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# Assessment Of Bacterial Colonization Of Office Door Handles And Palms Of Students In A University Faculty Building

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***Abstract***
***Background:*** *Door handles and palms of individuals can serve as a reservoir for pathogenic bacteria and a route for disease transmission. This study was aimed at assessing the bacterial colonization of office door handles and palms of students in a university faculty building.*
***Materials and Methods:*** *A total of one hundred and sixty (160) samples, eighty (80) each from office door handles and palms of students were collected using swab sticks. The samples were cultured in peptone water for 12 hours. The inoculum was ten-fold diluted and dilutions were cultured on mannitol salt agar, MacConkey agar, Salmonella - Shigella agar and nutrient agar and incubated at $37^0$C for 24 hours. Mean bacterial count ranged from $1.4\times10^6$ to $8.7\times10^6$cfu/ml and $2.8\times10^6$ to $6.6\times10^6$cfu/ml for samples collected from office door handles and palms of students respectively.*
***Results:*** *Results showed that 58.8% (47/80) and 51.3% (41/80) of samples from office door handles and palms of students showed bacterial growth. A total of 59(73.8%) and 63(78.8%) of bacterial isolates were seen in both office door handles and palms of students respectively. The isolated bacterial species were: Staphylococcus aureus, Escherichia coli, Klebsiella spp., Salmonella spp. and Pseudomonas spp.*
***Conclusion:*** *This study revealed that office door handles and palms of students are colonized by varieties of bacteria. It is therefore a necessity that personal hygiene be made a priority so as to help curb the public health hazards that may be associated with these contaminated door handles and palms of students.*
***Key Words:*** *Door handles, Formites, Palms of students, Bacterial contamination, personal hygiene*

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## I. INTRODUCTION

Door handles are attached objects or mechanisms used to manually open or close a door[1]. Door handles are observed to be a reservoir of microorganisms. As many hands apply on them, microbial contaminants are transmitted either from hands to door handles or from door handles to hands[1]. Further, person-to-person cross contamination can occur when exchanging pleasantries. These individuals must have touched some surfaces before coming to the office doors. Several factors have been shown to influence the bacterial transmissions between surfaces, such as source and destination, surface features, bacterial species involved, moisture levels, pressure and friction between the contact surfaces, and inoculum size on the surfaces [2,3]. Door handles serve as a formite, which can transmit organisms from one person to another [1,4]. Formites are any inanimate objects that when contaminated with or exposed to infectious agents, can transfer disease agents to a new host. Formites, when in constant contact with humans or natural habitats of pathogenic organisms constitute a major source of the spread of infectious diseases [5,6]. Such formites include door handles or knobs, showers, toilet seats and faucets, sinks, lockers, chairs and tables, especially those found in public offices, hospitals, hotels, restaurants and restrooms. Others include contaminated vehicles utensils, towels, pen, shovels, clothing, money, books, toys, bowls or buckets, brushes, tacks and clippers [6]. There is increasing evidence that contaminated inanimate surfaces, especially those frequently touched by hands, can contribute to the spread of healthcare- associated pathogens from place to place and from person to person [7].

The hand serves as a medium for the propagation of microorganisms from place to place and from person to person [8], hence introducing organisms to the surfaces they touch. Although it is nearly impossible for the hand to be free of microorganisms, the presence of pathogenic bacteria on hands may lead to chronic or acute illness [9].

Human hands usually harbour microorganisms both as part of the body's normal flora as transient microbes contacted from the environment [10]. In an environment like a faculty building, students, staffs and visitors move around and make use of different doors for different purposes [11]. The door handles and hands of students are not frequently disinfected and as such contribute to the distribution of pathogenic microorganisms. Different individuals and visitors come into the offices with different types of organisms that they have picked from where they come from and deposit them on the door handles. As people come in contact with these surfaces like desks, keyboards and office furniture, toilets and office lock handles, there is the possibility of picking up microbes deposited on them [11], thus furthering cross contamination [12]. These surfaces are commonly touched by hand, as such acts as sources of microbial dissemination [7]. It is worrisome that some departments in the institution lack adequate water supply in the toilets for users to wash their hands after toilet use. Faecal-oral transmission may occur when individuals use the same hand to eat food thereby increasing the incidence of infection in the community. Hand washing is a fundamental cautionary measure that protects against the spread of diseases and remains one of the primary practices to reduce the transfer of bacteria from person to person or from person to food contact surfaces [13].

