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Review Article

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Antibiogram And Microbial Carriage of Bus Door Cab Handles (Within Imo State University Owerri Campus)

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Abstract
This study examined the antibiogram and microbial carriage of bus door cab handles at Imo State University, Owerri Campus. Swab samples were obtained aseptically from bus door handles at three primary sites: Extension Gate Park, IMSU Junction Park, and Back Gate Park. Standard microbiological methods, such as serial dilution, culture, biochemical tests, and antibiotic susceptibility testing, were used to isolate and identify microbes.The overall number of heterotrophic bacteria was between 3.2×10^1 and 6.0×10^7 CFU, while the total number of coliform bacteria was between 1.6×10^1 and 5.0×10^6 CFU. The number of Staphylococcus ranged from 6.0×10^2 to 4.2×10^6 CFU, whereas the number of Salmonella–Shigella ranged from 6.0×10^2 to 6.5×10^6 CFU. The discovered bacterial isolates were Klebsiella spp., Proteus spp., Escherichia coli, Pseudomonas spp., Shigella spp., and Staphylococcus aureus. E. coli (23%) was the most common isolate, followed by Shigella spp. (20%), Klebsiella spp. (17%), Pseudomonas spp. (17%), Staphylococcus aureus (13%), and Proteus spp. (10%). Antibiotic susceptibility tests showed that different isolates had different levels of sensitivity and resistance. Most organisms were more sensitive to fluoroquinolones than to beta-lactam antibiotics. The study finds that bus door handles in the area studied are quite dirty with bacteria that could make people sick, showing how they can spread diseases. It is highly advised that people wash their hands often and clean the surfaces of public transport that people touch on a regular basis.

Keywords: Antibiogram, microbiological carrier, bus door cab handles.

INTRODUCTION

To better understand the discussion developed in this article, it is first necessary to consider how death and mourning have been historically constructed. Historical and sociocultural scholarship indicates that death was once more visibly integrated into everyday communal life, whereas modern societies progressively relocated death to more institutional, medicalized, and socially distant spaces. In contemporary Western contexts, death and mourning are frequently treated as taboo subjects, often surrounded by avoidance, euphemism, and discomfort (1; 2). This shift is particularly relevant to psychology because it shapes not only how loss is experienced, but also how grief is socially recognized or silenced.

Infectious diseases are still a major cause of illness and death around the world. Diarrhoeal and respiratory infections alone kill millions of people each year. These illnesses are closely linked to bad hygiene, dirty places, and sanitation systems that don't work well. In many poor areas, the problem is made worse by a lack of access to clean water and places to wash hands, which makes it easier for germs to spread throughout communities. These diseases are especially hard on people who are already weak, like kids, old people, and people with weak immune systems. Environmental pollution remains a significant yet frequently undervalued vector for the transmission of infectious diseases [3].

Numerous studies have shown that everyday objects in the environment, like door handles, mobile phones, desks, chairs, lift buttons and public transportation fixtures, can hold a wide spectrum of harmful germs. These encompass both Gram-positive and Gram-negative bacteria, including Staphylococcus aureus, Escherichia coli, Klebsiella spp., and Pseudomonas

spp. [4]. These organisms are clinically significant as numerous are linked to opportunistic infections, varying from moderate dermal infections to serious systemic conditions, including septicaemia, pneumonia, urinary tract infections, and gastrointestinal disorders. It is important to note that these bacteria can stay on dry, nonliving surfaces for a long time, depending on the temperature, humidity, and type of surface. Their ability to survive outside the host raises the risk of transmission upon contact with infected surfaces, followed by contact with the mouth, nose, eyes, or open wounds [5].

The public health consequences of environmental microbial contamination are exacerbated by the escalating issue of antibiotic resistance (AMR). The introduction and proliferation of resistant bacterial strains have markedly diminished the efficacy of widely utilised antibiotics, complicating the management of diseases. According to [6], the global rise in antibiotic resistance is mostly due to people misusing, overusing, and getting antibiotics prescribed in the wrong way. Environmental microorganisms subjected to sub-lethal levels of antibiotics or severe environmental stressors may acquire adaptive resistance mechanisms, such as enzyme synthesis, efflux pumps, and genetic changes. This makes it harder to treat infections caused by these organisms and raises the costs of healthcare, hospital stays, and deaths [7].

