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

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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.

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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 labelled 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 ^{0}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 ^{0}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), a microorganism 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 (%)
Staphylococcus aureus	14	35	11	23.9
Staphylococcus epidermidis	12	30	17	37
Bacillus sp.	12	30	10	21.7
Klebsiella pneumoniae	2	5	8	17.4
Total	40	100	46	100

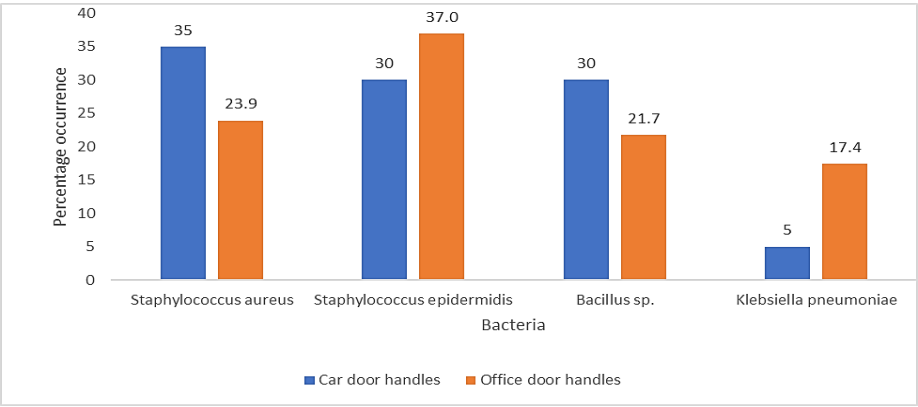

Fig. 1. Percentage occurrence of isolates in car and office door handles

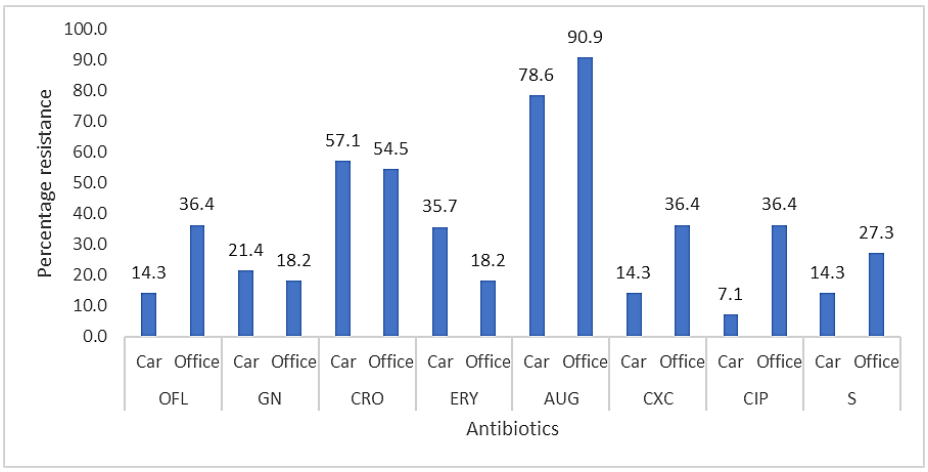

Fig. 2. Percentage resistance of *staphylococcus aureus* to multiple antibiotics
Key: OFL=Ofloxacin, GN=Gentamicin, CRO=Ceftriaxone, ERY=Erythromycin, AUG=Augmentin, CXC=Cloxacillin, CIP=Ciprofloxacin, S=Streptomycin

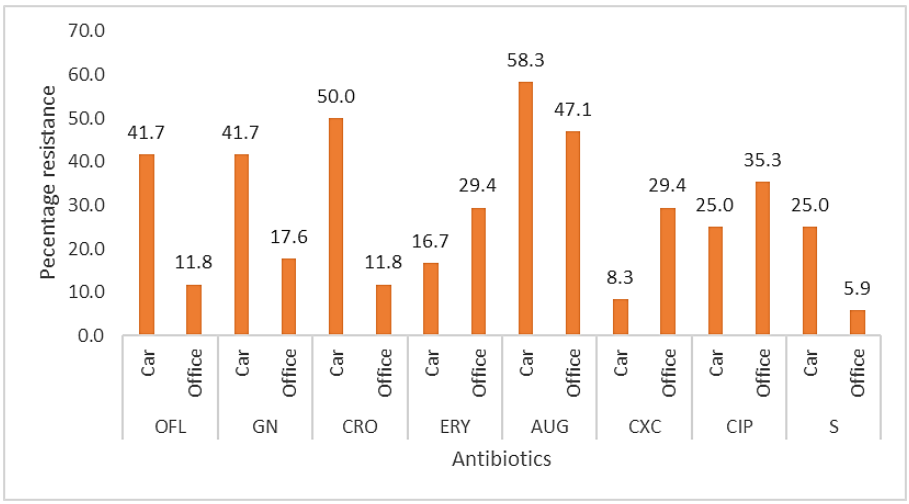

Fig. 3. Percentage resistance of *Staphylococcus epidermidis* to multiple antibiotics
Key: OFL=Ofloxacin, GN=Gentamicin, CRO=Ceftriaxone, ERY=Erythromycin, AUG=Augmentin, CXC=Cloxacillin, CIP=Ciprofloxacin, S=Streptomycin

