

**Investigation of the Multidrug Resistance Pattern of Bacteria Isolated from Car and Office
Door Handles in a Tertiary Institution**

UNDER PEER REVIEW

Abstract

Multidrug-resistant bacteria have posed a public health concern over the years, especially with the difficulty and cost of treatment of infections they cause. Fomites such as door handles are thus potent means through which pathogens are transmitted from one person to another as contact with them is made. This study thus involves isolating antibiotic-resistant bacteria from car and office door handles in a university environment. Using the simple random sampling method, twenty samples (20) from car door handles and twenty samples (20) from office door handles were collected, the isolation of bacteria was done using standard microbiological procedures and identification of the isolates was done using cultural, microscopic and biochemical characterization. Determination of the antibiotic sensitivity pattern of the isolates was done using the Kirby-Bauer disc diffusion method on Muller Hinton agar. Antibiotics used included Ofloxacin (5 µg), Gentamicin (10 µg), Ceftriaxone (30 µg), Augmentin (30 µg), Ciprofloxacin (5 µg), Erythromycin (5 µg), Streptomycin (30 µg) and Cloxacillin (30 µg). The results showed a significant frequency of occurrence of *Staphylococcus aureus* at 35% and *Klebsiella pneumoniae* having least at 5%. From car door handles, *S. epidermidis* recorded 37% while *K. pneumoniae* recorded the least with 17.4%. The isolates exhibited resistance to antibiotics including Augmentin and Ceftriaxone (≤ 22 mm) while they were more susceptible to Ofloxacin (≥ 16 mm). All the *K. pneumoniae* isolated from car door handles exhibited resistance to Augmentin and Ceftriaxone. These results show that these surfaces could be a possible reservoir of infections caused by resistant bacteria, leading to difficulty in the treatment of infections caused by them.

Keywords: antibiotics, bacteria, car door handles, multidrug resistance, office door handles, public health

1. Introduction

Microorganisms are found in every environment including inanimate objects and surfaces since they are able to survive different environmental conditions. Research has shown the presence of bacteria on various surfaces including door handles of toilets and commercial buses, thus serving as a reservoir of potential pathogenic microorganisms [1]. Thus, a major route through which microorganisms are transmitted is through fomites as they could survive on inanimate objects as transient contaminants, which could cause community-acquired infections [2]. The role of fomites in the transmission of microorganisms has been studied widely [3].

Of all the human organs, the hands are often more exposed to environmental contamination which makes them a means for transmitting microorganisms from one person to another as they are able to harbour transient microbes [4]. Sometimes, the organisms are from the human skin as normal flora while other times, they may have been deposited through air. Common among these transient environmental microorganisms are *Micrococcus* spp., *Corynebacterium* spp., *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Klebsiella* spp., *Escherichia coli* and *Pseudomonas aeruginosa* [5].

A major challenge is the multiple antibiotic resistance exhibited by these microbes when they cause diseases, which makes treatment difficult and expensive and reduces the treatment options [6,7]. This has become a public health concern as it keeps spreading resulting in little

success in treating and preventing diseases [8]. This serves as a threat to treating patients successfully resulting in the call for novel treatment options, relevant antibiotic prescription and continual surveillance. The increased prevalence of bacterial drug resistance has been largely associated with the inappropriate consumption of antibiotics in communities [9].

Most studies have focused on door handles of health facilities such as hospitals and medical laboratories and there is limited data on door handles in tertiary institutions. However, the study aimed to investigate the presence of multi-drug resistant bacteria in car and office door handles in a tertiary institution in Lagos, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Design and Area

The study was a cross-sectional laboratory-based one where swab sticks were used to collect samples from car and office door handles that had been in use. Doors that had been locked for more than a month were excluded since they would have minimal contamination. The study was carried out in May 2023. Twenty (20) samples were collected from car door handles and another twenty (20) from office door handles within a tertiary institution in Lagos, Nigeria.