Even though people are more aware of how to keep clean and avoid infections in homes and hospitals, less attention has been paid to germs that can get into public transit systems. Buses and other public transport vehicles are busy places where many people touch the same surfaces every day. Bus door handles are one of the most significant surfaces because almost every passenger touches them when they get on and off the bus. This frequent and repeated contact generates the perfect conditions for germs to build up and move from one person to another, which raises the danger of spreading infectious agents across the community [8].

Hard, non-porous surfaces like metal or plastic door knobs are considered high-risk fomites because they may hold live microbes for a long time. Even with regular cleaning, contamination can happen again quickly because people are often touching things. Hand hygiene has been pushed as a fundamental way to stop the spread of disease by public health campaigns, yet people still don't always follow the rules. Many people either don't wash their hands properly or don't have access to good handwashing facilities, especially in public places. This behavioural gap has a big role in the spread of microbes through contaminated surfaces [9].

Epidemiological data indicate that a significant percentage of infectious diseases may be transmitted indirectly by contact with infected things. Reports indicate that as much as 80% of illnesses may be associated with hand-mediated transmission channels involving fomites. This shows how important environmental surfaces are for keeping the transmission of infection going in communities. Poor cleanliness habits among those who use public transit are an essential but largely ignored reason why disease-causing germs proliferate in cities [10].

While numerous studies have investigated microbial contamination of mobile phones, financial notes, hospital equipment, and household surfaces, there is a paucity of study explicitly examining bus door handles, especially in university settings in Nigeria. This signifies a notable study deficiency, given the substantial human traffic and regular engagement with public transit systems in these environments. Consequently, this study is essential to ascertain the microbial load and antibiogram of organisms found on bus door handles at Imo State University, Owerri Campus. The results are anticipated to yield significant insights into the epidemiology of surface contamination, elevate public health awareness, and facilitate the formulation of effective infection prevention and control strategies designed to mitigate the risk of disease transmission within public transportation systems.

MATERIALS AND METHODS

Study Area

This study was conducted within the premises of Imo State University Owerri Campus of Nigeria. Imo State is a state in the South-East geopolitical zone of Nigeria. It is bordered by Anambra State to the north, Rivers State to the west and south, and Abia State to the east. Imo State is one of the oldest states in the south-east region of Nigeria, created in 1976. It is the 3rd smallest state in Nigeria by landmass and is the 13th most populated state. The state is dominated by Christians and is made up of just one tribe.

Materials

Normal saline, MacConkey agar, Nutrient agar, Mannitol salt agar and Blood agar, Mueller Hinton agar, test tube, spirit lamp, Standard paper discs, meter rule and a protractor, Ofloxacin, Peflacine, Ceftriaxone, Amoxicillin, Gentamycin, Ciprofloxacin, Amoxicillin/Clavulanate and Ampicillin.

Sample Collection and Processing

Samples were collected from three different locations as stated below:
Samples were collected in Extension Gate Park, IMSU Junction Park and Back Gate Park. All samples were properly labeled and transported to the Microbiology laboratory for examinations. Samples were collected by swabbing the door

handle with a sterile cotton swab stick soaked in sterile water from each location aseptically. Each sample was taken twice per bus randomly and was transported to the laboratory for analysis.

Sample Preparation

The samples were assigned alphabetical numbering in the lab using masking tape and pen after which they were kept in normal saline for 1hours after which the water were used for serial dilution.

Media

The culture media were Nutrient agar, MacConkey agar, Mannitol Salt agar, Simmon's citrate agar

Media preparations

The solid components of the media were dissolved in a conical flask according to the manufacturer's instructions; the flask was closed with cotton plug and covered with Aluminum foil, placed into an autoclave and sterilized at 121^0C for 15mins. After sterilization, the medium was cooled to 45^0C, the cotton plug was removed and the mouth of the flask was flamed over a Bunsen burner in other to ensure sterility, and the medium was poured into sterile, petri dishes (15-20ml into each petri dish) containing inoculums. The petri dishes was swirled on the worked bench to ensure even distribution of inoculums and they were kept horizontally until the medium are completely solidified, then they were turned upside down and incubated.