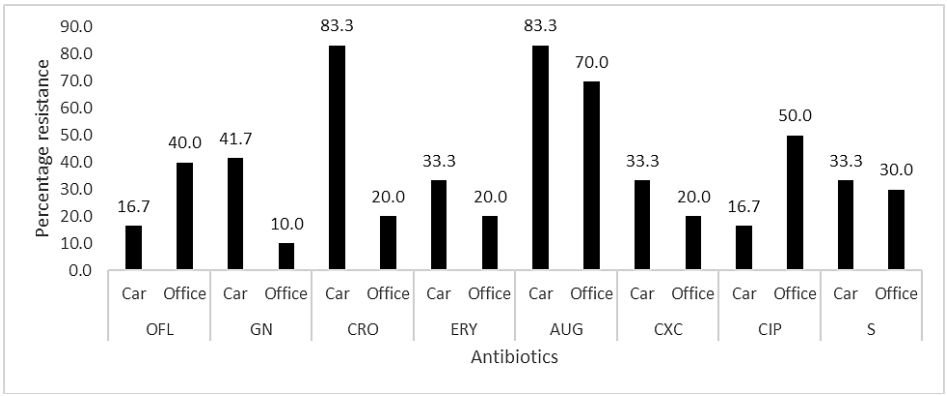

Fig. 4. Percentage resistance of *Bacillus* sp. to multiple antibiotics
Key: OFL=Ofloxacin, GN=Gentamicin, CRO=Ceftriaxone, ERY=Erythromycin, AUG=Augmentin, CXC=Cloxacillin, CIP=Ciprofloxacin, S=Streptomycin

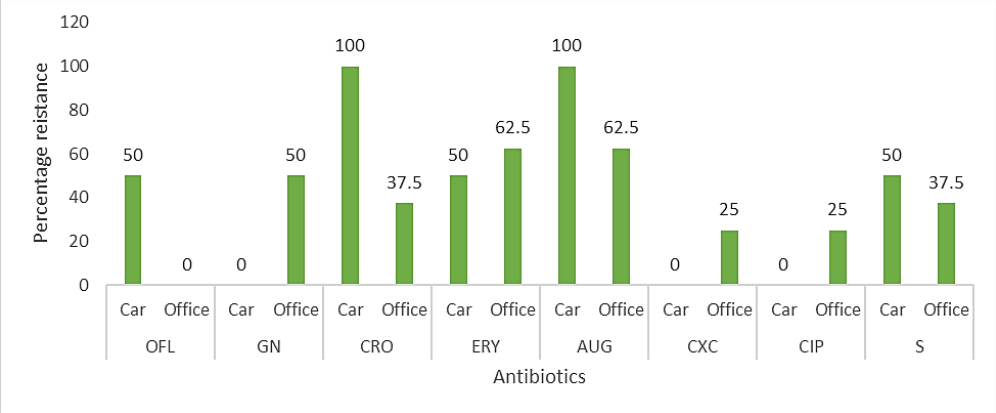

Fig. 5. Percentage Resistance of *Klebsiella pneumoniae* to Multiple Antibiotics
Key: OFL=Ofloxacin, GN=Gentamicin, CRO=Ceftriaxone, ERY=Erythromycin, AUG=Augmentin, CXC=Cloxacillin, CIP=Ciprofloxacin, S=Streptomycin