2.2 Sample Collection and Isolation of Bacteria

Sterile cotton swabs moistened with sterile peptone water were used for the collection of samples from both the internal and surfaces of the door handles. Samples were relabelled appropriately and immediately transported to the Microbiology Laboratory for analysis. Samples were streaked on Nutrient Agar, an all-purpose medium and MacConkey Agar used to differentiate between lactose and non-lactose fermenting bacteria. Inoculated plates were incubated at 37 °C for 18 to 24 hrs. Gram's staining and biochemical tests including sugar fermentation, catalase, coagulase, Simon's citrate, urease and oxidase tests were carried out to identify pure bacterial cultures to species level.

2.3 Antibiotic Sensitivity Testing

Sensitivity testing was done as described by Bauer *et al.* using the disc diffusion method [10]. Using a sterile swab stick, an inoculum size equivalent to 0.5 McFarland standard was inoculated on Mueller Hinton agar and allowed to sit for 15 mins. After which, the test discs were placed on the plates and incubated at 37 °C for 18 to 24 hrs. Using the CLSI chart, isolates were termed resistant or susceptible based on the diameter of the zones of inhibition (mm). Antibiotics tested included Ofloxacin, Gentamicin, Ceftriaxone, Erythromycin, Augmentin, Cloxacillin, Ciprofloxacin, and Streptomycin.

3. RESULTS

From the forty (40) samples, eighty-six (86) isolates were obtained. Biochemical characterization revealed the presence of *Staphylococcus aureus*, *S. epidermidis*, *Bacillus* sp. and *Klebsiella pneumoniae*. Forty (40) isolates were obtained from the car door handles while forty-six (46) were obtained from office door handles. The car door handles were more contaminated with *Staphylococcus aureus* (35%), while the office door handles were contaminated more by

Staphylococcus epidermidis (37%). The least contaminant from both samples was *K. pneumoniae* with 5% and 17.4% for car and office door handles, respectively (Table 1).

The multiple antibiotics sensitivity testing of the isolates showed that *K. pneumoniae* isolated from door handles exhibited 100% resistance to Ceftriaxone and Augmentin while they were all susceptible to Gentamicin and Cloxacillin. A high level of resistance to Augmentin was observed among the isolates with *S. aureus* from car and office door handles recording 78.6% and 90.9% resistance, respectively. The isolated bacteria were largely susceptible to Ofloxacin and Gentamicin with *Bacillus* sp. from car and office door handles recording 16.7% and 40.0% resistance, respectively and *S. aureus* from car and office door handles recording 14.3% and 36.4% resistance, respectively.

Based on the definition of multidrug resistance (MDR), amicroorganism is said to exhibit MDR when it is resistant to three (3) or more drug classes. Most of the isolated bacteria from the car door handles exhibited resistance to mainly Ceftriaxone (Cephalosporin), Augmentin (Penicillin), and Erythromycin (Macrolide).

Table 1: Occurrence of Bacterial Isolates from the Samples

Bacteria	Car door handles		Office door handles	
	Frequency(n)	Percentage(%)	Frequency(n)	Percentage(%)
<i>Staphylococcus aureus</i>	14	35	11	23.9
<i>Staphylococcus epidermidis</i>	12	30	17	37
<i>Bacillus</i> sp.	12	30	10	21.7
<i>Klebsiella pneumoniae</i>	2	5	8	17.4
Total	40	100	46	100

