ARC Journal of Public Health and Community Medicine
Volume 10 Issue 2, 2025, PP 1-6
ISSN No. (Online) 2456-0596
DOI: https://doi.org/10.20431/2456-0596.1002001
www.arcjournals.org

Bacteria Contamination of Lecture Halls at a Higher Learning Institution in Zambia: The Public Health Risk

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Received: 06 November 2024 Accepted: 14 April 2025 Published: 17 May 2025

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Abstract

Pathogenic microorganisms in public areas can be a critical concern in public health, because these pathogens can spread easily from one person to another. Public or community areas such as public transportation systems, university lecture halls, restaurants, schools and day care centres can bring a large number of people together and facilitate the transmission of pathogenic microbes. This study was a cross sectional. It was designed to evaluate bacterial contamination and antimicrobial resistance of bacterial isolates from two lecture halls at a higher learning institution in Lusaka, Zambia from January 2023 to November 2023. The bacterial isolates included, Pseudomonas aeruginosa, Escherichia coli, Shigella spp, Enterobacter aerogenes were prevalent on door knobs, and Staphylococcus aureus. Pseudomans aeruginosa were prevalent on wall surfaces. This study established that majority of the bacteria isolates were susceptible to Amoxicillin, Ciprofloxacin, Chloramphenicol, Gentamicin, Sulphamethizole, Nalidixic acid and tetracycline and all of the isolates were resistant to penicillin. Therefore, the contamination of surfaces and door knobs in lecture halls could be a source of infection which would be difficult to treat with some commonly used antibiotics reported to be resistance in this study.

Keywords: *Lecture halls, Bacteria, Antibiotics, Public health, Zambia*

1. INTRODUCTION

Pathogenic microorganisms in public areas can be a critical issue in public health, because these pathogens can easily spread from one person to another. Public or community areas such as public transportation systems, university lecture theatres, restaurants, schools and day care centres can bring a large number of people together and facilitate the transmission of pathogenic microbes.(Adwan, Salama and Hasan, 2016). It has further been reported by several studies that the common health and discomfort effects reported for indoor environments are the perception of malodour, eye and airway irritation symptoms regarding the classic "sick building syndrome" ((Burge, 2004)(Ghaffarianhoseini *et al.*, 2018); (Reijula & Sundman-Digert, 2004; Wolkoff *et al.*, 2006;Wolkoff & Kjærgaard, 2007)). Therefore, there has been a growing interest in indoor microbial assessment in recent years, as an essential determinant of healthy life and people's well-being (Ekhaise *et al*., 2010). In recent years, indoor air quality has become a serious public health concern, since most people spend their time indoors, either in their house, office, school or other public places, where they are exposed to some indoor microorganisms which have much effect on their health and physical condition. Microbial contamination of indoor air is mostly caused by bacteria, molds, and yeast. Pathogenic living cells present in the air, or the chemical substances secreted by the airborne microbes, can cause severe human infections and diseases (Stryjakowska-Sekulska A. *et al*. 624, 2007.).

Bacterial contaminants in indoor air may originate from sources including outdoor air, human occupants, indoor bacterial growth, and pets (Nejadkoorki et al., 2011). Clinically important bacteria found mainly in the indoor

environment include *Staphylococcus aureus, Staphylococcus epidermis, Corynebacterium diphtheroids, Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Proteus mirabilis, Salmonella typhi and Shigella dysenteriae* ((Hussin *et al.*, 2011); Boyce et al., 2007;Rintala et al., 2008); J.Harrison et al. 1992;Bonadonna, Briancesco and Coccia, 2017; Onmek *et al.*, 2020; Bouillard et al., 2005)) reported isolating approximately 175 bacterial species on floor surfaces, with majority being gram-positive cocci. In public buildings contamination is derived from airborne microorganisms, which may become re-aerosolized and subsequently inhaled by students, workers or casual passers-by. Humans are an important source of indoor bacteria, transferring microorganisms through hand contact, contaminated food, or direct ingestion (Del Campo et al., 2019). Antimicrobial resistance (AMR) has accounted for about 4.95 million global deaths due to drug resistance infections, out of which about 1.27 million deaths were directly caused by AMR in the year 2019. In Zambia in the same year, 3,700 deaths were attributable to AMR and 15,600 deaths were associated with AMR thus making Zambia the 14th highest country having an age-standardized mortality rate per 100,000 population attributed to AMR among all countries (IHME., 2022). High resistance patterns in Zambia has been addressed due to high prescription rate from hospitals hence the situation needs to be monitored and addressed as ambulatory care. Therefore, this study aimed at assessing drug resistance of bacteria responsible for contamination of lecture hall surfaces and door knobs.

