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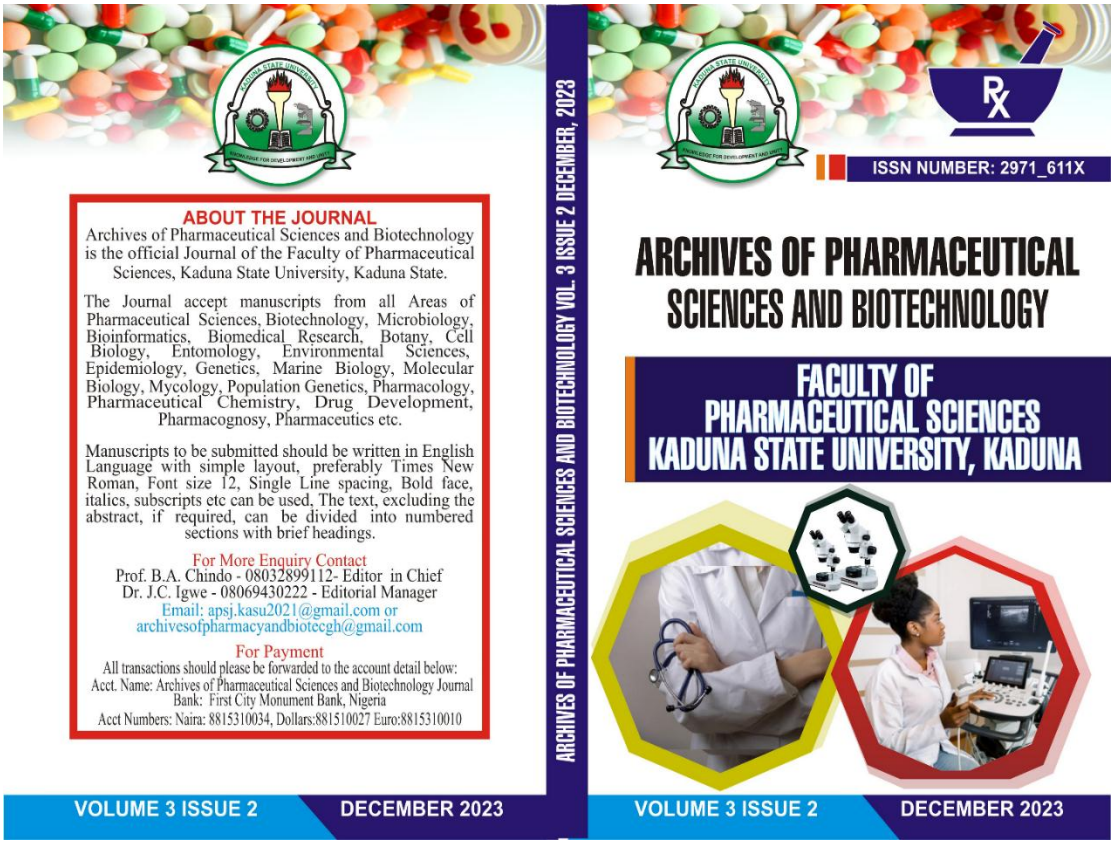

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DOOR HANDLES OR KNOBS AS POTENTIAL THREAT TO PUBLIC HEALTH

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ABSTRACT

Background: The use of door handles or knobs have potential to increase the chances of acquiring or transmitting pathogenic organisms. **Aim**: This study assessed bacterial contaminant on door handles of tertiary education and health institutions and their antibiotic resistance pattern were carried out in order to determine the possibility of door handles being a potential public health risk.

Methods: Twenty swab samples each were collected from door handles of male hostels of Ahmadu Bello University, Zaria and toilets, offices from Barrau Dikko Teaching Hospital, Kaduna. Gram staining and biochemical tests were used to isolate the bacterial contaminants while agar diffusion method was used to carry out antibiotics susceptibility testing. Antibiotics resistance pattern of the isolates were determined.