It has been shown that hard and non-porous surfaces such as door handles, have the highest bacterial transfer rates to hands [14]. Bacterial pathogens that have been isolated from door knobs and hands of individuals in previous studies include: *S. aureus*, *K. pneumonia*, *E. coli*, *Enterobacter* spp., *Citrobacter* spp., *P. aeruginosa*, *Proteus* spp., *Streptococcus*, *Salmonella*, *Shigella*, and *Campylobacter* [15,16,8,17]. These organisms have been known to cause one or more diseases that are mild and could sometimes be serious [11]. Examples of these diseases include: pimples, impetigo, scalded skin syndrome, pneumonia, meningitis, osteomyelitis, rhinoscleroma, kidney failure,and septicaemia [18,19].

Faculty surroundings are seen as dirty and unkept. Hence, monitoring and evaluation of office door handles and individuals' hands are necessary for infection control. This is because there is a possibility that contaminated door handles may increase the risk of acquiring infections due mainly to poor personal hygiene [20]. Poor personal hygiene predisposes the environment and individuals to pathogenic microorganisms, leading to increased incidence and outbreaks of infectious diseases [21]. The increasing cases of epidemics and their corresponding spread to neighbouring communities are major public health concerns [15]. This study is sought to assess the bacterial colonization on office door handles and hands of students in the Faculty of Applied Natural Sciences of Enugu State University of Science and Technology.

## II. MATERIALS AND METHODS

**Area of study:** This study was undertaken at the Faculty of Applied Natural Sciences of Enugu State University of Science and Technology. Sample collection was done on office door handles of selected departments and palms of students within the faculty. These Departments are: Industrial Chemistry (ICH), Industrial Physics (IPH), Applied Microbiology and Brewing (AMB), Biochemistry (BCH), Industrial Mathematics and Statistics (IMS) and Applied Biology and Biotechnology (ABB).

**Sample collection:** A total of one hundred and sixty (160) samples, eighty (80) each from office door handles and palms of students of Faculty of Applied Natural Sciences (FANS) of Enugu State University of Science and Technology (ESUT) were collected. The samples were collected at noon when people made use of these door handles so as to maximize the chances of isolation [22]. The sterile swab sticks were moistened with 5ml of sterile peptone water and were used to swab different office door handles of the selected Departments which are hand related public surfaces and palms of students. The swab sample collection was accomplished in a tri-directional manner; up/down left/right and diagonally, and the swab stick recapped and properly labelled [11]. The samples were then promptly transported to the laboratory of Department of Applied Microbiology and Brewing for bacteriological assessment. The samples were cultured in peptone water for 12 hours. This was to ensure that any microorganisms present in the swab stick diffused into the broth and for bacteriological analysis [15, 23].

**Bacteriological Analysis of the Sample:** A total of 1 ml of each of the12 hours broth cultures were inoculated into 9 ml of sterile distilled water in test tubes and ten- fold dilution was done. A total of 0.1 ml from the fifth tube ($10^{-5}$) was then inoculated in duplicates onto Nutrient agar (NA), MacConkey agar (MA), Salmonella- Shigella agar (SSA) and Mannitol salt agar (MSA). All the plates were incubated for 24 hours at $37^0$C. After the overnight incubation, the plates were observed for colony characteristics. Thereafter the colonies were also counted using the colony counter. Bacterial counts were expressed as the log of colony forming units per millilitre.