2. Materials And Methods

2.1. Study Design

This was an experimental cross sectional study designed to evaluate bacterial contamination and antimicrobial resistance of bacterial isolates from two lecture halls at a higher learning institution in Lusaka, Zambia from the period of January 2023 to November 2023. The two lecture halls were selected based on the huge number of students and the frequency of their use. Purposive sampling was employed and a convenient sample size of 30 samples was obtained from wall surfaces, floor, bench tops and door knobs.

2.2. Isolation and Identification of Bacteria

Sterile wet swabs were used to swab on the doorknobs and surfaces**.** The swabs were then rinsed in peptone water for enrichment. From each of the enriched buffer peptone water tube, one loopful culture was streaked across MacConkey and Mannitol salt agar surface. Plates were incubated for 24 hours at 37°C. After incubation, both lactose fermenter and non-lactose fermenter colonies were isolated and purified. Presumptive *E. coli*, *Enterobacter* spp, *Pseudomonas* spp, and *Staphylococcus* aureus isolates were screened and identified based on their physiological characters, biochemical behaviours as well as their hallmark characteristic growth on Eosine Methylene Blue (EMB) Agar. Similarly, *Salmonella* and *Shigella* spp were screened out from the non-lactose fermenter isolates based on their growth characteristics on Bismuth Sulfate Agar (BSA), Brilliant Green Agar (BGA), Xylose Lysine Dextrose (XLD) agar and Salmonella-Shigella (SS) agar. Physiological and biochemical behaviours were also investigated to confirm their identity.

2.3. Antibiotic Susceptibility Test

Antibiotic susceptibility tests for selected five isolates were performed using Kirby Bauer disk diffusion method (A. W. Bauer, W. M. M. Kirby, 1966). Sensitivity of the enteric bacteria isolates antibiotics was assessed against commercially available standardized antibiotic discs of Ampicillin (10µg), Amoxycillin (30µg), Ceftriaxone (30µg), Ciprofloxacin (5µg), Gentamicin (10µg), Nalidixic acid (30µg), Penicillin (30µg), Trimethoprim-sulfamethoxazole (30µg) and Tetracycline (20µg). By using subculture of each isolate, desired bacterial suspension was prepared in nutrient broth for antibiotic susceptibility test and the turbidity of the culture was adjusted with the McFarland standard 0.5. A cotton swab was dipped in the culture preparation and streaked over the surface of the Muller-Hinton agar medium. The antibiotic discs were then placed on the surface of the seeded plates at appropriate arrangement by using sterile forceps and kept at 4°C for 30 minutes to diffuse antibiotic in the media. Then the plates were incubated at 37°C for 24 hours and the diameter of the clear zone of inhibition was measured, recorded and defined according to the standard table given by the CLSI.

3. Results

3.1. Isolation and Identification of Bacteria in Lecture Halls

A total of five different bacterial isolates were identified from door knobs and surfaces of

lecture halls. The isolated bacterial contaminants were similar in all the lecture halls from similar sites. The isolates included; *Pseudomonas aeruginosa*, *Escherichia coli*, *Shigella spp*, *Enterobacter aerogenes* were prevalent on door knobs, and *Staphylococcus aureus*. *Pseudomans aeruginosa*, *Escherichia coli* and *Enterobacter aerogenes* were found to be the most prevalent in the sampled Lecture Halls and floor and walls.

