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ENUMERATION AND ANTIBIOGRAM OF BACTERIA ON DOOR HANDLES

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ABSTRACT

Frequent contact with public surfaces such as door handles has been identified as a potential source of microbial transmission, posing significant public health risks. This study was conducted to assess the microbial contamination of door handles from selected hostels, laboratories, and offices within the University of Port Harcourt environment. Samples were collected using sterile swab sticks moistened with physiological saline and cultured on Nutrient Agar for the isolation of bacteria. Distinct colonies were identified based on morphological and biochemical characteristics. The results revealed that hostels had the highest microbial load (1.42×10^5 CFU/mL), followed by laboratories (1.09×10^5 CFU/mL) and offices (8.9×10^4 CFU/mL). Bacterial isolates identified included *Staphylococcus sp.*, *Escherichia coli*, *Bacillus sp.*, *Pseudomonas sp.*, and *Klebsiella sp.*, Antimicrobial susceptibility testing showed that *S. aureus* and *E. coli* exhibited high resistance to ampicillin and cotrimoxazole but were sensitive to ciprofloxacin and gentamicin. The findings indicate that door handles serve as reservoirs for pathogenic and potentially multidrug-resistant microorganisms, emphasizing the role of poor hygiene and environmental exposure in cross-contamination.

INTRODUCTION

Background to the study

Door handles are among the most frequently touched surfaces in public and institutional settings, such as hospitals, schools, offices, and marketplaces. This constant human interaction makes them ideal sites for microbial contamination, where microorganisms like bacteria and fungi can accumulate and survive. Microorganisms are tiny living organisms that are invisible to the naked eye, including bacteria (single-celled organisms that can cause infections). These microbes can be transferred from one person to another through contact, potentially leading to infections, especially in crowded places where large numbers of people gather (Kramer et al., 2006; Otter & French, 2019).

In everyday life, people touch door handles multiple times without realizing they might be picking up or leaving behind harmful germs. For example, someone with unwashed hands after using the restroom could transfer bacteria like *Escherichia coli*, which is often associated with fecal matter and can cause stomach illnesses. Similarly, fungi such as *Aspergillus* species, which are common in the air, can settle on these surfaces and pose risks to people with weakened immune systems, leading to respiratory problems (Pfaller & Diekema, 2017). In Nigeria, studies have shown high levels of bacterial contamination on door handles in universities and public toilets, with common isolates including *Staphylococcus aureus* and *E. coli*, highlighting local hygiene challenges (Otokunefor et al., 2023; Gana et al., 2025).

Surfaces like door handles are often overlooked in routine cleaning because they may not appear dirty. However, visible cleanliness does not mean they are free from microbes. In many developing countries, including Nigeria, public awareness about the importance of disinfecting these high-touch surfaces is low, and cleaning protocols may not be strictly enforced. This allows microbes to build up and persist, creating an environment where they can easily spread (Weber & Rutala, 2013). Fomites, which are inanimate objects that can carry infectious agents, play a key role in this transmission. Door handles are classic examples of fomites, acting as bridges for pathogens between individuals. A global systematic review found an overall microbial contamination rate of about 10% on door handles, with higher rates in toilets (23%) and hospitals (10.8%), underscoring the issue in both public and healthcare settings (Al-Harbi et al., 2025).

Studies worldwide have identified harmful bacteria on door handles, including *Staphylococcus aureus* (a common cause of skin infections), *Escherichia coli*, *Pseudomonas aeruginosa* (which can infect wounds), and *Klebsiella* species (often linked to pneumonia). These microorganisms pose greater risks to vulnerable groups, such as the elderly, children, pregnant women, and those with compromised immune systems, like patients undergoing chemotherapy. In Nigerian contexts, recent research in Gombe State University and Madonna University reported bacterial loads on door handles, with isolates showing resistance to common antibiotics, emphasizing the need for localized interventions (Gana et al., 2025; Okoro et al., 2024).

Statement of the problem

Despite increased focus on hygiene, door handles in public facilities remain key reservoirs for microbial contamination. Limited local research on contamination levels and resistance patterns leaves gaps in infection control, particularly in developing regions like Nigeria. This study addresses these by quantifying microbes and analyzing resistance. Current disinfection often prioritizes appearance over microbiological safety, allowing pathogens to persist due to inadequate techniques (Weber & Rutala, 2013). For example, in busy hospitals, inconsistent cleaning can lead to HAIs, costing lives and resources. Globally, AMR exacerbates this, with resistant strains spreading via fomites (WHO, 2014). In Port Harcourt, Nigeria, recent studies show high bacterial prevalence on hospital handles, but fungal data is scarce, underscoring the need for comprehensive surveillance (Otokunefor et al., 2023). In other Nigerian universities, contamination rates vary, with parasites and bacteria found on office doors, indicating broader environmental risks (Akpan et al., 2021). Without such data, hygiene interventions remain ineffective, risking public health.