Sterilization

All glass wares used were sterilized after washing with detergent using hot air oven, the Nutrient agar, MacConkey and Simmon's citrate agar and Peptone water were sterilized by Autoclaving at 121^0 C, 15Psi. Wire loops were sterilized by flaming to red hot using Bunsen burner and all laboratory benches was cleaned before and after work with 75% alcohol. Bunsen burner was lighted during the course of the experiments to keep the environment sterile.

Bacteriological evaluation of samples

Serial dilution was done from the soaked sample collected from the different locations within Imo State University Owerri. In the procedure, 9ml of normal saline was poured into 5 different sterile test tubes labelled 10-1, 10-2, 10-3, 10-4, and 10-5. For each of the sample collected, 2ml of normal saline was added and shaken, 1 ml was transferred into the first test tube, 10-1 and tilted gradually to mix, after that 1ml from it was taken into the second test tube labeled 10-2 and from it 1 ml was taken after shaking to mix to the test tube labeled 10-3 until the last dilution factor i.e. 10-5 where after mixing I ml is discarded. Serial dilution was done throughout the project processes for each of the sampled collected. All the available samples were processed for microbial isolation in a sterile atmosphere, by swabbing the work bench and lightning a spirit lamp on the table. The following culture media were used: Mac Conkey agar, Nutrient agar, Mannitol salt agar and Blood agar were used. The samples were inoculated on the plates of the different prepared media aseptically using streak method and incubated for 24hours at 37°C. Pure colonies of isolate organisms were identified and characterized using standard microbiological techniques.

Identification of Isolates

The bacterial isolates were identified using colonial, cellular characteristics, Gram Staining, Motility test and biochemical properties. Biochemical test carried out include; Urease test, Citrate Utilization test, Indole test, Methyl-Red test, Coagulase test, Sugar test and Catalase test.

Colonial and Cellular Characteristics

Colonial and cellular characteristics were used in the identification of microbial isolates and they include; Colony's shape, colour, consistency, surface appearances and sizes (diameter in mm)

- Shape or form of the colony (punctiform, circular, irregular, filamentious, rhizoid, spindle)
- Elevation of the colony (flat, convex, pulvinate, umbonate, crateriform)
- Margin of the colony (entire, undulate, lobate, filamentous)
- Pigmentation of the colony (diffusible water soluble or water-insoluble pigments)
- Surface of the colony (smooth, glistening, rough, dull, wrinkled)
- Density of colony (transsparent-clear, opaque, translucent-almost clear, but distorted vision-like looking through frosted glass, iridescent-changes colour in reflected light)

Gram's Staining

This is a differential staining technique. This technique is used to differentiate microorganisms into Gram-positive and Gram-negative. Gram staining method was adopted with the aid of a sterile inoculating wire loop; smears of the isolates were made on clean grease-free glass slides, air-dried and heat-fixed by passing the slides 2 – 3 times over a Bunsen burner flame. Afterwards, each smear was covered with a Crystal violet (primary stain) for 30 seconds and quickly washed off with clean water. The smear was flooded with iodine (mordant) for 60 seconds. After which, they were decolorized with

75% alcohol for 30 seconds, which was washed off quickly with clean and counter stained with safranine for 30 seconds. The safranine stain was washed off quickly with clean water. Back of the slides was wiped and placed in a draining rack to air-dry. The smear was then examined microscopically using the oil immersion objective (X100). Gram positive cells showed purple while gram negative cells showed red colour.

Motility Test

It is used to differentiate between motile and non-motile organisms due to the presence of locomotory structures like flagella. This test was carried out using the stab method. Test tubes of semi-solid motility medium were inoculated by stabbing a sterile straight inoculating needle charged with inoculums from the isolated pure culture vertically into the media and it was incubated at 37^0C for 24hours. Non-motile bacteria produced growths that was un-diffused from the line of stab while motile bacteria produced diffused growth away from the line of stab into the medium and rendered it opaque.

Biochemical Tests

The following biochemical tests were used in identification of the bacteria.