Table 1. *Showing the isolated bacteria from Door knobs and surfaces*

Location/Site	Organisms
Door Knobs	*Pseudomonas aeruginosa, Escherichia coli, Shigella spp, Enterobacter aerogenes, Staphylococcus aureus*
Floors And Walls	*Pseudomonas aeruginosa, Escherichia coli* and *Enterobacter aerogenes*

3.2. Antimicrobial Susceptibility Patterns

The diameters of the zones of inhibition observed were measured and the critical diameters indicated with reference to current standard guidelines. Inhibition zones of different antibiotics for the various bacterial isolates are show below (Table 1). Penicillin was found to be the most resistant to all bacterial isolates. *E. coli* and *Shigella spp.* were resistant to amoxicillin, ciprofloxacin and penicillin. Among all the isolates, *E.aerogenes* was the most drug resistant bacteria which was resistant to amoxicillin, Nalidixic acid, Sulphamethozole and Penicillin. On the other hand, tetracycline effectively inhibited growth of *S. aures*. *E.aerogenes* and *Shigella spp.*

Table 2. *Antimicrobial Susceptibility profiles of the isolates*

Antimicrobial Agent	*S.aureus,*		*E. coli,*		*Shigella*		*E. aerogenes*	
	S (%)	R (%)	%S	%R	%S	%R	%S	%R
Amoxicillin	0	0	39	61	30	70	22	78
Cefotaxime	0	0	0	0	0	0	100	0
Ciprofloxacin	0	0	78	22	100	0	100	0
Gentamicin	100	0	100	0	0	0	0	0
Nalidixic acid	0	0	0	0	0	0	96	4
Penicillin	0	100	0	100	0	100	0	100
Sulphamethoxazole	70	30	0	0	100	0	0	100
Tetracycline	100	0	100	0	0	0	100	0
MAR index	0.5		0.6		0.5		0.6	

%S: Percentage of Susceptibility

%R: Percentage of Resistance

3.3. Multiple Antibiotic Resistance (Mar) Index

The MAR index assesses the level of antibiotic resistance in bacterial isolates, with one (1) indicating total resistance, and zero (0) indicating the lowest index. Our results showed that the MAR index for *E. aerogenes* and *E. coli* was 0.6, whereas for *S. aureus* and *Shigella* scored 0.5.

4. Discussion

This study aimed at assessing bacterial microbial contaminants found in lecture halls at a higher learning institution in Zambia and assessing their antimicrobial resistance patterns. In this study *Staphylococcus aureus, E. coli, Enterobacter aerogenes, Shigella* spp, *Pseudomonas aeruginosa* were isolated. This is similar to a study done in Iraq (AL-Harmoosh et al., 2019) in which similar bacteria were isolated from door room handles. Another study done in India (Chowdhury et al., 2016) isolated similar bacteria on most touched surfaces in a bus used by students. The possible sources of bacteria in all the above cases could be contaminated hands of students and other users of the lecture halls as well as the air. The isolation of such bacteria could pose a public health threat as some of them are known pathogens and are associated with infections such as diarrhoea. Although *S. aureus* usually acts as a commensal of the human microbiota it can also become an opportunistic pathogen, and are associated with causation of skin infections including abscesses, respiratory infections such as sinusitis, and food poisoning (Corey P. Parlet1, 2019).