Results: A total of 56 bacterial isolates were obtained. *Staphylococcus aureus* 21 (37.5%) was the most predominant, followed by *Escherichia coli* 8 (14.3%), *Pseudomonas aeruginosa* 7 (12.5%), *Streptococcus* spp 6 (10.7%), *Salmonella* spp 5 (8.9%), *Klebsiella* spp 5 (8.9%), while the least were *Bacillus subtilis* 2 (3.6%) and *Proteus vulgaris* 2 (3.6%). Ciprofloxacin 21 (77.8%), and ofloxacin 25 (86.2%) were the most active antibiotics against the Gram negative and Gram positive bacterial isolates respectively. The antibiotic resistance pattern showed 11 (40.7%) and 8 (27.6%) of the Gram negative and Gram positive isolates respectively to be multidrug resistant. Pandrug resistance was observed in 2 (7.41%) and 2 (6.9%) of the Gram negative and Gram positive isolates.

Conclusion: Pathogenic bacterial contaminants were observed in all the door handles and knobs sampled. The multidrug resistance isolates observed in this study are potential source of public health risk. Regular disinfectant of public and private door knobs and handles and regular hand-wash is therefore recommended.

Keywords: Door handles, bacterial contaminants, public health

INTRODUCTION

Toilet hygiene and cleanliness of toilet door handles is an important issue in public toilets in all types of shared buildings. It is widely recognized that there is a growing need to improve standards of toilet hygiene and toilet door handles to prevent the spread of infection. Eighty percent (80%) of infectious diseases are spread by touch; hand contact with hands and other objects [1]. Research from the British Toilet Association showed that 30% of the general public does not wash their hands after going to toilet. Of those that do, 64% do not use soap and 88% do not wash their hands for long enough time to kill germs, and since everyone including those who have good toilet hygiene practice and those who don't must exit through the same public door, cleanliness of the toilet

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door handle is a key concern [2]. Human beings have a marked tendency to pick up microorganisms from environmental objects including door handles of offices and toilets. The hands have also been shown to play a role in the transmission of organisms [3]. *Salmonella* spp and *Escherichia coli* had been shown to be transferred from the hand to raw processed foods, even at low levels on the fingers [4]. It has been shown that microbes once attached to hands and surfaces may survive for a while and may be difficult to remove [5]. Environmental (contact) surfaces became an issue of health concern particularly in recent years as they have been reported as potential carriers and transmitters of disease-causing microorganisms [6]. Fomites are major source transmission of community acquired infections [7]. Fomites include door handles of toilets, showers, toilet seats, sinks lockers, chairs and tables especially those found in public places such as markets, banks, dormitories, schools, churches, public offices, hotels and restaurants [8]. Transmission of diseases through fomites can be determined by the frequency of site contamination and exposure, possibility of transferring the infectious agent to a susceptible individual, immune-competence of the persons in contact and virulence of the organisms control measures (e.g use of disinfectants) and personal hygiene [3]. Therefore, it is important to assess the bacterial contaminant on door handles from the male students' toilet of a tertiary institution and that of toilets and offices of a health institutions in our environment in order to determine the possibility of door handles being a potential threat to public health.

MATERIALS AND METHODS

Study Area

The study area included the following male hostels of Ahmadu Bello University: Umar Suleiman Hall, Usman Danfodio Hall, ICSA Hall, and Bakassi Hall. Also door handles of the offices of the following units in Barrau Dikko Teaching Hospital, Kaduna: Paediatrics, Male and Female Medical Wards, Haematology Laboratory, Out Patients Department, Surgical ward, Accident and Emergency Unit and the hospital public female toilet (Table 1).

