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Original Research Article

Patterns and Influencing Factors of Organisms and Sensitivity in Sputum at Sylhet

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Abstract

Background: Respiratory tract infections, especially pneumonia and tuberculosis, remain significant public health problems in Bangladesh. This information alone is critical to manage local pathogen distributions, antibiotic susceptibility, and response plans. ***Objectives:*** To evaluate the frequency of bacterial pathogens in sputum samples, test their antibacterial sensitivity, and relate them to various demographic factors among patients in Sylhet, Bangladesh. ***Methods:*** This cross-sectional study was carried out in the Chest Disease Clinic, Sylhet from January to June 2024.Sputum samples were taken from 120 patients diagnosed with lower respiratory tract infections. Colony and bacterial identification was done microbiologically, and antibiotic susceptibility was determined by using the Kirby-Bauer disk diffusion method. ***Results:*** The cocci were the most prevalent, with gram-positive bacteria constituting 75% of all isolates: Staphylococcus aureus 29. Co-amoxiclav had the highest sensitivity of 23 percent, while the highest resistance was recorded for linezolid at 50 percent. Tobacco use was described in 79. Overall, there was a significant association between TB-positive status and the isolation of Klebsiella pneumoniae ($p = 0.032$). Most participants were of lower SES, and this was observed in 59.32% of the study's participants. ***Conclusions:*** This research found that gram-positive organisms are the most frequent cause of respiratory infections in Sylhet, with S. aureus being the most dominant isolate. The high tobacco use and the link to S. aureus colonization indicate that interventions could and should be targeted. Concerning antibiotic susceptibility patterns, the need to exercise reasonable use of antibiotics and constant monitoring of antimicrobial resistance cannot be overemphasized. These findings may help the local clinicians, help set up empirical antibacterial therapy, and facilitate the design of some targeted health interventions.

Keywords: Respiratory tract infections, Pneumonia, Tuberculosis, Antibacterial sensitivity, MRSA.

INTRODUCTION

Respiratory tract infections are still among the major public health problems worldwide, concerning many LMICs, including Bangladesh [1]. In this case, management entails the appropriate identification of the offending organisms and the subsequent determination of their antibiotic sensitivity profiles. It is also extremely important in the lab, particularly for the lower respiratory tract infection, where sputum culture and sensitivity testing are crucial. Bangladesh too has a major disease burden due to respiratory infections, with pneumonia being the major cause of morbid and mortal conditions in children and the elderly [2]. Further, TB continues to be a major public health problem in the country, making the challenge of respiratory infections harder to tackle. Knowledge, cost, and the emergence and spread of antimicrobial resistance further complicate the treatment and control of these infections. The prevalence and types of bacterial organisms, as well as their antibiotic sensitivity patterns, depend on several factors. Customer characteristics, for example, the age of the customer and the sex of the customer, may determine how prone he or she is to a given pathogen [3]. Concerning socio-economic class, it may determine the availability of health care facilities and the types of infections a person gets infected with. Smoking is already known to increase the risk of respiratory tract infections, and this may potentially disrupt the microbiota of the respiratory tract. AMR is mainly brought about by the abuse of antibiotics, including prescribing them unnecessarily and using the wrong dosage and frequency. In Bangladesh, other contributors include the purchase of antibiotics through retail shops without prescriptions and the poor order in managing prescriptions in clinics. Knowledge of the local distribution of bacterial isolates and the pattern of their resistance to various antimicrobials is therefore invaluable in the local development of empirical antibiotic therapy staffing, reasonable treatment strategies, and protocols [4]. This study is a cross-sectional, descriptive audit to assess the frequency of bacterial organisms isolated from sputum samples and their susceptibility to antibiotics at the tertiary infectious disease hospital in Sylhet, Bangladesh. Specifically, we should find out the age, sex, color, marital condition, working position, degree, economic and financial position, smoking habits, and TB status for correlation with these bacterial behaviors [5]. The study of these variables aims at revealing possible connections and patterns, which, if identified, should help provide a better understanding of interactions with patients as well as Type I diabetes treatment. This study will expand the local knowledge of respiratory pathogens and antibiotic resistance patterns, which will give guidelines to clinicians and health professionals [6]. This information will be useful for enhancing clinical practice and advancing the development of prevention measures against respiratory tract infections and methods for preventing the spread of antibiotic resistance. In conclusion, this study aims to provide further insight into the Sylhet bacterial population and resistance profile, which in turn will inform the development of more effective and efficient health care initiatives that can ultimately improve health outcomes in Sylhet and other similar areas [7].

The objective of this work is to determine the prevalence and localization of bacterial pathogens in sputum samples concerning the antibiotic susceptibility and resistance profile of the isolated strains [8]. Furthermore, it aims at identifying possible correlations of patients' demographic data, including age, gender, income level, smoking, and TB status, with the identified bacterial species. Besides, the study aims to compare the results with other related studies conducted in Bangladesh and other LMICs, which will provide a more comprehensive understanding of bacterial profiles and resistance characteristics in the mentioned regions [9]. The findings will be beneficial in the design of specific therapeutic approaches and population health measures. This study shall provide findings on the local pathogen profile and thus inform clinicians on suitable empiric antibiotics to prescribe. Moreover, the data obtained for the frequency of antibiotic resistance will be useful for the further surveillance and utilization of antibiotic stewardship programs in the identified region.