The findings of this study demonstrated that *E. coli* was the most predominant isolate associated with contamination of lecture halls. These findings are consistent with those of a study done in the escalator handrails and lift buttons of Selected shopping malls in Lusaka Zambia, in which *E. coli* was the most predominant

organism isolated (Musawa., 2020). Further, the isolation of *E. coli* from different surfaces in the current study could be due to dissemination of this organism through contaminated hands of those working in the Microbiology Laboratories or other sources of fecal contamination. This finding indicates low levels of hygienic conditions. These results were consistent with a previous report were contaminated surfaces with this pathogen in a university setting. (Adwan, Salama and Hasan, 2016)

Bacteria species like *Staphylococcus spp*. are found on human skin scales (Odutayo et al., 2007). *S. aureus* are emitted from the nasopharynx of normally healthy individuals when the person talks, and are commonly found in air, water, the skin (Odutayo *et al.*, 2007). *Pseudomonas spp* has been reportedly associated with wet surfaces of air- conditioning systems, cooling coils, drain pans (Cao et al., 2021) sump pumps reported the isolation and characterization of thirty-one microorganisms from different lecture hall locations including walls, tables and floor. This might be attributed to the fact that people put different objects on surfaces in the lecture halls. however, the presence of other bacteria in a room indicates the presence of people and their levels may get high when the building is heavily populated (Adwan, Salama and Hasan, 2016)

This study further investigated the antimicrobial susceptibility of the isolated bacteria. The study observed that *Staphylococcus* isolates were susceptible to Tetracycline, Gentamicin and Sulphamethoxazole, except for Penicillin where they showed resistance. These results are consistent with studies done in some parts of Africa and India ((Ishrat Bano, 2012); (Tatah et al., 2014). A higher percentage of *E. aerogenes* isolates were susceptible to tetracycline, Cefotaxime and nalidixic acid, while resistant to amoxicillin and Sulphamethoxazole. These results are significant because they indicate a possibility of emerging resistant strains of *Staphylococcus aureus* which would be difficult to treat using currently available antibiotics in the near future. The isolated *Shigella* spp were resistant to amoxicillin and Penicillin, while the isolates for *E. coli* were resistant to Ampicillin, Cefotaxime, Co-trimoxazole and Penicillin. The resistance of these microorganisms to some of the commonly used antibiotics imply that both the students and lecturers who frequently use these lecture halls might be at risk of being exposed to bacterial infections that would be difficult to treat once infected. Antimicrobial susceptibility testing demonstrated that all the isolates were susceptible to most of the antibiotics used in this study, with the exception of penicillin, to which they were all resistant. These results are similar to a study conducted in Cameroon (Tatah et al., 2014). *E. coli,* the most common isolated organism was highly susceptible to ciprofloxacin, gentamicin and tetracycline but were resistant to amoxicillin. The 61% resistance of the *E. coli* isolates to amoxicillin is of medical importance, because it is an indication of emerging resistance of these common contaminants to frequently used antibiotic.

These results suggest that people who regularly use these lecture halls may be at risk of acquiring bacteria that will cause infections. Presence of large number of selected pathogenic bacteria in this study shows that the people found in these lecture halls do not practice hygiene. Therefore, there is need for the relevant authorities and the general public to ensure that these surfaces are kept clean by disinfecting them and observing good hygiene practices at all times.

5. CONCLUSION

This study established that majority of the bacteria isolates were susceptible to Amoxicillin, Ciprofloxacin, Chloramphenicol, Gentamicin, Sulphamethoxazole, Nalidixic acid and Tetracycline and all of the isolates were resistant to Penicillin. Further, the study established that *E. coli* was resistant to Amoxicillin and *Enterobacteria* spp were resistant to amoxicillin and Sulphamethoxazole. Therefore, the contamination of surfaces and door knobs in lecture halls could be a source of infection which would be difficult to treat with some commonly used antibiotics. This therefore, presents a public health risk and emergence of antimicrobial resistance. It is recommended that lecture halls are periodically disinfected and sterilised.

Author contribution

SM conceptualised the study and drafted the manuscript, ARM, AC, BK and LN analysed experimental data and drafted the manuscript.

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Citation: *Sydney Malama et al. Bacteria Contamination of Lecture Halls at a Higher Learning Institution in Zambia: The Public Health Risk. ARC Journal of Public Health and Community Medicine. 2025; 10(2):1-6. DOI: https://doi.org/10.20431/2456-0596.1002001.*