Catalase Test

This is a test used to differentiate catalase producing bacteria like *Staphylococci* from non catalase producing bacteria such as *Streptococci*. The catalase produced acts as a catalyst in the breakdown of hydrogen peroxide to oxygen and water. A drop of 3% hydrogen peroxide was placed on each end of a microscope slide, with the aid of a sterile wire loop, colonies of the test organisms were transferred on to one end of the microscope slide, and the other end was not inoculated but served as a control. The presence of gas bubbles indicates a positive catalase test, while absence of bubbles indicates a negative catalase test.

Citrate Utilization Test

This test is used to identify members of the family *Enterobacteriaceae.* The test is carried out to-demonstrate the use of citrate as a sole source of carbon by alkalinisation of the medium and ammonia as the only source of nitrogen by the bacteria. The test was carried out by inoculating sterilized Simmon's citrate agar with the test organisms using a sterile wire loop and incubating at 37^0C for 48 hours and observing for changes in colour. Positive result shows a change of the medium colour from green colour of to royal blue colour, indicating the presence of citrate utilizing bacteria.

Coagulase Test

The test demonstrates the ability of bacteria to produce coagulase as a defence mechanism, by clotting the area of plasma around it by converting fibrinogen to fibrin, thereby enabling them resist phagocytosis. It is used for the identification of *Staphylococcus aureus*. A drop of distilled water was placed on each end of the microscope slide. A colony of test organism was emulsified in each of the drops of distilled water that was placed on the ends of the microscopic slide, to make thick suspensions. A 100cfu/l of plasma was added to one of the suspension and mixed gently. No plasma was added to the same suspension serving as control. Clumping of the mixture within 10 seconds will indicate positive coagulase test, while absence of clumps within 10seconds indicates a negative result.

Indole Test

Testing for indole production is important in the identification of enterobacteria. The test organism is cultured in a medium which contains tryptophan. Indole production is detected by Kovac's reagent which, contain 4-p-dimethylaminobenzaldehyde; it reacts with the indole to produce a red coloured compound. The test organisms were inoculated in a bijou bottle containing 3ml of sterile tryptone water, which was incubated at 37^0C for 48hrs, after incubation, 0.5ml of kovac's reagent was added, the tubes were gently shaken, and the appearance of a red surface layer within 10mins indicates a positive indole test.

Oxidase Test

The test is used to assist in the identification of *Pseudomonas, Neisseria, Vibrio, Brucella, Pasturella* species, all of which produce the enzyme cytochrome oxidase. A piece of filter paper was soaked with a few drops of oxidase reagent (tetra-ethyl-p-phenylendeamine dihydrochloride). A colony of the test organism was picked with a sterile glass rod and smeared on the filter paper. A blue purple colour develops within a few seconds if the organism is an oxidase producer as a result of the oxidation of the phenylendeamine, while the absence of a blue purple colour indicates a negative result.

Methyl Red/ Voges-Proskauer (Mr/Vp)

This test is used to determine which fermentation pathway is used to utilise glucose. It is used to differentiate bacteria that are capable of fermenting glucose with the production of enough acid to lower the pH of the medium to 4 - 4.5 and that ferment glucose without much acid production. Methyl red contains glucose and peptone. The bacteria isolates were inoculated into 2mls of glucose phosphate (peptone water) and was incubated at 37^0C for 48hours. After the period of incubation, 4 drops of methyl red indicator was added to the tube. The solution was homogenised and observed immediately

for colour change. The appearance of a red colour indicates a positive result while the appearance of a yellow colour indicates a negative result. For Voges-proskauer test, the bacteria isolates were added to 2ml of glucose phosphate (peptone water) and it was incubated at 37^0C for 48hrs, after incubation, 40% KOH and 3ml of 5% alcoholic alpha-naphthol were added, the appearance of a pink colour after 2-5 minutes indicates a positive result.

Sugar Fermentation Test

This test was employed to check for the ability of an organism to ferment sugar. The agar used in this test is called Triple Sugar Iron (TSI). This test engines the ability of the organism to produce gas, Hydrogen sulphide, to ferment Glucose, lactose and sucrose to also ascertain if its Slant and Base are acidic or basic. The agar was sterilized at 121^0C at 15mins. The test organism was inoculated at a slanted test tube. A colour change from pink to yellow indicates the utilization of several sugars. A black duct at the slanted area indicates the presences of H_2S. And also, a gaseous bubble at the bottom or slant of the test tube indicates the presence of gases while displacement in the durham's tube indicates gas production.

