-	-
Amoxyclav	-	-	-	1 (14.3)	-	-
Erythromycin	5 (10.0)	4 (23.5)	3 (18.8)	-	-	-
Ceftriaxone	5 (10.0)	3 (17.6)	1 (6.3)	1 (14.3)	1 (50.0)	-
Cefotaxime	1 (2.0)	-	1 (6.3)	-	-	-
Cefepime	-	1 (5.9)	1 (6.3)	-	-	-
Vancomycin	2 (8.0)	-	2 (12.5)	-	1 (50.0)	-
Ciprofloxacin	4 (8.0)	3 (17.6)	3 (18.8)	-	-	-
Ofloxacin	4 (8.0)	1 (5.9)	2 (12.5)	-	-	-
Moxifloxacin	-	-	1 (6.3)	-	-	-
Levofloxacin	1 (2.0)	1 (5.9)	-	-	-	-
Gentamycin	1 (2.0)	1 (5.9)	2 (12.5)	-	-	-
Amikacin	-	1 (5.9)	-	1 (14.3)	-	-
Imipenem	1 (2.0)	-	2 (12.5)	-	-	-
Azithromycin	3 (6.0)	1 (5.9)	1 (6.3)	-	-	-
Clindamycin	-	-	1 (6.3)	-	-	-

In Table 7, the isolates that are resistant to the various antibiotics tested are shown. Out of the 50 isolates of *S. pneumoniae,* the highest resistance was to cefotaxime (20%) followed by amoxicillin (16%). For the 17 *Staphylococcus spp,* the highest resistance was to amoxiclav (17.6%) and imipenem (17.6%). For the 16 other *Streptococcus spp,* they were highly resistant to ciprofloxacin (37.5%), gentamycin (31.3%), and cefotaxime (25.0%). Of the seven (7) *Pseudomonas spp,* ceftazidime, and amoxycillin/clavulanate demonstrated highest resistance. The two *E. coli* and *Klebsiella* strains were resistant to several of the antibiotics tested.

Table 7: Showing Isolates That Demonstrated Resistance

Antibiotic	*S.pneum n=50*	*Staph n=17*	*Strept spp n=16*	*Pseud n=7*	*E. coli n=2*	*Kleb n=1*
Penicillin	1 (2.0)	1 (5.9)	-	-	1 (50.0)	-
Amoxicillin	8 (16.0)	1 (5.9)	2 (12.5)	-	1 (50.0)	-
Amoxyclav	5 (10.0)	3 (17.6)	-	2 (28.5)	1 (50.0)	-
Erythromycin	7 (14.0)	1 (5.9)	1 (6.3)	-	-	-
Ceftriaxone	7 (14.0)	1 (5.9)	2 (12.5)	1 (14.3)	1 (50.0)	1 (100.0)
Cefotaxime	10 (20.0)	1 (5.9)	4 (25.0)	1 (14.3)	1 (50.0)	-
Cefepime	2 (4.0)	2 (11.8)	1 (6.3)	-	-	-
Cefpodoxime	-	-	-	1 (14.3)	-	1 (100.0)
Ceftazidime	2 (4.0)			2 (28.5)		-
Vancomycin	1 (2.0)	-	1 (6.3)	1 (14.3)	-	-
Ciprofloxacin	2 (4.0)	2 (11.8)	6 (37.5)	-	1 (50.0)	1 (100.0)
Ofloxacin	3 (6.0)	-	1 (6.3)	1 (14.3)	-	-
Levofloxacin	2 (4.0	2 (11.8)	-	-	-	1 (100.0)
Gentamicin	2 (4.0)	-	5 (31.3)	-	1 (50.0)	-
Imipenem	4 (8.0)	3 (17.6)	-	-	1 (50.0)	-
Piperacillin	2 (4.0)	-	-	1 (14.3)	-	-
Colistin	1 (2.0)	-	-	1 (14.3) 7	-	-
Azithromycin	4 (8.0)	-	-	-	-	-
Trimethoprim-Sulphamethoxazole	4 (8.0)	1 (5.9)				
Clindamycin	3 (6.0)	-	2 (12.5)	-	-	-

Discussion

The antimicrobial susceptibility patterns of pharyngeal isolates from paediatric patients in this study provide important information into the local epidemiology of bacterial and fungal pathogens, informing both clinical management and public health interventions. The predominance of children under five years in this study aligns with previous research showing that younger children are more susceptible to respiratory infections due to underdeveloped immune systems and higher exposure risks in communal settings such as daycare centres and schools.[15] The significant male predominance among children below five years in this cohort may reflect differences in healthcare-seeking behaviours or underlying biological susceptibility, although further investigation is needed to confirm these trends.