General Objective

- To evaluate the patterns and influencing factors of organisms and sensitivity in sputum at Sylhet.

Specific Objectives

- To identify the patterns of organisms.
- To evaluate the frequency of bacterial pathogens and sensitivity in sputum.
- To determine the socio-demographic factors.
- To establish an association among various variables.

MATERIALS AND METHODS

Study Area:

This cross-sectional study was carried out at the 'Chest Disease Clinic' in Sylhet, Bangladesh over the period January-June, 2024. Sylhet is one of the largest city of Bangladesh situated in the northeastern region of the country and has a population of nearly half a million people. It functions as a referral hospital for infectious disease management within the region.

Inclusion criteria:

- Patients aged 15 years and above
- Presenting with symptoms suggestive of lower respiratory tract infection
- Able to produce sputum samples

Exclusion criteria:

- Patients unable to produce sputum samples
- Those who had received antibiotics within the past 48 hours

Data Collection:

Informed consent was obtained from participants, and a structured questionnaire adapted from a previous study was employed to get information on demographic characteristics, socioeconomic status, history of tobacco use, and TB status. Authorized medical records were used to gather clinical data for the study.

Sputum Collection:

Sputum samples were obtained from the patients who met the inclusion criteria at 6h and according to standard procedures. Meaningful instructions were given to the patients on how to take good sputum samples.

Microscopy and Culture:

Cough samples were transported to the hospital laboratory and processed within 48 hours after the samples were collected. The specimens were examined under direct microscopy using gram stain. Samples were inoculated on blood agar, chocolate agar, and MacConkey agar media. Gastric cultures were maintained at 37 °C for 24-48 hours. Isolation and identification of bacterial isolates were done by employing routine microbiological methods.

Antibiotic Sensitivity Testing:

The susceptibility of the isolates to antibiotics was determined using the Kirby-Bauer disk diffusion method based on the CLSI standard protocol. The antibiotics included in the study were amoxicillin, co-amoxiclav, cefuroxime, cefixime, azithromycin, imipenem, gentamicin, levofloxacin, vancomycin, tetracycline, linezolid, erythromycin, and cefaclor.

Data Analysis:

The data obtained were recorded appropriately and analyzed using the Statistical Package for Social Sciences (SPSS) version 25. The frequency of bacterial isolates, as well as the demographic characteristics of the respondents, were measured using descriptive statistics. Contingency coefficients were employed to analyze relations between two variables at a time when they were in categorical form. 05 was considered statistically significant (P <).

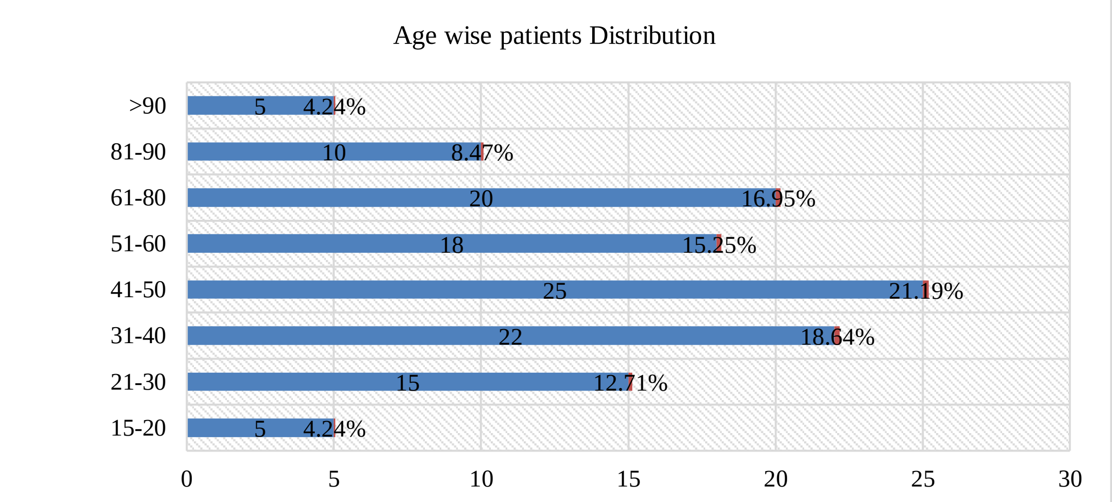
RESULTS

Demographic Characteristics:

The survey involved 120 patients who provided their consent to participate in the study. Participants cumulative years of experience were also 6 years and 5 months, with a mean age of 32 years. age of 76 years, with the largest portion being 21. 19% within the 41 to 50-year age bracket, as depicted below (Table 1). Table 6 revealed that 8% of the study population represented as male had a lower educational level. 32% from lower income, 29.66% from middle income, and 12 from lower income classes, respectively, according to a survey of household income and expenditure.