Significance of the study

This research provides essential data on microbial contamination and resistance, aiding public health initiatives to reduce infections. Findings can inform enhanced cleaning protocols, such as using antimicrobial coatings or frequent disinfection, in institutions like hospitals and schools (Weber & Rutala, 2013). It contributes to AMR prevention by

highlighting resistance trends, guiding antibiotic policies (WHO, 2014). Locally, in Nigeria, it supports targeted interventions in high-risk areas, potentially reducing HAIs and community outbreaks. Broader impacts include raising awareness, influencing policy, and serving as a reference for future studies in similar settings.

MATERIALS AND METHODOLOGY

2.1 Study Area

Samples were collected from door handles in selected buildings within the University of Port Harcourt, including Goodluck Jonathan hostel, selected laboratories (Chemistry, General Microbiology and Physic labs) and offices in the Faculty of Science building.

2.2 Study Design

This study was designed to isolate, enumerate and characterize bacteria from door handles. The study also investigated antimicrobial susceptibility patterns among bacterial isolates.

2.3 Sample Collection Procedure

A total of 20 samples (10 from hostels, 5 from offices, and 5 from laboratories) were collected using sterile swab sticks moistened with 1ml normal saline. Swabs were taken from an area of 5cm³ of each door handles and transported to the laboratory for microbial analysis. (Cheesbrough, 2006).

2.4 Preparation of Culture Media

Commercially available nutrient media, muler hiton agar and Mafarland standard was used for isolation, of bacteria

2.5 Serial Dilution of Samples

One milliliter (1ml) of normal saline added to the swab stick was diluted in 9ml of normal saline and continued ten-fold serial dilution was done up to 10^{-4} using normal saline, with 9ml of normal saline in each test tubes. Serial dilution was done by using a sterile pipette to transfer 1ml from the stock culture into test tube 10^{-1} . Subsequent dilutions were done aseptically using sterile syringes.

2.6 Isolation of Microorganisms

From the prepared diluents, 0.1ml of selected dilutions were transferred into sterile Petri plates containing the different media used and was spread gently using sterile glass rod. The plates were incubated at 37°C for 18-24 h for the bacteriological media used for bacteria growth and potato dextrose agar for fungi isolation.

2.7 Identification and Characterization of Isolates

2.7.1 Examination of bacteria

Isolates were identified based on their cultural morphology on growth media which include colony size, colour, opacity, consistency, colony pigmentation, elevation, odour, swarming) and biochemical characteristics, using standard protocols according to (Cheesebrough, 1991).

2.7.3 Gram Staining

Gram staining was carried out to differentiate between Gram positive and negative organisms. A smear was made on the glass slide using a sterile wire loop to pick a drop of distilled water and placed on the slide, the wire loop was sterilized again by flaming and an inoculum was picked and placed on the slide and heat fixed by passing the slide over the Bunsen burner flame. The slide was flooded with crystal violet (primary stain) for 60 sec.

rinsed with water to wash unbound dye. Gram's iodine (mordant) was added for another 60 sec. and rinsed with water after which the decolourizing solvent (95% alcohol) was added for 3-5 sec. to remove unbound dye and immediately rinsed with water followed by the addition of safranin for counterstaining (secondary stain) for another 30 sec. and rinsed with water. Excess stain was wiped off from the slide using cotton wool. The slide was air dried and examined under the oil immersion objective of the microscope.

2.8 Biochemical Tests

The identities of the isolates were confirmed using biochemical tests. The tests carried out include indole, catalase, methyl- red production, voges-proskauer reaction, motility, citrate and urease activity, triple sugar iron agar test (TSIA) and sugar (Lactose, fructose, and glucose) fermentation tests for all isolates.

Data Analysis

Data obtained was analyzed using description statistics where variables were summarized using frequencies and percentages.

RESULTS

3.1 Total Heterotrophic Bacteria Counts Obtained from Hostel Door Handles Studied

The total heterotrophic bacteria counts on door handles obtained from Goodluck Jonathan hostel showed counts ranging from 2.5×10^3 CFU/5cm³ obtained for sample GJH4 to 8.55×10^4 CFU/5cm³ obtained for sample GJH9.

Samples GJH1, GJH2, GJH3 and GJH5 had counts of 7.5×10^3 , 4.5×10^3 , 1.05×10^3 and 3.0×10^3 CFU/5cm³ respectively. Counts of 7.35×10^4 , 4.15×10^3 , and 8.5×10^4 CFU/5cm³ were recorded for samples GJH7, GJH8 and GJH10. (See Table 4.1).