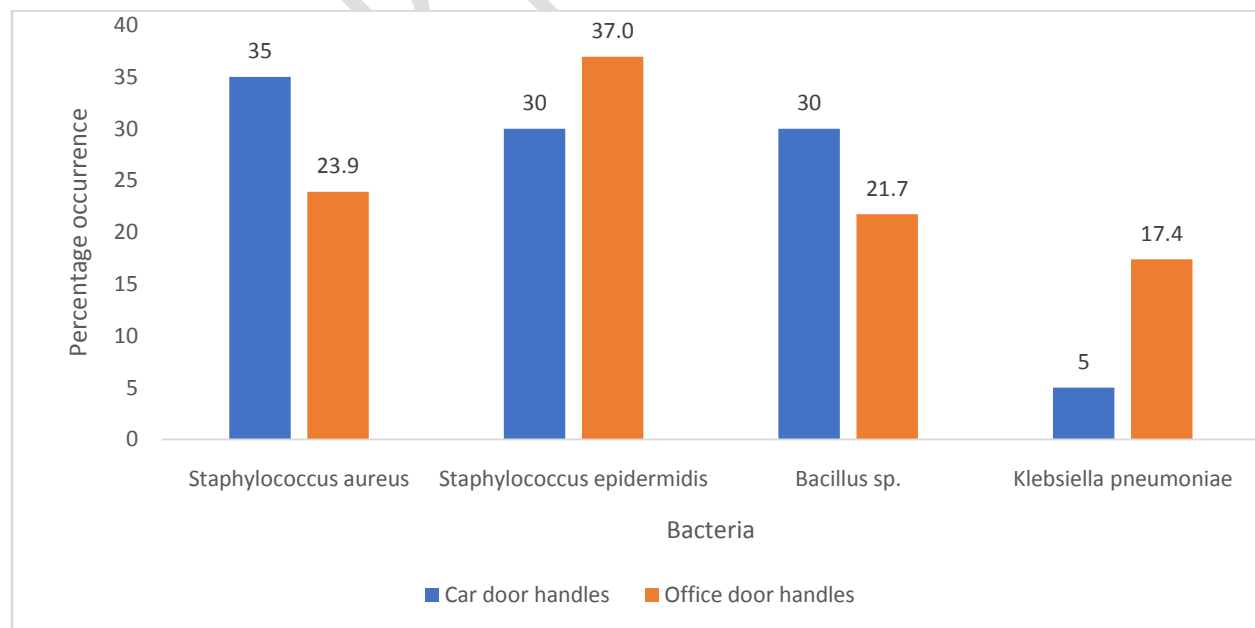
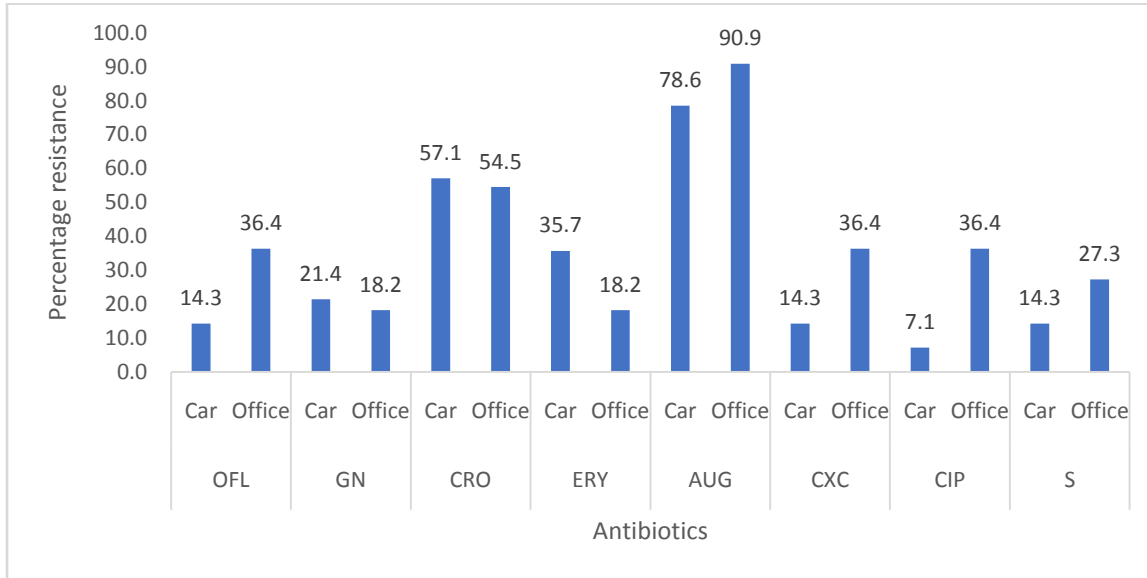
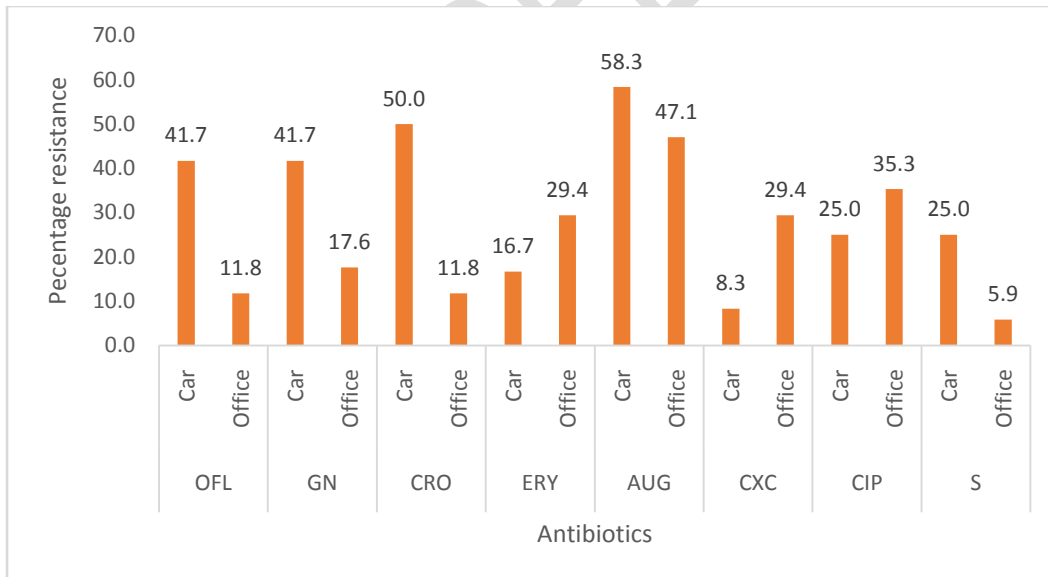