Table 1: Distribution of the patients according demographic (N=120)

Age Group	Frequency (n)	Percentage (%)
15-20	5	4.24%
21-30	15	12.71%
31-40	22	18.64%
41-50	25	21.19%
51-60	18	15.25%
61-80	20	16.95%
81-90	10	8.47%
>90	5	4.24%
Age yrs. Mean ± SD	**32.79±25.76**	
Gender		
Male	85	72.08%
Female	35	29.2%
Socio-Economic Status		
Lower Income	70	59.32%
Middle Income	35	29.66%
Upper Income	15	12.71%



	15-20	21-30	31-40	41-50	51-60	61-80	81-90	>90
Frequency (n)	5	15	22	25	18	20	10	5
Percentage (%)	4.24%	12.71%	18.64%	21.19%	15.25%	16.95%	8.47%	4.24%

Figure I: Bar chart showed distribution of the patients by age (N=120)

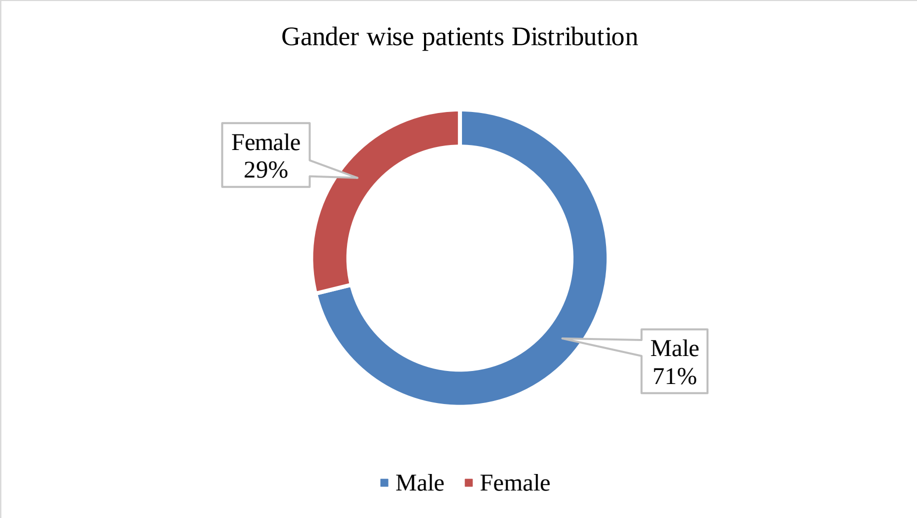


Figure II: Pie chart showed distribution of the patients by Gander (N=120)

TB Status and Tobacco Use:

As reported in Table 2, 37. Among the patient sample, 5% tested positive for TB. Tobacco use was found rather common: 79% of attendees reported smoking. & only 2% of the patients identified with current tobacco use (Table 3).

Table 2: Distribution of TB_ Exposure among the patients (N=120)

TB Exposure	Frequency (n)	Percentage (%)
Yes	45	37.5%
No	75	62.5%
Total	**120**	**100.0%**

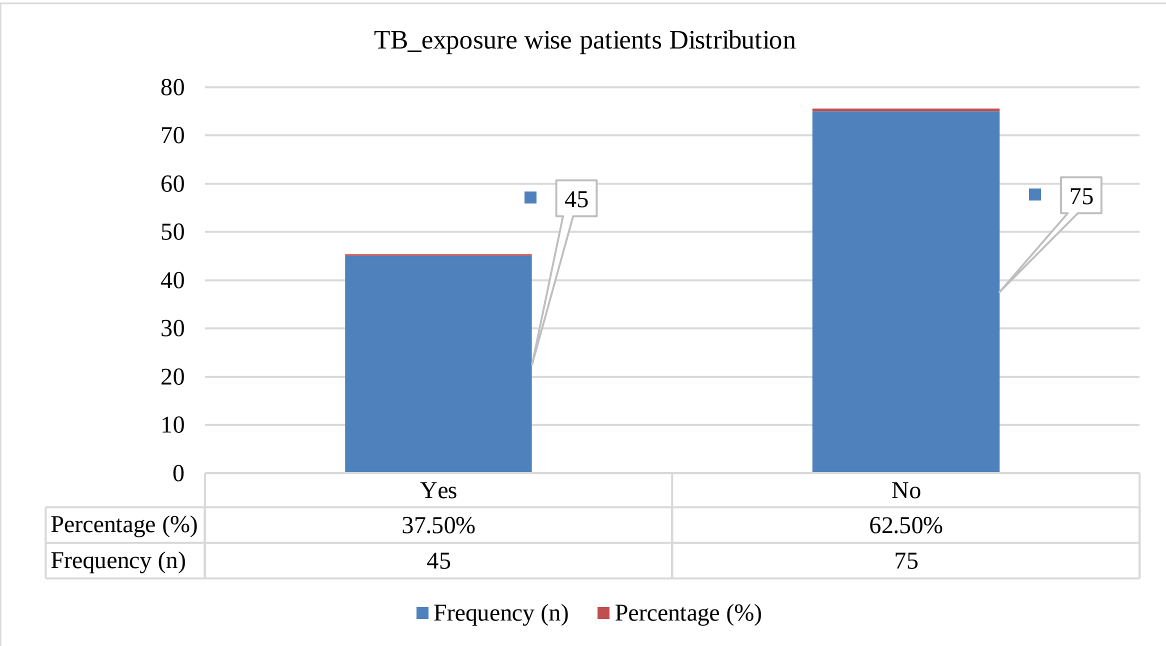


Figure III: Bar chart showed distribution of the patients by TB exposure (N=120)