Table 3.1 Total Heterotrophic Bacteria Counts Obtained from Hostel Door Handles Studied

Sample Code	Dilution Plated	Plate 1	Plate 2	Av. Count	CFU/5cm ³	LogCFU/5cm ³
GJH1	10 ⁻¹	80	70	75	7.5x10 ³	
GJH2	10 ⁻¹	30	60	45	4.5x10 ³	
GJH3	10 ⁻¹	160	50	105	1.05X10 ⁴	
GJH4	10 ⁻¹	30	20	25	2.5x10 ³	
GJH5	10 ⁻¹	40	20	30	3.0x10 ³	
GJH6	10 ⁻²	82	17	49.5	4.95x10 ³	
GJH7	10 ⁻²	75	72	73.5	7.35x10 ⁴	
GJH8	10 ⁻¹	60	23	41.5	4.15x10 ³	
GJH9	10 ⁻²	118	53	85.5	8.55x10 ⁴	
GJH10	10 ⁻²	80	90	85	8.5x10 ⁴	

GEJ= Goodluck Jonathan Hostel sample 1-10

3.2 Total Heterotrophic Bacteria Counts Obtained from Laboratories Door Handles Studied

The total heterotrophic bacteria counts obtained for door handles from selected laboratories showed values ranging from

1.75×10^3 CFU/5cm³ obtained from sample LAB2 to 7.75×10^5 CFU/5cm³ obtained for sample LAB4. Samples from LAB1, LAB3 and LAB5 had counts of 5.7×10^4 , 9.0×10^4 , and 5.35×10^5 CFU/5cm³ respectively. (See Table 4.2)

Table 3.2 Total Heterotrophic Bacteria Counts Obtained from Laboratories Door Handles Studied

Sample Code	Dilution Plated	Plate 1	Plate 2	Av. Count	CFU/5cm ³	LogCFU/5cm ³
LAB1	10 ⁻²	45	70	57.5	5.75×10^4	
LAB2	10 ⁻¹	210	140	175	1.75×10^3	
LAB3	10 ⁻²	80	100	90	9.0×10^4	
LAB4	10 ⁻³	83	72	77.5	7.75×10^5	
LAB5	10 ⁻³	47	60	53.5	53.5×10^5	

3.3 Total Heterotrophic Bacteria Counts Obtained from Office Door Handles Studied

The total heterotrophic bacteria counts obtained from selected offices showed viable counts ranging from 4.1×10^3 CFU/5cm³ recorded for sample OFF5 to 7.0×10^3 CFU/5cm³ recorded for sample OFF2. Counts of 4.6×10^4 , 6.75×10^3 , and 4.35×10^3 CFU/5cm³ were recorded for samples OFF1, OFF3 and OFF4 respectively. (Table 4.3).

Table 3.3 Total Heterotrophic Bacteria Counts Obtained from Office Door Handles Studied

Sample Code	Dilution Plated	Plate 1	Plate 2	Av. Count	CFU/5cm ³	LogCFU/5cm ³
OFF1	10 ⁻¹	45	47	46	4.6×10^3	
OFF2	10 ⁻¹	80	60	70	7.0×10^3	
OFF3	10 ⁻¹	60	60	67.5	6.75×10^3	
OFF4	10 ⁻¹	50	37	43.5	4.35×10^3	
OFF5	10 ⁻¹	42	40	41	4.1×10^3	

Discussions

The results of this study revealed varying degrees of bacterial contamination on door handles obtained from hostels, laboratories, and offices. The total heterotrophic bacterial counts on hostel door handles ranged from 2.5×10^3 to 8.55×10^4 CFU/5cm³, suggesting a high level of microbial presence. This finding is consistent with the report of Olatunji et al. (2020), who recorded bacterial counts ranging from 1.2×10^3 to 9.1×10^4 CFU/cm² on hostel door handles in a Nigerian university, attributing such high contamination to poor sanitary practices and the large number of students using common facilities. Similarly, Eze and Ibezim (2018) observed bacterial loads between 3.0×10^3 and 7.8×10^4 CFU/cm² in hostels, explaining that frequent human contact and infrequent disinfection contribute significantly to microbial buildup on such surfaces. However, the bacterial load recorded in this present study was slightly higher than that of Oluwole et al. (2019), who found an average of 6.2×10^3 CFU/cm² on dormitory door handles. The difference could be attributed to environmental variations such as humidity, population density, and cleaning frequency, which greatly influence microbial survival and proliferation on contact surfaces.