Figure 1: Percentage Occurrence of Isolates in Car and Office Door Handles



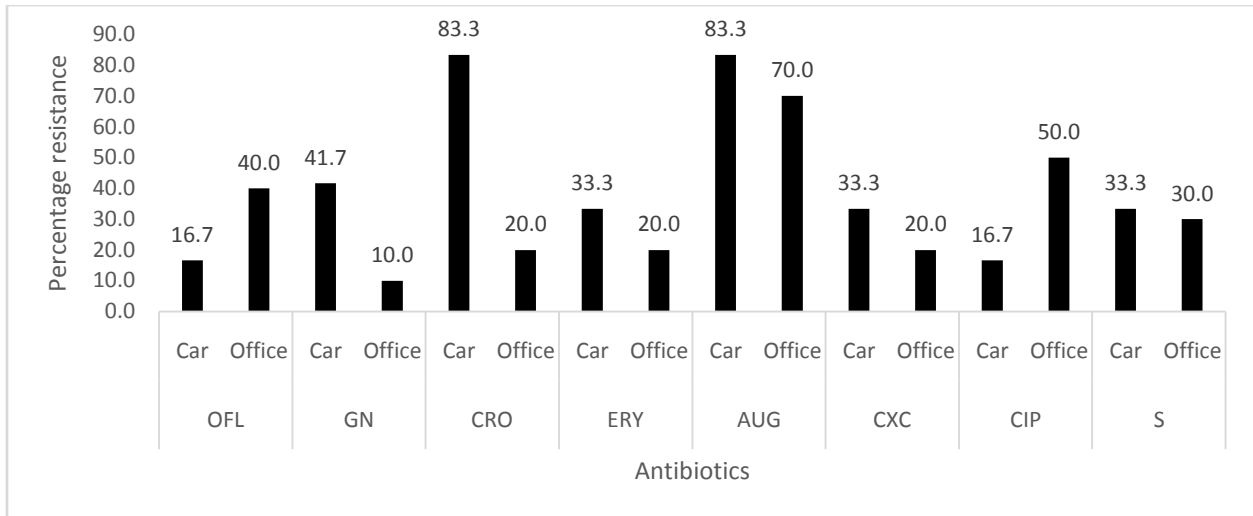
Key: OFL=Ofloxacin, GN=Gentamicin, CRO=Ceftriaxone, ERY=Erythromycin, AUG=Augmentin, CXC=Cloxacillin, CIP=Ciprofloxacin, S=Streptomycin