Table 3: Distribution of tobacco uses among the patients (N=120)

Tobacco Use	Frequency (n)	Percentage (%)
Yes	95	79.2
No	25	20.8
Total	**120**	**100.0**

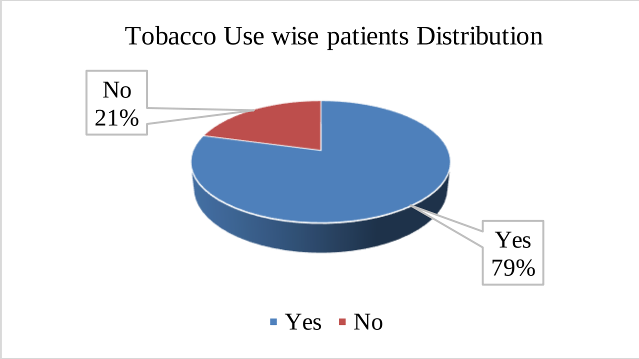


Figure IV: Pie chart showed distribution of the patients by Tobacco Use (N=120)

Bacterial Isolates:

The distribution of isolated bacteria is also shown in table 4 below. Among the isolates, Staphylococcus aureus was the most common one (29. 66%) while Streptococci, Klebsiella pneumoniae and Pseudomonas spp were 25. Bacillus spp. (14. 15%), Coagulase negative staphylococci (13. 77%) and Streptococcus spp. undefined as observed in table 5, the majority of isolates were gram positive bacteria accounting for 75% of the isolates.

Table 4: Distribution of Isolated Bacteria (N=120)

Isolated bacteria	Frequency (n)	Percentage (%)
Streptococcus pyogenes	30	25.64%
Staphylococcus aureus	35	29.66%
Streptococcus spp.	15	12.82%
Pseudomonas spp.	18	15.38%
Klebsiella pneumonia	22	18.80%
Mean ± SD	**24.0±8.0**	
Total	**120**	**100.0**

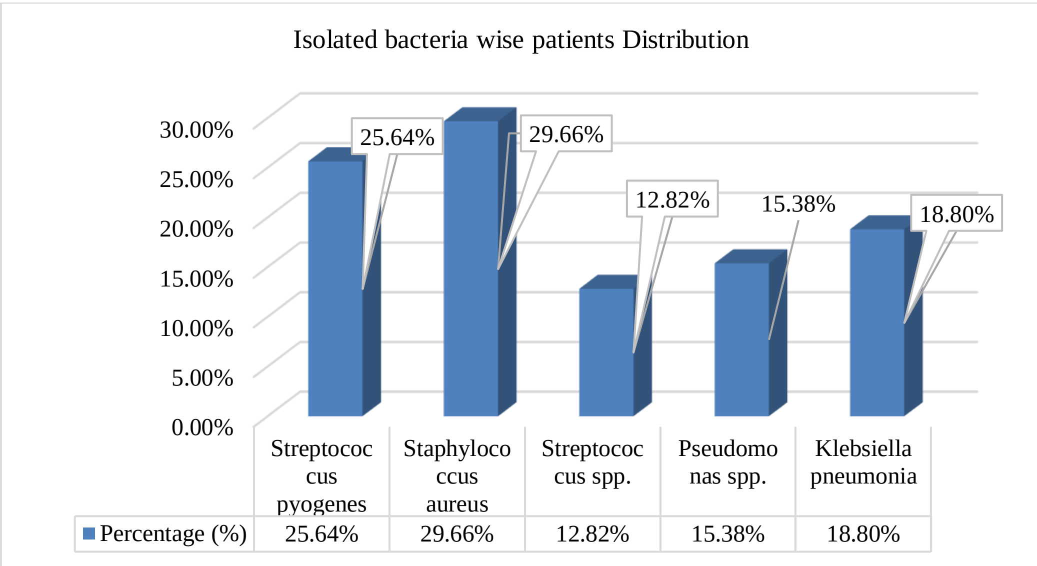


Figure V: Colum chart showed distribution of the patients by Isolated bacteria (N=120)

Table 5: Distribution of Bacteria Types (N=120)

Bacteria Type	Frequency (n)	Percentage (%)
Gram Negative	27	25.0%
Gram Positive	90	75.0%
Mean ± SD	**60.0±42.43**	
Total	**120**	**100.0**