Antibiotic susceptibility test

Antibiotic disc sensitivity testing was carried out on each of the bacterial Isolates with the Mueller Hinton agar. Standard paper discs soaked with adequate amount of antibiotics was placed in the Mueller-Hinton agar in this method. After Incubation for 24 hours, antibiotic activity was determined by zone of Inhibition, (No growth) around the antibiotic disc and was measured in millimeters (mm) with a transparent meter rule and a protractor. The susceptibility was carried out for the following antibiotics; Ofloxacin (10µg), Peflacine (10µg) Ceftriaxone (10µg), Amoxicillin (30µg), Gentamycin (10µg), Ciprofloxacin (5µg). Amoxicillin/Clavulanate (10µg) and Ampicillin (30µg). With the aid of 0.1ml of 0.5 McFarland's standard as a turbidity check for a semi confluent growth, these antibiotics were tested after an overnight culture of the isolates on Mueller-Hinton agar. With reference to the Clinical and Laboratory.

Standard Institute (CSL1) performance standard for anti-microbial susceptibility, the organism's susceptibility or resistance pattern to the drugs used was done.

RESULTS

The result shows the bacterial load of the various samples gotten from the door handles of shuttles. The various samples were represented with alphabets A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, S, T and U. The total heterotrophic bacteria count ranged from 3.2×10^1 to 6.0×10^7, the total coliform count for the samples ranged from 1.6×10^1 to 5.0×10^6. The total staphylococcus count for the samples ranged from 6.0×10^2 to 4. 2×106.Total Salmonella Shigella count for the samples ranged from 6.0×10^2 to 6.5×10^6. The research also reveals that the bacterial isolates belong to the Klebsiella spp, Proteus spp, *E.coli,* Pseudomonas spp, Shigella spp and *Staphylococcus aureus.* The percentage occurrence of Klebsiella spp was 17, the percentage occurrence of Pseudomonas spp was 10, the percentage occurrence of Shigella spp was 20, the percentage occurrence of *E.coli* was 23, the percentage occurrence of Proteus spp was 10, while the percentage occurrence of *Staphylococcus aureus* was 13.

Table 1: Bacterial Loads of Door Handles of Bus Imo Cab

SAMPLES	THPC (Cfu/g)	TCC (Cfu/g)	TSC (Cfu/g)	TSSC (Cfu/g)
A	6.0×10^6	2.0×10^5	6.0×10^5	6.0×10^6
B	6.0×10^7	1.0×10^6	4.0×10^6	3.2×10^6
C	7.0×10^6	1.6×10^4	3.5×10^6	6.5×10^6
D	4.5×10^6	2.5×10^6	2.6×10^6	2.0×10^4
E	3.2×10^4	2.0×10^4	4.2×10^6	4.0×10^3
F	2.0×10^6	5.0×10^6	3.4×10^6	6.0×10^6
G	4.2×10^5	4.2×10^4	7.2×10^5	1.0×10^5
H	3.9×10^4	5.2×10^5	8.6×10^5	5.0×10^4
I	4.7×10^5	4.2×10^5	7.6×10^5	4.2×10^6
J	3.2×10^6	7.2×10^4	9.2×10^5	6.0×10^4

THPC= Total Heterotrophic Plate Count
TCC= Total Coliform Count
TSC= Total Staphylococcus Count
TSSC= Total Salmonella Shigella Count

Table 2: Bacterial Loads of Samples of Door Handles of Bus Imo Cab

SAMPLES	THPC (Cfu/g)	TCC (Cfu/g)	TSC (Cfu/g)	TSSC (Cfu/g)
K	6.0×10^3	2.0×10^2	6.0×10^2	6.0×10^3
L	No Growth	No Growth	No Growth	No Growth
M	7.0×10^3	1.6×10^1	3.5×10^3	6.5×10^3
N	4.5×10^3	2.5×10^3	2.6×10^3	2.0×10^1
0	No Growth	No Growth	No Growth	No Growth
P	2.0×10^3	5.0×10^3	3.4×10^3	6.0×10^3
Q	4.2×10^2	4.2×10^1	7.2×10^2	1.0×10^2
R	3.9×10^1	5.2×10^2	8.6×10^2	5.0×10^1
S	4.7×10^2	4.2×10^2	7.6×10^2	4.2×10^3
T	3.2×10^3	7.2×10^1	9.2×10^2	6.0×10^1