Figure 2: Percentage Resistance of *Staphylococcus aureus* to Multiple Antibiotics



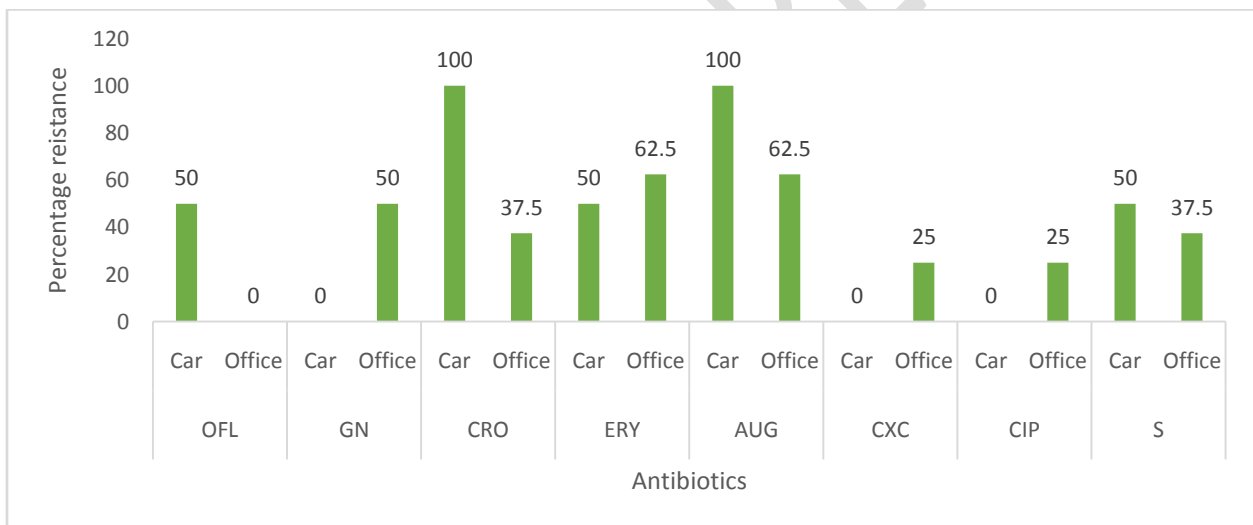
Key: OFL=Ofloxacin, GN=Gentamicin, CRO=Ceftriaxone, ERY=Erythromycin, AUG=Augmentin, CXC=Cloxacillin, CIP=Ciprofloxacin, S=Streptomycin

Figure 3: Percentage Resistance of *Staphylococcus epidermidis* to Multiple Antibiotics



Key: OFL=Ofloxacin, GN=Gentamicin, CRO=Ceftriaxone, ERY=Erythromycin, AUG=Augmentin, CXC=Cloxacillin, CIP=Ciprofloxacin, S=Streptomycin

Figure 4: Percentage Resistance of *Bacillus sp.* to Multiple Antibiotics



Key: OFL=Ofloxacin, GN=Gentamicin, CRO=Ceftriaxone, ERY=Erythromycin, AUG=Augmentin, CXC=Cloxacillin, CIP=Ciprofloxacin, S=Streptomycin

Figure 5: Percentage Resistance of *Klebsiella pneumoniae* to Multiple Antibiotics

4. DISCUSSION

All the samples showed bacterial growth at various frequencies; however, more organisms were isolated from office door handles. This can be associated with the traffic and the number of persons with different hygiene backgrounds that open those doors daily as well as the temperature and humidity of the environment[2]. This poses a public health risk as there could be a transfer of resistant pathogenic bacteria strains between staff, students and visitors. Ayuba *et al.* had earlier noted that some academic institutions may not have properly trained cleaners and in some

cases, the cleaners lack materials such as disinfectants needed to adequately carry out their jobs which results in a high rate of contamination [11].