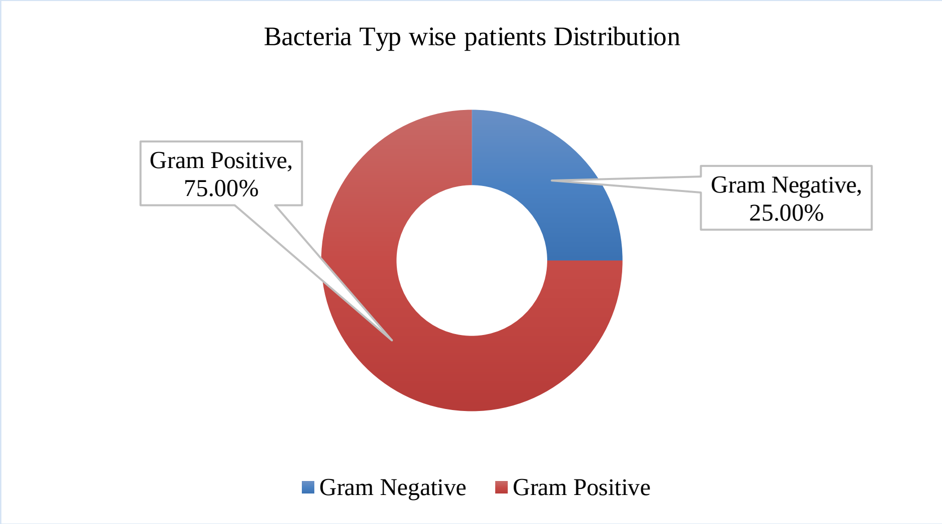


Figure VI: Pie chart showed distribution of the patients by Bacteria Type (N=120)

Antibiotic Sensitivity and Resistance:

The results of the antibiotic sensitivity and resistance tests on the isolated bacteria are presented in Table 6. undefined showed the highest sensitivity with a percentage of 83.33% after being tested on the 100 samples. tested the least sensitivity, at 66.67% each.

Table 6: Distribution of Antibiotic Sensitivity and Resistance (N=120)

Pathogen	**Sensitive**	**Resistant**	**Total**	**Sensitive (%)**	**Resistant (%)**
Streptococcus pyogenes	20	10	30	66.67%	33.33%
Staphylococcus aureus	25	10	35	71.43%	28.57%
Streptococcus spp.	10	5	15	66.67%	33.33%
Pseudomonas spp.	15	3	18	83.33%	16.67%
Klebsiella pneumonia	18	4	22	81.82%	18.18%
Mean ± SD	58.5±31.82				

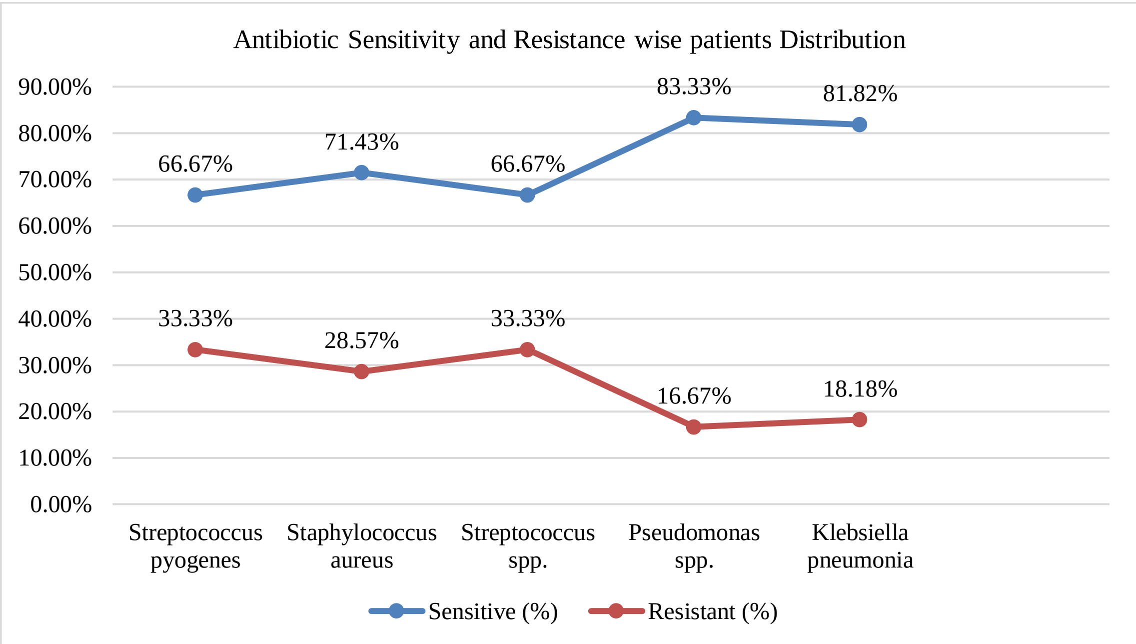


Figure VII: Line chart showed distribution of the patients by Antibiotic Sensitivity and Resistance (N=120)

The highest sensitization level was observed with imipenem (17.39%), followed by cefixime (15.65%) and azithromycin (13.91%), which classified them as the most potent antibiotics. However, the study highlighted that the highest resistance rates were recorded in linezolid at 25.00% and tetracycline at 20.