THPC= Total Heterotrophic Plate Count
TCC= Total Coliform Count
TSC= Total Staphylococcus Count
TSSC= Total Salmonella Shigella Count

Table 3: Colonial and Morphological Characteristics of Bacterial Isolates

Sample	**Colour**	**Shape**	**Surface**	**Arrangement**	**Probable organism**
1	Yellow	Round	Glassy	Cocci in clusters	Staphylococcus aureus
2	Pink	Irregular	Smooth	Rod	Proteus spp
3	Pink	Raised growth	Smooth and dry	Rods in singles	Eschericia coli
4	Pink	Raised growth	Slimy	Short Rods	Klebsiella spp
5	Greenish	Irregular	Smooth	Rods	Pseudomonas spp
6	Pale	Raised growth	Smooth	Rod	Shigella spp

Table 4: Morphological appearances and biochemical properties of isolated bacteria from the door handles

Isolates	Bacteriological tests		Biochemical tests											Probable organism
	Gram reaction test	Cellular arrangement	Motility test	Catalase test	Citrate test	Indole test	Oxidase test	Coagulase test	Voges Proskuer test	Methyl red test	Glucose test	Lactose test	Sucrose test	
1	-	Rods	+	+	+	-	+	-	-	-	-	-	-	Pseudomonas spp.
2	-	Rod	+	+	-	+	-	-	-	+	+	+	+	Escherichia coli
3	-	Rod	-	+	+	-	-	-	-	+	+	-	-	Shigella spp.
4	+	cocci	-	+		-	-	+	+	+	+	+	+	Staphylococcus aureus
5	-	Rod	+	+	+	-	-	-	+	-	+	+	+	Klebsiella spp.
6	-	Rod	+	+	+	-	-	-	+	-	-	-	-	Proteus spp

Table 5: Frequency of Occurrence of Bacterial Isolates from the Door Handles

ISOLATES	FREQUENCY	PERCENTAGE (%)
Staphylococcus aureus	4	13
Pseudomonas spp	5	17
Eschericia coli	7	23
Proteus spp	3	10
Klebsiella spp	5	17
Shigella spp	6	20
Total	30	100

Antibiotics susceptibility pattern of the isolates from various motor vehicle door handles

Antibiotic pattern of the isolates is shown in Table 3.6 The result indicates that most of the isolates were sensitive to the tested antibiotic. *Pseudomonas aeruginosa,* Proteus species*,* Klebsiella species, *Escherichia coli, Staphylococcus aureus, Shigella spp,* were sensitive to some of the tested antibiotics.

Table 6. Antibiotics susceptibility pattern of the isolates from various motor vehicle door handles

Organism	No tested	Number sensitive (%)							
		OFX	PEF	CN	AU	S	SXT	PN	CPX
Pseudomonas aeruginosa	15	8(61.5)	7(53.8)	1(7.7)	6(46.1)	0(00)	0(00)	8(61.5)	3(23.0)
Proteus species	17	14(82.3)	12(70)	4(23.5)	5(29.4)	2(11.8)	2(11.8)	10(58.8)	4(23.5)
Klebsiella species	4	4(100)	3(75)	2(50)	2(50)	0(00)	0(00)	2(50)	1(25)
Escherichia coli	5	3(60)	3(60)	3(60)	3(60)	0(00)	0(00)	0(00)	1(20)
Staphylococcus aureus	5	3(60)	3(60)	1(20)	2(40)	0(00)	0(00)	1(20)	1(20)
Shigella spp	2	0(00)	1(50)	1(50)	0(00)	1(50)	0(00)	0(00)	0(00)

DISCUSSION

The results of this study show that bus door handles at Imo State University, Owerri Campus, are quite dirty with bacteria. This shows that these surfaces, which are touched a lot, are important for spreading germs. The identification of a vast array of bacterial isolates further illustrates that public transport contact surfaces are perpetually subjected to microbial deposition from a variety of users with differing hygiene habits. The separation of both Gram-positive and Gram-negative bacteria aligns with previous research on environmental contamination of public surfaces, which has documented analogous microbial diversity in high-contact locations such as door handles, benches, mobile devices, and public toilets [11]. This indicates that these habitats offer conducive circumstances for microbial survival and transmission, particularly in areas characterised by significant human activity and inadequate sanitation oversight.