Most of the isolates were Gram-positive bacteria, which is in accordance with the studies by Al-Harbi *et al.* and Al-Harmoosh *et al.* who isolated similar groups of bacteria from door handles [12,13]. Previous studies have shown that *Bacillus* sp. and *Staphylococcus aureus* are among the 5 most commonly isolated bacteria from door handles [2,14,15]. The presence of *Bacillus* sp. on solid surfaces such as door handles has been related to their ability to form spores under unfavourable environmental conditions which can survive for longer periods [16]. The isolation of Gram-positive cocci such as *S. aureus* could be related to their role as normal flora of the human skin and nostrils [17]. *S. aureus* is known for its ability to cause infections such as endocarditis, meningitis, osteomyelitis and abscesses which makes it a potential pathogenic bacterium [18].

The results from this study indicate that *Staphylococcus aureus* was common in car door handles (35%), *S. epidermidis* was common in office door handles (37%) while *Klebsiella pneumoniae* was least isolated from both samples. The isolation of coagulase-negative *Staphylococci* and *Klebsiella* sp. had earlier been reported by Nwankwo and Chinyeaka as well as Iskander *et al.* from vehicle door handles [19,5]. Both *Staphylococcus* spp. isolated are the skin's normal flora which could have accounted for their high occurrence [18]. The isolation of *S. aureus* and *Bacillus* sp. in this study was also reported by Odigie *et al.* [20]. The presence of these bacteria in door handles has also been reported by Ayuba *et al.* who attributed their presence to hand-to-hand and skin contact with these door handles [11].

All the isolated bacteria exhibited multiple resistance to the tested antibiotics from different classes except *K. pneumoniae* isolated from office door handles which were susceptible to ofloxacin and those from car door handles which were also susceptible to Ciprofloxacin, Gentamicin and Cloxacillin. The susceptibility of bacteria especially *S. aureus*, to Gentamicin, has been reported in previous studies [21,22]. The route of administration of gentamicin (parenteral) may have contributed to the reduced rate of abuse of the drug and subsequently low resistance rate unlike those administered through the oral route [22]. Similarly, the resistance of *S. aureus* to Cefuroxime was reported by Apenten *et al.* in their study on door handles in a health facility [23]. Resistance of bacteria from environmental sources to Cefuroxime and Augmentin has also been reported by Azuonwu and Ogbonna [23]. This calls for the need to educate the public on the danger of continually consuming antibiotics without proper diagnosis and following doctor's prescription.

5. CONCLUSION

This study showed the presence of *Staphylococcus aureus*, *S. epidermidis*, *Bacillus* sp. and *Klebsiella pneumoniae* in swab samples collected from car and office door handles in a tertiary institution. The isolates showed varied resistance to the antibiotics tested including Augmentin and Ceftriaxone but were susceptible to fluoroquinolones such as Ofloxacin. Strict environmental and personal hygiene within the office environments is thus needed, as this will avoid or reduce the proliferation of microorganisms. Public awareness programmes in the form of, workshops and lectures could help alert the public on the possible health risks associated with surfaces of office and car door handles and also the importance of carrying out proper personal

hygiene such as washing hands and moderate use of disinfectants as preventive measures. These office door handles are cleaned daily, however, because different persons come in contact with them, it is important to clean and disinfect them more than once during working hours to prevent cross-contamination. Disinfection of these surfaces will reduce contamination of the school environment with resistant bacteria.

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