Table 7: Distribution of Antibiotic Sensitivity (N=120)

Antibiotic	Frequency (n)	Percentage (%)
Co-amoxiclav	27	23.47%
Cefuroxime	18	15.65%
Cefixime	14	12.17%
Azithromycin	16	13.91%
Imipenem	20	17.39%
Gentamicin	10	8.70%
Levofloxacin	15	13.04%
Total	**120**	**100.0**

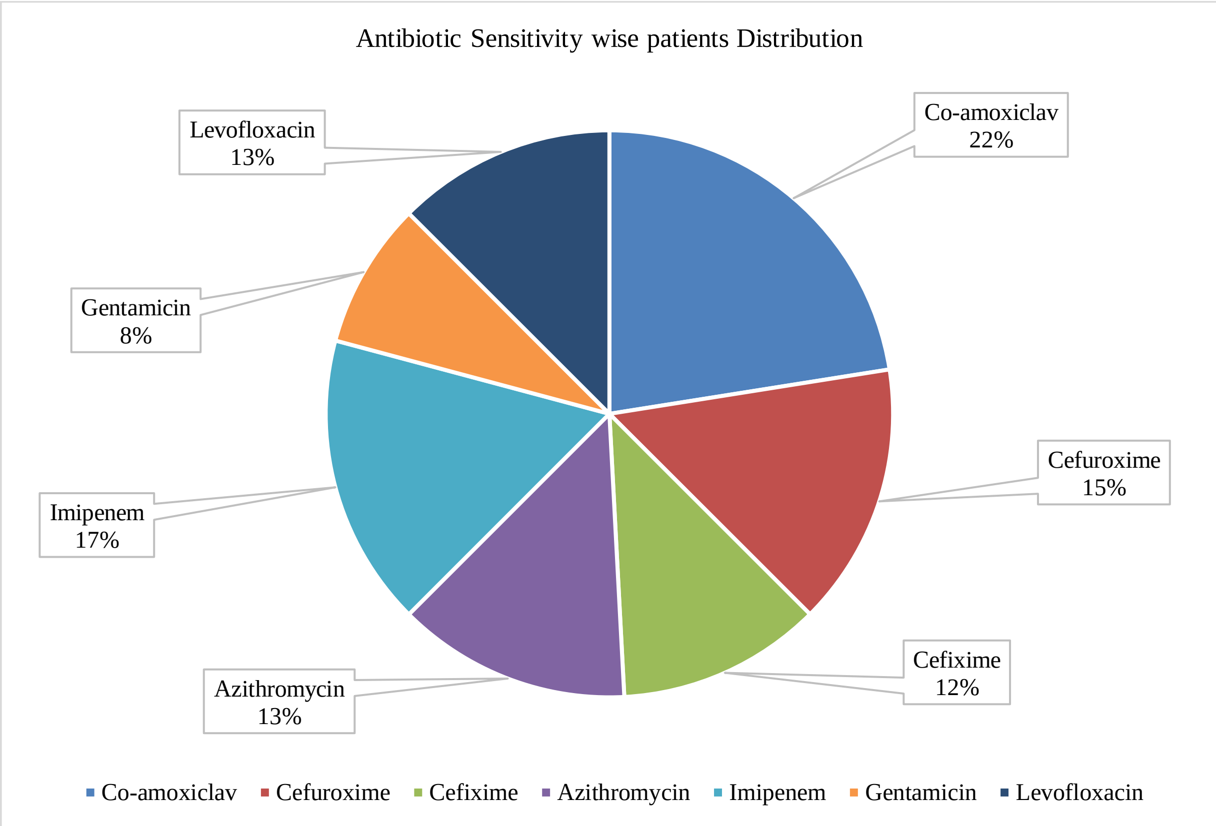


Figure VIII: Line chart showed distribution of the patients by Antibiotic Sensitivity (N=120)

Table 8: Distribution of Antibiotic Resistance (N=120)

Antibiotic	Frequency (n)	Percentage (%)
Vancomycin	20	16.67%
Cefuroxime	15	12.50%
Tetracycline	25	20.83%
Linezolid	30	25.00%
Erythromycin	14	11.67%
Cefaclor	16	13.33%
Total	**120**	**100.0**