Our study demonstrated a 35.7% prevalence of positive throat cultures, predominantly comprising *Streptococcus pneumoniae* followed by *Staphylococcus spp* then *Candida spp.* This distribution is consistent with reports identifying *S. pneumoniae* as a leading pathogen in respiratory tract infections globally.[16] Similar studies in the Netherlands and China have also reported similar findings, with *Streptococcus pneumoniae* being the most common bacterial isolate in children with pharyngitis.[17,18] However, some studies done post-COVID-19 pandemic from the United States, Australia, and New Zealand have reported a higher prevalence of Group A *Streptococcus* (GAS) as the cause of bacterial pharyngitis.[19] This difference could be due to variations in study population, diagnostic methods, or geographical location. The isolation of Gram-negative organisms, though less common, is clinically significant, as they often exhibit multidrug resistance, complicating treatment options.

The findings of this study highlight varying levels of antimicrobial susceptibility across pathogens, underscoring the need for targeted therapy guided by local antibiograms. The high susceptibility of *S. pneumoniae* to ciprofloxacin and ceftriaxone supports their use as frontline therapies for pharyngeal infections caused by this pathogen. However, the low sensitivity to penicillin is concerning, given its historical role as the drug of choice for pneumococcal infections mainly because of its cheaper cost. This pattern reflects the growing global trend of penicillin-resistant *S. pneumoniae* strains, particularly in regions with high antibiotic misuse.[20] The susceptibility of *Staphylococcus spp.* to ciprofloxacin and erythromycin aligns with global data on Staphylococcal pharyngitis.[20,21] However, emerging resistance to first-line antibiotics such as amoxicillin and ceftriaxone warrants vigilance, especially in light of methicillin-resistant *Staphylococcus aureus*(MRSA) concerns.[21] *Streptococcus spp* showed higher sensitivity to ceftriaxone and clindamycin, indicating their potential as alternative treatments. However, resistance to penicillin among these isolates highlights the necessity of continuous surveillance for resistance trends. The sensitivity of *Pseudomonas spp* to Levofloxacin and gentamycin reflects limited but effective options for managing these infections. The resistance of *Klebsiella spp* to all tested antibiotics is alarming and underscores the threat posed by carbapenem-resistant Enterobacterales (CRE), as highlighted in recent global AMR reports.[22] The isolation of *Candida spp* in some cases underscores the role of fungal pathogens in pharyngitis, particularly in immunocompromised children. Antifungal susceptibility testing should be integrated into routine diagnostic protocols to guide appropriate therapy.

The findings have several clinical and public health implications. Firstly, the high prevalence of *S. pneumoniae* and its susceptibility profile supports the use of fluoroquinolones or third-generation cephalosporins in empiric therapy for suspected bacterial pharyngitis. However, empiric use must be balanced against the risk of promoting resistance. Secondly, regular surveillance of AMR patterns is essential to detect emerging resistance trends, particularly among Gram-negative pathogens and *Candida spp,* and programs promoting judicious antibiotic use, particularly in pediatric populations, are important to curb resistance. Finally, strengthening pneumococcal conjugate vaccination (PCV) could reduce the burden of *S. pneumoniae*-associated infections and mitigate resistance through reduced antibiotic use.

Conclusion

Streptococcus pneumoniae, Staphylococcus spp, and other *Streptococcus spp* were the most common bacterial isolates from the pharynx. These isolates showed mixed sensitivity and resistance to various antibiotics, including quinolones and cephalosporins with resistance to penicillin and its derivatives. There is a need for increased focus on antimicrobial stewardship to curb the development of antibiotic resistance.

The study is limited by being a retrospective study, causality cannot be adequately established. Also, data on the clinical presentation of the patients, which could have helped to identify factors associated with antibiotic resistance, were not collected. Likewise, prior antibiotic use could have resulted in false negative results.

It is recommended that kits for typing Streptococcal organisms are made available for use to isolate the specific strains. Further studies on longer trends of antimicrobial sensitivity and resistance over a period of ten years or more with constant updates may be very useful. This should increase awareness on antimicrobial stewardship to prevent widespread anti-microbial resistance.