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 days 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 Apenteng 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Nwankwo EO, Chinyeaka HA. Isolation and identification of bacterial contaminants from door handles in a tertiary institution in Umuahia, Abia State, Nigeria. Nigerian Society of Microbiology. 2015;29:3139-3147
2. Otukunefor K, Famakin BO, Douglas DO. Assessment of door handles as potential reservoirs of drug-resistant enterococci. Bulletin of the National Research Centre. 2020;44:203.
3. Xiao S. The role of fomites in disease spread and the transmission characteristics. HKU Theses Online (HKUTO); 2018.
4. Dodrill L, Schmidt WP, Cobb E, Donachie P, Curtis V, De-Barra M. The effect of hand washing with water or soap on bacterial contamination of hands. International Journal Environmental Public Health Resource. 2011;8(1):97–104.
5. Iskandar S, Saif A, Nawas T. Isolation of potentially pathogenic bacteria from public service cars door handles. International Journal of Current Microbiology and Applied Sciences. 2018;7(12):1154-1159.
6. Chatterjee M, Anju CP, Biswas L, Kumar VA, Mohan CG, Biswas R. Antibiotic resistance in Pseudomonas aeruginosa and alternative therapeutic options. International Journal of Medical Microbiology. 2016;1(306):48-58.
7. Ogbonna DN, Azuonwu TC. Plasmid profile and antibiotic resistance pattern of bacteria from abattoirs in Port Harcourt City, Nigeria. International Journal of Pathogen Research. 2019;2(2):1-11.
8. Muluye D, Wondimeneh Y, Ferede G, Nega T, Adane K, Biadgo B, Tesfa H, Moges F. Bacterial isolates and their antibiotic susceptibility patterns among patients with pus and/or wound discharge at Gondar university hospital. BMC Res Notes. 2014;9(7):619. DOI:10.1186/1756-0500-7-619 .
9. Yevutsey SK, Buabeng KO, Aikins M, Anto BP, Biritwum RB, Frimodt-Møller N, Gyansa-Lutterodt M. Situational analysis of antibiotic use and resistance in Ghana: policy and regulation. BMC Public Health. 2017;17:896.
10. Bauer AW, Kirby WM, Sherris JC, Turck M. Antibiotic susceptibility testing by a standardized single disk method. Am J Clin Pathol. 1996;45(4):493-496.
11. Ayuba L, Suwange MP, Enefiok UO. Bacterial contamination of door handles/knobs in gombe state university, Nigeria. International Journal of Modern Science and Technology. 2019;4(8):204-211.
12. Al-Harbi M, Anderson A, Elmi A. Evaluation of microbial contamination in frequently used Fomites in Kuwait. Biodivers Int J. 2017;1(3):80–86.
13. Al-Harmoosh RA, Eidan AJ, Al-Hadrawy HA, Mohammed QA, Hamed AQ. Potential bacterial contaminants in the handles of car doors. J Pure Appl Microbiol. 2018; 12(4):2193–2198.
14. Alonge OO, Auwal BM, Aboh MI. Bacterial contamination of toilet door handles on Baze University campus Abuja Nigeria. Afr J Clin Exp Microbiol. 2019;20(1):35–41.

15. Moshi AA, Kyarab EC, Mabulab PL, Urokib EC, Kajegukaa *DC*, Mkumbaye SI. Proportions of pathogenic bacteria isolated from door locks and working benches in clinical laboratory: A laboratory based study. East African Health Research Journal. 2022;6(1):106-122.
16. Al-Harmoosh RA, Eidan AJ, Al-Hadrawy HA, Mohammed QA, Hamed AQ. Potential bacterial contaminants in the handles of car doors. J Pure Appl Microbiol. 2018; 12(4):2193–2198.
17. Nwankwo EO, Okey-kalu EU, Eze FA. Bacterial contamination of door handles of commercial buses in Umuahia Metropolis Abia State. Suan Sunandha Science and Technology Journal. 2022; 10(1):54-61.
18. Tong SYC, Davis JS, Eichenberger E, Holland TL, Fowler VG Jr. *Staphylococcus aureus* infections: Epidemiology, pathophysiology, clinical manifestations, and management. Clinical Microbiology Reviews. 2015;28(3):603-61.
19. Nwankwo EO, Chinyeaka HA. Isolation and identification of bacterial contaminants from door handles in a tertiary institution in Umuahia, Abia State, Nigeria. Nigerian Society of Microbiology. 2015;29:3139-3147.
20. Odigie AB, Ekhiase FO, Orjiakor PI, Omozuwa S. The role of door handles in the spread of microorganisms of public health consequences in University of Benin Teaching hospital (UBTH), Benin city, Edo state. Pharm Sci Technol. 2017;2(2):15–21.
21. Onwubiko NE, Chinyeaka AH. Isolationand identification of bacterial contaminants from door handles in a tertiary institution in Umuahia, Abia State, Nigeria. Nigerian Journal of Microbiology. 2015;29:3139-3147.
22. Apenteng JA, Yeboah EEA, Kyere-Davies G. Antibiotic susceptibility of bacteria isolates from ward environment of a hospital in Tema, Ghana. African Journal of Microbiology Research. 2022;16(6):211-216.
23. Azuonwu TC, Ogbonna DN. Resistant genes of microbes associated with abattoir wastes. Journal of Advances in Medical and Pharmaceutical Sciences. 2019;21(2): 1-11.

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