Door handles from laboratory environments showed bacterial counts ranging between 1.75×10^3 and 7.75×10^5 CFU/5cm³, indicating higher contamination levels compared to hostels. The high counts obtained may be due to the handling of biological materials and frequent contact with gloved or contaminated hands during laboratory work. Similar findings

were reported by Onajobi et al. (2021), who recorded bacterial counts ranging from 2.0×10^4 to 8.0×10^5 CFU/cm² on laboratory door handles, suggesting that laboratories can serve as major reservoirs of microorganisms if not regularly disinfected. In contrast, Adeniyi and Odu (2020) reported lower bacterial loads ranging between 1.2×10^3 and 5.4×10^4 CFU/cm², attributing the difference to better hygiene enforcement and controlled access in the laboratories studied. The higher bacterial counts in the present study could therefore be linked to poor cleaning culture, high usage frequency, and environmental factors that favor bacterial persistence.

The bacterial counts on office door handles ranged from 4.1×10^3 to 4.6×10^4 CFU/5cm³, which were comparatively lower than those from hostels and laboratories. Offices generally experience less human traffic, and users are often more conscious of hygiene, which may account for the lower counts observed. This agrees with the findings of Adebayo et al. (2019), who reported bacterial counts between 3.8×10^3 and 3.2×10^4 CFU/cm² from office door handles, suggesting that offices, though not sterile, present a lower risk of microbial contamination compared to high-traffic areas. However, Chikere et al. (2018) reported even lower counts, ranging from 1.0×10^3 to 2.4×10^3 CFU/cm², and attributed this to regular cleaning schedules and disinfectant use. The slightly higher values in this study may therefore be due to inconsistent cleaning routines and the influence of environmental dust or air conditioning systems that can harbor and spread microbes.

A total of fifty-eight bacterial isolates were identified across all sampled locations, including *Escherichia coli*, *Proteus* spp., *Staphylococcus* spp., *Pseudomonas* spp., *Bacillus* spp., *Micrococcus* spp., *Streptococcus* spp., and *Klebsiella* spp. These organisms are well-known for their association with human skin, fecal matter, and the environment, which indicates that door handles act as potential fomites for microbial transmission. Similar organisms were isolated by Oluwole et al. (2019) and Eze and Ibezim (2018), who also identified *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *E. coli* from public door handles, emphasizing that frequent contact surfaces are important reservoirs for both commensal and pathogenic microorganisms.

5.2 Conclusions

The findings of this study clearly demonstrate that door handles in hostels, laboratories, and offices harbor a wide range of bacteria with varying degrees of contamination across locations. The total heterotrophic bacterial counts was high, indicating that bacteria remain the predominant contaminants on frequently touched surfaces. Among the environments studied, laboratory door handles exhibited the highest microbial loads, followed by hostels and then offices—reflecting the influence of human activity, hygiene practices, and environmental conditions on microbial persistence.

The bacterial isolates identified, such as *Staphylococcus* spp., *Escherichia coli*, *Proteus* spp., *Pseudomonas* spp., *Klebsiella* spp., and *Bacillus* spp., are organisms commonly associated with human contact and the environment, suggesting that door handles

serve as potential fomites for the transmission of pathogenic microorganisms. In conclusion, this study underscores the critical need for improved hygiene practices, particularly regular disinfection of frequently touched surfaces, proper handwashing behavior, and awareness of infection control measures in public and institutional settings. Routine microbial monitoring of contact surfaces is also recommended to reduce the potential spread of pathogenic and antibiotic-resistant microorganisms. The findings contribute valuable baseline data for future studies aimed at controlling microbial contamination and curbing the spread of antimicrobial resistance in public environments.

5.4 Recommendation

The study therefore recommends the following:

1. Routine cleaning and disinfection of door handles and other frequently touched surfaces should be enforced, particularly in high-traffic areas such as hostels, laboratories, and offices. Effective antimicrobial agents like alcohol-based or chlorine-based disinfectants should be used to reduce microbial load.
2. Hand sanitizing stations should be installed at strategic locations within institutions—such as entrances, laboratories, and hostel corridors—to promote compliance with hygiene practices.
3. Institutions should conduct routine microbiological assessments of commonly touched surfaces to monitor contamination levels and evaluate the effectiveness of cleaning protocols. This will help in identifying and controlling microbial hotspots early.

DISCLAIMER

All products used for this research are commonly used products in our area of research and country. There is no conflict of interest between the authors and producers of the products used because we intend to use the products only for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

Consent And Ethical Approval

Individuals recruited as participants in this study were those who gave verbal informed consent. Ethical approval was obtained from Rivers State Ministry of Health, Port Harcourt.

Conflicting Interests

Authors have declared that there were no conflicting interests.

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