References

1. Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases. 2015. doi:10.1016/C2012-1-00075-6.
2. Renner B, Mueller CA, Shephard A. Environmental and non-infectious factors in the aetiology of pharyngitis (sore throat). Inflamm Res. 2012;61(10):1041–1052.
3. Head N, Surgery Deepthi M. Role of usage of antibiotics in pharyngitis: a prospective study. International Journal of Otorhinolaryngology and Head and Neck Surgery. 2017;3(2):303–307.
4. Ndu IK, Chinawa JM, Emeka CK, Asinobi IN, Ekwochi U, Nduagubam OC, et al. Bacterial Contamination of Medical Equipment and Surfaces in the Main Operating Theater of Enugu State University Teaching Hospital. International Journal of Medicine and Health Development. 2022;27(2):164–168.
5. Pharyngeal carriage of group A streptococci in school children in Chennai - PubMed. https://pubmed.ncbi.nlm.nih.gov/17015934/. Accessed 1 March 2025.
6. Pharyngitis: Approach to diagnosis and treatment - PubMed. https://pubmed.ncbi.nlm.nih.gov/32273409/. Accessed 1 March 2025.
7. Lam TP, Ho PL, Lam KF, Choi K, Yung R. Use of antibiotics by primary care doctors in Hong Kong. Asia Pac Fam Med. 2009;8(1):5.
8. Avire NJ, Whiley H, Ross K. A Review of Streptococcus pyogenes: Public Health Risk Factors, Prevention and Control. Pathogens. 2021;10(2):1–18.
9. Akram S, Khan MA, Khan SA, Shah HBU. Group a beta hemolytic streptococcal carriage and antibiotic sensitivity among school going children in mardan, pakistan. Journal of Postgraduate Medical Institute. 2021;35(1):36–39.
10. Alzahrani MS, Maneno MK, Daftary MN, Wingate L, Ettienne EB. Factors Associated with Prescribing Broad-Spectrum Antibiotics for Children with Upper Respiratory Tract Infections in Ambulatory Care Settings. Clin Med Insights Pediatr. 2018;12:117955651878430.
11. Muthanna A, Zakariah SZ, Rashid AA, Ghazali SS, Hamat RA, Mawardi M, et al. Antibiotic Prescribing Patterns for Patients with Pharyngitis in Malaysian Public Primary Care Clinics. Malaysian Journal of Medical Sciences. 2022;29(1):91–100.
12. O'Neill BC, Balk D, Brickman M, Ezra M. A Guide to Global Population Projections. Demogr Res. 2001;4:203–288.
13. Sokoto | Nigeria, Map, & Population | Britannica. https://www.britannica.com/place/Sokoto-state-Nigeria. Accessed 1 March 2025.
14. Schumacher AE, Kyu HH, Antony CM, Aravkin AY, Azhar GS, Bisignano C, et al. Global age-sex-specific mortality, life expectancy, and population estimates in 204 countries and territories and 811 subnational locations, 1950-2021, and the impact of the COVID-19 pandemic: a

comprehensive demographic analysis for the Global Burden of Disease Study 2021. Lancet. 2024;403(10440):1989–2056.

15. Nair H, Simões EAF, Rudan I, Gessner BD, Azziz-Baumgartner E, Zhang JSF, et al. Global and regional burden of hospital admissions for severe acute lower respiratory infections in young children in 2010: a systematic analysis. Lancet. 2013;381(9875):1380–1390.

16. O'Brien KL, Wolfson LJ, Watt JP, Henkle E, Deloria-Knoll M, McCall N, et al. Burden of disease caused by Streptococcus pneumoniae in children younger than 5 years: global estimates. Lancet. 2009;374(9693):893–902.

17. Smith EL, Wheeler I, Adler H, Ferreira DM, Sá-Leão R, Abdullahi O, et al. Upper airways colonisation of Streptococcus pneumoniae in adults aged 60 years and older: A systematic review of prevalence and individual participant data meta-analysis of risk factors. Journal of Infection. 2020;81(4):540–548.

18. Ning X, Li L, Liu J, Wang F, Tan K, Li W, et al. Invasive pneumococcal diseases in Chinese children: a multicentre hospital-based active surveillance from 2019 to 2021. Emerg Microbes Infect. 2024;13(1). doi:10.1080/22221751.2024.2332670.

19. Thacharodi A, Hassan S, Vithlani A, Ahmed T, Kavish S, Geli Blacknell N-M, et al. The burden of Group A Streptococcus (GAS) Infections: The challenge continues in the twenty-first century. iScience. 2024;111677.

20. 2019 Antibiotic Resistance Threats Report | Antimicrobial Resistance | CDC. https://www.cdc.gov/antimicrobial-resistance/data-research/threats/index.html. Accessed 1 March 2025.

21. Tong SYC, Davis JS, Eichenberger E, Holland TL, Fowler VG. Staphylococcus aureus infections: epidemiology, pathophysiology, clinical manifestations, and management. Clin Microbiol Rev. 2015;28(3):603–661.

22. GLASS whole-genome sequencing for surveillance of antimicrobial resistance. https://www.who.int/publications/i/item/9789240011007. Accessed 4 November 2024.