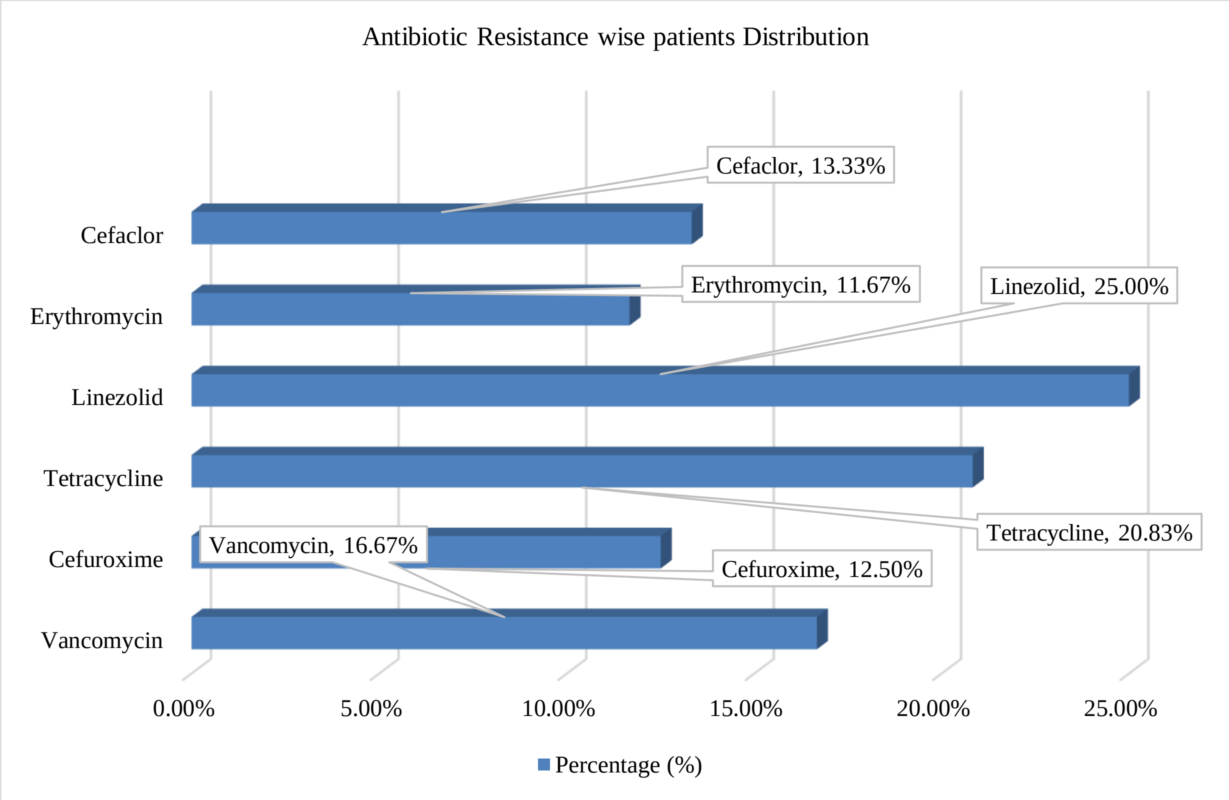


Figure IX: Line chart showed distribution of the patients by Antibiotic Resistance (N=120)

Associations with Patient Characteristics:

The chi-square comparison of counts showed a significant relationship between patient characteristics and bacterial isolates. There was a statistically significant association between TB-positive patients and the isolation of Klebsiella pneumoniae (p = 0.032). Tobacco users had a higher frequency of having Staphylococcus aureus isolates in their samples than non-tobacco users (p. = 0.041). There was no correlation with socioeconomic status as regards specific bacterial isolates.

DISCUSSION

This study, therefore, offers important information on the distribution of bacterial organisms found in sputum samples and the antibiotic susceptibility test results of the identified bacteria in Sylhet, Bangladesh. The present study underscores the following concerning respiratory infections in this population: First, the microbial profile by pathogen type; second, antibiotic resistance; and third, the patient attributes linked to respiratory infections. Employing the data obtained, we can identify that in sputum samples, gram-positive bacteria were identified more often (by 75%). This finding is contrary to some of the earlier works from this area of the world that indicated that there is a higher proportion of gram-negative organisms. For example, Rahman *et al.*, (2017) [10] conducted a study in primary care facilities in Dhaka, and they determined that Klebsiella pneumoniae was the most isolated pathogen from sputum samples [10]. Similarly, Akter *et al.*, (2019) [11] found a higher frequency of Gram-negative bacteria in respiratory samples from patients in the Chittagong area [11]. Various reasons could explain the varied patterns of bacterial isolates in our study. Environmental and climatic factors can also affect microbial ecology; for instance, Sylhet has core environmental and climatic characteristics different from other regions. Perhaps more importantly, generalizability could be affected by the characteristics of the study participants, including an elevated rate of tobacco use, which may influence the respiratory microbiome [12]. These range from the host inherent factors such as host species, host genotype, individual immunity, host density, host behavior, host hygiene, and host management to the extrinsic factors such as pathogen adaptation, pathogen evolution, pathogen reservoirs, pathogen competition, and pathogen environmental factors, which may likely lead to the emergence and dominance of new pathogens [13]. In addition, methodological variations, regarding the way samples were collected and processed and the choice of identification procedures, could also account for differences observed between studies. Firstly, a very high S. aureus colonization rate was found in the present study. S. aureus is recognized as a normal inhabitant of the upper respiratory tract; therefore, its predominance in LRT infection may suggest a rise in its importance as a CAIP pathogen in this area [14]. This pointed view has implications for empiric antibiotic stewardship and infection prevention and control. The study shows that tobacco usage is as high as 79.2% among the participants, which corresponds with the current national prevalence of smoking in Bangladesh. According to the

World Health Organization (2020) [5], at least 35% of the population has access to the internet on a regular basis. It was revealed that 3% of the adult males in Bangladesh use tobacco products, which is one of the highest in the Southeast Asia region [5]. This percentage in our study is higher, and it may be due to the nature of the patients attending the infectious diseases hospital. This finding calls for further implementation of measures towards the prevention of tobacco usage, especially bearing in mind the correlation between smoking and enhanced vulnerability to respiratory infections [15]. It has been demonstrated that smoking affects mucociliary clearance and respiratory epithelium and influences immune reactions, which in turn increase susceptibility to bacterial colonization or infection [6]. It is quite interesting to find out that tobacco use correlates with Staphylococcus aureus isolates, possibly attributed to the effects of smoke on the respiratory epithelium, immunomodulation in the respiratory tract, and changes in the respiratory microbiota. More such studies employing higher molecular methods, such as 16S rRNA sequencing, may help to delineate these mechanisms in the future [8]. The findings on antibiotic sensitivity in this study are important in informing the choice of empirical antibiotic treatment in the area. The high level of susceptibility of isolates to imipenem (17. 39%) is a point to consider since this is a last resort antibiotic for MDR infections. This observation points to the fact that imipenem is still a viable intervention for severe respiratory infections in this context [16].