Table 1: Distribution of Samples Collected from Door Handles

S/N	Sample site	No of Sample
1	Paediatrics unit	3
2	Male and female medical wards	2
3	Accident and emergency unit	3
4	Outpatient department	5
5	Female public Toilet of Barrau Dikko Hospital	4
6	Hemaetology Laboratory	3
7	Umar Suleiman Hall toilet	5
8	Usman Danfodio Hall toilet	5
9	ICSA Hall toilet	5
10	Bakassi Hall toilet	5
	Total	**40**

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Sample Collection and Pre-treatment

Twenty swab samples each were collected from door handles of male hostels of Ahmadu Bello University, Zaria and toilets, offices from Barrau Dikko Teaching Hospital, Kaduna. The swab samples were aseptically inoculated into sterile nutrient broth and incubated for 24 hours at 37ºC. The swab sticks were aseptically removed and swabbed unto the surfaces of sterile blood agar and nutrient agar plates, and were incubated for 24 hours at 37 ºC. Distinct colonies were picked and streaked on nutrient agar slant, incubated for 24 hours at 37 ºC and kept in the fridge for further tests.

Isolation and Purification of Isolates

Gram staining was carried out according to Cheesbrough [9]. Gram positive isolates were cultured on mannitol salt agar while Gram negative rods were cultured on cetrimide agar, Salmonella/Shigella agar and Eosine methylene blue agar to isolate *Pseudomonas* spp, *Salmonella* spp and *Escherichia coli*. The following biochemical tests were also carried out for further identification as described by Cheesbrough [9]: Catalase test, coagulase test, indole formation test, citrate utilization test, Voges-proskauer's test, methyl red test, urease test, triple sugar iron test and oxidase test.

Antibiotic Susceptibility Testing

Antibiotic susceptibility test of the isolated bacteria against commonly prescribed antibiotics was carried out using Kirby Bauer modified disc diffusion method according to CLSI guideline [10]. The standard antibiotic discs used were: cotrimoxazole (30 µg), ciprofloxacin (10 µg), amoxicillin (30 µg), amoxicillin-clavulanate (30 µg), gentamicin (10 µg), ofloxacin (10 µg), tetracycline (30 µg), ceftriaxone (30 µg), nitrofurantoin (300 µg). Standardized overnight culture of each isolate, as compared with McFarland standard (10^8 cfu/ml) was used to seed melted Mueller Hinton agar at 45ºC and poured into sterilized plates (in triplicates) aseptically. These were allowed to solidify. The standard antibiotic discs were then placed aseptically and the plates kept for 1 hour to allow the antibiotics to diffuse, the plates were thereafter incubated at 37 ºC for 18 hours. The diameter zone of inhibition produced by each antibiotic disc was measured using a metric rule and the results were interpreted using CLSI antibiotics sensitivity testing interpretation chart [10].

Determination of Antibiotic Resistance Pattern

The bacterial isolates were classified as multidrug resistant (MDR), extended drug resistant (XDR) and pandrug resistant (PDR). According to European Centre for Disease Control (ECDC) and Centre for Disease Control & Prevention (CDC), Atlanta, multidrug resistant (MDR) was defined as acquired non-susceptibility to at least one agent in three or more antimicrobial categories. Extensively drug resistant (XDR) was defined as non-susceptibility to at least one agent in all but two or fewer antimicrobial categories (i.e., bacterial isolates remain susceptible to only one or two antimicrobial categories). Pandrug resistant (PDR) was defined as non-susceptibility to all agents in all antimicrobial categories [11].

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RESULTS

A total of 56 bacterial isolates were obtained (Table 2): *Staphylococcus aureus* 21 (37.5%), *Escherichia coli* 8 (14.3%), *Pseudomonas aeruginosa* 7 (12.5%), *Streptococcus* spp 6 (10.7%), *Salmonella* spp 5 (8.9%), *Klebsiella* spp 5 (8.9%), *Bacillus subtilis* 2 (3.6%), and *Proteus vulgaris* 2 (3.6%).