The prevalence of Escherichia coli and Shigella spp. in this study is particularly noteworthy, given these organisms are frequently linked to faecal contamination. Their appearance on bus door handles indicates a probable failure in personal hygiene habits, particularly insufficient handwashing following the use of toilet facilities or the handling of contaminated objects. This finding suggests that commuters can unknowingly spread gastrointestinal germs to surfaces that many people touch, which would help them spread through the population. These types of organisms are well-known causes of gastrointestinal diseases, such as diarrhoea and dysentery. When they exist on public transport surfaces, the danger of outbreaks goes up, especially in crowded areas. This finding is consistent with earlier studies that show that fecal-oral transmission channels are still a major cause of diseases that people get in underdeveloped areas [12].

The isolation of Staphylococcus aureus underscores the significance of dermal touch in surface contamination. Staphylococcus aureus is a common bacterium that lives on the skin and in the nasal cavity. It is often passed from person to person by direct contact. The fact that it is on the handles of bus doors means that it is constantly being contaminated by passengers who touch it over and over again. This observation aligns with the report of [13], which indicated that high-touch surfaces are often colonised by skin-associated bacteria due to continuous human interaction. S. aureus is usually innocuous when it is part of normal flora, but other strains can cause a lot of different illnesses, such as wound infections, abscesses, respiratory tract infections, and in really bad cases, systemic disorders. Consequently, its presence on public surfaces is a significant public health issue, especially for immunocompromised patients.

Finding both environmental and opportunistic diseases like Pseudomonas spp. and Klebsiella spp. shows even more how diverse the bacteria on bus door handles are. These organisms are known for being able to live in difficult environments

and are often linked to infections that happen in hospitals. The fact that these germs are found in community settings shows that they are not only found in hospitals but also in many other places. This supports the notion that public transport systems may function as reservoirs and transmission vectors for clinically significant microorganisms [14, 15].

The identified antibiotic resistance pattern among the isolates is of particular significance in our investigation. The diminished susceptibility and heightened resistance to frequently utilised antibiotics, including Ampicillin and other beta-lactam medicines, indicate an escalating public health concern. Antibiotic resistance in environmental isolates is particularly concerning as these organisms can serve as repositories for resistance genes, potentially facilitating their transfer to more virulent strains via horizontal gene transfer [16]. This occurrence complicates treatment alternatives for community-acquired infections and heightens the chance of therapeutic failure. The presence of resistant organisms in public spaces may indicate the prevalent misuse and overuse of antibiotics in human medicine, self-medication, and insufficient treatment protocols, particularly in many developing regions [17].

The prevalence of antibiotic-resistant bacteria on often touched public surfaces, including bus door handles, shows how important it is to keep the environment clean to stop the spread of resistant bacteria. It also shows how important it is to do surveillance studies that look at both microbial contamination and resistance tendencies in community settings. These data are critical for directing public health measures and supporting antibiotic stewardship initiatives designed to mitigate the dissemination of resistance pathogens.

In general, the results of this study show that bus door handles in the study area are not only polluted with a variety of harmful bacteria, but they may also be places where antibiotic-resistant organisms can live [19]. This circumstance presents a considerable public health threat, especially in a densely populated university setting where frequent human interaction and mobility enhance the probability of pathogen transmission [20].

CONCLUSION

The findings of this investigation unequivocally demonstrate that bus door handles at Imo State University Campus are significantly infected with various potentially harmful germs. The presence of both intestinal and skin-associated organisms underscores the significance of these surfaces as critical conduits for microbial transmission. Additionally, finding antibiotic-resistant isolates makes people even more worried about the possibility of hard-to-treat illnesses spreading in the population. In general, these results show that bad hygiene in the environment and not washing your hands properly are big risks to public health. To lower the danger of infections spreading on public transport, it is important to have good control measures in place. These include regularly disinfecting high-contact surfaces and making people more aware of how to keep themselves clean.

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