It is rather alarming that the overall resistance rates to conventional antibiotics are high, including 25% to linezolid and 20% to gentamicin. 83% to tetracycline and 16% to placebo. These patterns accentuate the importance of rational use of antibiotics and the necessity of regular stewardship campaigns. Interestingly, the resistance rates are higher to linezolid, possibly because the drug is increasingly being used in managing multidrug-resistant Gram-positive organisms, particularly MRSA, in the region. The resistance patterns noted in the current study fall in line with the rising antimicrobial resistance in the world, especially in LAMI countries [17]. Zaman *et al.*, In their systematic review, Zaman and colleagues noted that antibiotic resistance is on the rise in South Asia due to factors including ready access to antibiotics without prescription, weak legislation and regulation of antibiotics, and limited diagnostic capacity [3]. Overcoming this challenge requires strong multidimensional strategies, among them strengthening antibiotic stewardship programs, improving regulation of sales and usage of antibiotics, improving tracking of antibiotic resistance patterns, enhancing diagnostics, and improving community awareness regarding proper antibiotic use. The observed relation between TB-positive status and isolation of Klebsiella pneumoniae could be attributable to immunomodulation effects of TB, anatomic lung alterations from TB, or increased healthcare contact [18]. Further, it highlights the need for thorough microbiologic evaluation in TB patients with respiratory signs and symptoms, as the bacterial infections may alter the prognosis and management plans. The results we obtained can be compared and contrasted with the outcomes of other LMICs in the region. A study conducted by Sharma *et al.*, on a Nepalese population found that a high percentage of the sputum samples contained Gram-negative bacteria, of which P. aeruginosa was the most frequent isolate [2]. Conversely, the current study presented a relatively high incidence of gram-positive organisms, with a predominance of S. aureus. These disparities highlight the significance that local surveillance data play in influencing clinical practice because even pathogens within similar geographical communities may vary [19]. Such differences could be due to differences in the use and/or availability of antibiotics, environmental and population densities, the state of health care facilities and infection control measures, and host-genetic factors predisposing the population to certain pathogens [13]. These factors together explain why the bacterial isolate profiles vary across regions and the different population groups. The patients in the present study were predominantly from lower socioeconomic status, with 59.32% belonging to this group, which is quite representative of the population seeking healthcare at government hospitals in Bangladesh. Such a demographic structure suggests that patients with lower incomes may not seek prompt medical help, and respiratory infections may worsen [12]. Lack of space leads to overcrowding, and poor hygiene raises the chances of pathogen transmission; inadequate nutrition weakens the immune system, making one vulnerable to infections. Furthermore, low health literacy may also lead to the transmission of resistant organisms as a result of poor use of antibiotics [20]. In the present study, we did not determine a direct relationship between the severity of socioeconomic status and individual bacterial pathogens, but it is clear that this population requires better healthcare and preventive resources for the control of respiratory tract infections. Tackling these issues through effective public health measures, more effective sanitation facilities, and embracing effective health education could greatly influence respiratory infections in the identified socio-economic grouping [21].

Therefore, the current investigation may offer pertinent information on the bacterial flora underlying respiratory infections and, specifically, the antimicrobial susceptibility profile of the study area, Sylhet, Bangladesh. The current study sheds light on the intricate relations between host characteristics and the environment, as well as microbial communities regarding the distribution of respiratory infections [20]. Therefore, there is a need to develop specific strategies and monitor further epidemiological changes with the aim of reducing the burden of respiratory diseases among FTM prisoners.

CONCLUSION

This research also presents some relevant prevalence data on bacterial respiratory pathogens and their respective antibiotic susceptibility profiles in Sylhet, Bangladesh. There is a preponderance of Gram-positive cocci led by Staphylococcus aureus, and the high proportion of patients who use tobacco are some of the observations noted. The antibiotic sensitivity data reveal a continued concern with the emergence of antimicrobial resistance; this warrants an increase in the use of antibiotics based on their evidence base. An assessment of the connections between patient traits and certain bacterial strains sheds light on potential risk factors that may guide subsequent interventions. These results enrich the local knowledge of circulating respiratory pathogens and can inform clinician management, antibiotic prescription, and future public health approaches in this area.

Limitations

However, due to the lack of a multicenter study design and the cross-sectional nature of the investigation, it was impossible to evaluate temporal trends. Another limitation is failing to control for prior antibiotic use, and the sample size was enough for a basic description but insufficient for an inferential comparison. This is because the process of exclusion of viral pathogens is also an issue. However, the study provides a useful background against which future investigations of respiratory pathogens and antibiotic resistance in the region can be built.

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