Table 2: Frequency of Occurrence of Bacterial Isolates from Door Knobs

Organisms	Frequency of Occurrence	Percentage
Escherichia coli	8	14.3
Klebsiella spp	5	8.9
Pseudomonas aeruginosa	7	12.5
Bacillus subtilis	2	3.6
Salmonella spp	5	8.9
Staphylococcus aureus	21	37.5
Streptococcus spp	6	10.7
Proteus vulgaris	2	3.6
Total	**56**	**100**

Antibiotic Susceptibility Result

Ciprofloxacin 21 (77.8%), and ofloxacin 25 (86.2%) were the most active antibiotics against the Gram negative and Gram positive bacterial isolates respectively (Tables 3 and 4).

Table 3: Percentage Susceptibility of Gram positive isolates

Antibiotics	No of isolates (%) n = 29		
	Sensitive	Intermediate	Resistant
Ofloxacin	25 (86.2)	0	4 (13.8)
Gentamicin	20 (69.0)	1 (3.4)	8 (27.6)
Nitrofurantoin	13 (44.8)	0	16 (55.2)
Cotrimoxazole	20 (69.0)	0	9 (31.0)
Amoxicillin	1 (3.4)	0	28 (96.6)
Tetracycline	2 (6.9)	0	27 (93.1)
Amoxicillin-clavulanate	1 (3.4)	0	28 (96.6)
Ciprofloxacin	19 (65.5)	1 (3.4)	9 (31.0)
Ceftriaxone	2 (6.9)	0	27 (93.1)

Table 4: Percentage Susceptibility of Gram negative isolates

Antibiotics	No of Isolates (%) n = 27		
	Sensitive	Intermediate	Resistant
Ofloxacin	19 (70.3)	1 (3.7)	7 (25.9)
Gentamicin	13 (48.1)	1 (3.7)	13 (48.1)
Nitrofurantoin	7 (25.9)	1 (3.7)	19 (70.4)
Cotrimoxazole	12 (44.4)	4 (14.8)	11 (40.7)
Amoxicillin	6 (22.2)	1 (3.7)	20 (74.1)
Tetracycline	3 (11.1)	1 (3.7)	23 (85.2)
Amoxicillin-clavulanate	6 (22.2)	1 (3.7)	20 (74.1)
Ciprofloxacin	21 (77.8)	1 (3.7)	5 (18.5)
Ceftriaxone	3 (11.1)	1 (3.7)	23 (85.2)

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Antibiotic Resistant Pattern of Isolates

The antibiotic resistance pattern showed that 11 (40.7%) and 8 (27.6%) isolates of the Gram negative and Gram positive bacteria respectively were multidrug resistant. Pandrug resistance was observed in 2 (7.41%) and 2 (6.9%) of the Gram negative and Gram positive isolates (Table 5).

Table 5: Resistance Pattern of Bacterial Isolates

Classification of Resistance	Gram negative isolates n (%)	Gram positive isolates n (%)
Multidrug resistant	11 (40.7)	8 (27.6%)
Extended drug resistant	11 (40.7%)	11 (37.9%)
Pandrug resistant	2 (7.4%)	2 (6.9%)
No resistance	3 (11.1%)	8 (27.6%)
Total	**27**	**29**

DISCUSSION

All the door handles sampled had bacterial contaminants with the highest being *S. aureus* (37.5%), and the least was *B. subtilis* and *P. vulgaris* (3.6% each). Other bacterial contaminants isolated were *E. coli* (14.3%), *Ps. aeruginosa* (12.5%), *Streptococcus* spp (10.7%), *Klebsiella* spp and *Salmonella* spp (8.9%). In humans, *E. coli* is part of intestinal microbiome of over 90% individuals [12]. Also *S. aureus* is a microbiome of about one third of human population, which may remain asymptomatic for a long period of time except in immune-compromised individuals [13, 14]. *S. aureus* is known for causing potentially life-threatening infections and has the capacity to acquire multidrug resistance [15, 16].

Considering the locations where the samples were collected from: university students' male toilets, tertiary health institution's offices and patients' toilets, all these can be considered as public places. Though the percentage occurrences of the organisms seems not too high, their presence especially in the hospital is a great concern, because it can be a source of nosocomial infection. This is possible as patients could transmit these pathogens from one person to another through contacts with the door handles. Cases of diarrhea and typhoid fever symptoms often presented by some of the students in the students' residing in the male hostel might have been caused by these coliforms and other microorganisms.

In a reported study [17], higher percentages of bacterial contaminants were isolated from door handles of a Federal School of Medical Laboratory Technology offices in Jos. *S. aureus* (43.3%) was also reported to have the highest occurrence followed by *E. coli* (23.3%), *Klebsiella pneumonia* (20%), and *Bacillus* spp (13.3%)]. A higher percentage of bacterial isolates was also reported by Nworie [18] from door handles of selected public conveniences in Abuja metropolis, Nigeria with *S. aureus* (30.1%) having the highest occurrence, followed by *Klebsiella pneumonia* (25.7%), *E. coli* (15.6%), *Ps. aeruginosa* (5.9%), and *Proteus* spp (4.5%). *Enterobacter* and *Citrobacter* spp were also isolated.

Ciprofloxacin 21 (77.8%), and ofloxacin 25 (86.2%) were the most active antibiotics against the Gram negative and Gram positive bacterial isolates respectively. Both ciprofloxacin and ofloxacin belong to the class of antibiotics called quinolones, they are active against type

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II topoisomerase and function by blocking DNA replication and inhibiting synthesis and cell division [19]. Other antibiotics with good activities against Gram positive isolates were gentamicin (69%), cotrimoxazole (69%), and ciprofloxacin (65.5%). Comparing the activities observed with these antibiotics against the Gram positive and Gram negative isolates, it was observed that the Gram negative isolates were less susceptible to the antibiotics used: gentamicin (48.4%), cotrimoxazole 44.4%). Both the Gram positive and Gram negative isolates demonstrated high percentage resistance against all the beta lactam antibiotics and tetracycline used (Amoxicillin 96.6%), 74.1%), amoxicillin-clavulanate (96.6%, 74.1%), ceftriaxone (93.1%, 85.2%), tetracycline (93.1%, 85.2%). A study by Alonge [20] on bacterial contamination of toilet door handles on Baze University campus, Abuja, Nigeria showed a similar antibiotic susceptibility results with general susceptibility to ciprofloxacin and ofloxacin by all isolates and highest resistance against ampicillin-cloxacillin and amoxicillin-clavulanate.

Multidrug resistant (MDR) isolates were observed in both Gram negative and Gram positive with Gram negative isolates having a higher percentage (40.7%) than Gram positive (27.6%). These presence of MDR and extended drug resistant isolates may be an indication that the individuals who handled the doors before the samples collection were previously exposed to one or more of the antibiotics tested. The indiscriminate use of antibiotics (misuse and/or abuse) and over-the – counter collection of antibiotics without an authentic prescription by authorized prescribers has been a major problem in this country, Nigeria. This calls for urgent action for the interest of the public' health. The negative impact and danger of transmission of antimicrobial resistant isolates within the community and students' fold cannot be over emphasized. Though Nigerian government had published a National Action Plan for AMR in Nigeria [21], much more still need to be done especially in the area of carrying out public awareness (both in the major cities and rural area) on the dangers of antibiotics misuse and abuse. Also the matter of antibiotics stewardship should be critically enforced in health institutions in Nigeria at all level (primary, secondary and tertiary). Passing a bill that will enforce the restriction of the use of antibiotics to prescription only is recommended.

CONCLUSION AND RECOMMENDATIONS

All the door handles sampled in this study were contaminated with pathogenic bacteria, which included *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Streptococcus* spp, *Salmonella* spp, *Klebsiella* spp, *Bacillus subtilis*, and *Proteus vulgaris*. Ciprofloxacin, and ofloxacin were the most active antibiotics against the Gram negative and Gram positive bacterial isolates respectively even though high level of multidrug resistance was observed. It is recommended that the use of automated doors, which does not allow the use of handle at all be introduced to our public places in Nigeria to reduce the health risks associated with the use of door handles.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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