**Isolation and Purification:** After colony counting, distinct colonies were sub-cultured onto fresh Nutrient agar, MacConkey agar, Salmonella- Shigella agar and Mannitol salt agar plates for proper preliminary identification. Purified isolates were stocked in nutrient agar slants for further studies. The morphological appearances of the organisms were recorded. The isolates were further subjected to more identification tests.

**Characterization and Identification of Bacterial Isolates:** Bacterial isolates were characterized on basis of their Gram-stain reaction and biochemical test (catalase, coagulase, citrate, oxidase, indole, urease,

methyl red and sugar fermentation tests) and the identification was according to Bergey's Manual of Determinative Bacteriology.

**Data Analysis:** The data collected were subjected to statistical analysis using SPSS.Statistical test, Analysis of Variance (ANOVA) was used to determine significant differences in the distribution of bacteria among office door handles and palms of students.

## III. RESULTS

**Total Bacterial Count (cfu/ml) of the Samples**

The total bacterial counts (cfu/ml) of the samples were determined and the result shown in Table 1.

**Percentage (%) Occurrence of Bacterial Growth in Office Door Handles and Palms of ESUT Students**

A total of 47(58.8%) out of 80 samples from office door handles at FANS were positive while 41(51.30%) out of 80 palms of ESUT students were positive. The results are shown in table 2.

**Identification Scheme of the Bacterial Isolates**

The bacteria isolates showed varying biochemical, microscopy and morphological characteristics on different media. The result is shown in table 3.

**Percentage Distribution of Bacterial Isolates from various office Door handles of different Departments and Palms of Students**

A total of 59(73.8%) and 63(78.8%) bacterial isolates were seen in all the samples. The result is shown in table 4.

**Table 1: Total Bacterial Count (cfu/ml)**

| Sample sites | Palms of students | Office Door handles |
|---|---|---|
| Industrial Mathematics/Statistics<br>Microbiology | $2.3x10^6$<br>$4.6x10^6$ | $5.4x10^6$<br>$6.6x10^6$ |
| Biochemistry | $8.7x10^6$ | $3.4x10^6$ |
| Applied Biology and Biotechnology | $7.1x10^6$ | $6.4x10^6$ |
| Industrial Chemistry | $1.4x10^6$ | $2.8x10^6$ |
| Industrial Physics | $3.5x10^6$ | $5.2x10^6$ |

**Table 2: Percentage (%) Occurrence of Bacterial Growth in Office Door Handles and Palms of Students**

| Sample Sites | Door handles No of samples | No (%) of Positive samples | Palms of Students No of Samples | No (%) of Positive Samples |
|---|---|---|---|---|
| Industrial Mathematics/Statistics | 9 | 4(44.4) | 5 | 3(60) |
| Microbiology | 25 | 18(72) | 30 | 16(53.3) |
| Biochemistry | 12 | 5(41.7) | 8 | 2(25) |
| Applied Biology and Biotechnology | 10 | 7(70) | 18 | 12(66.7) |
| Industrial Chemistry | 11 | 7(63.6) | 8 | 3(37.5) |
| Industrial Physics | **13** | 6(46.2) | **11** | 5(45.5) |
| **Total** | **80** | **47(58.8)** | **80** | **41(51.3)** |

**Table 3: Identification Scheme of the Bacterial Isolates**

| Isolates | Colonial Appearance on Media | Biochemical Tests | | | | | | | | | | | Possible organisms |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Sugar fermentation | | | | | |
| | | Gram reaction | Cat | Ox | Coa | Ct | Ind | Glu | Fru | Mal | Man | La | |
| A | Greyish white, smooth, mucoid and medium sized colonies on Nutrient agar | Gram -ve short rod in pairs | + ve | - ve | - ve | - ve | + ve | AG | AG | AG | AG | AG | *Escherichia coli* |
| B | Greenish flat and smooth colonies with alligator skin-like appearance on MacConkey agar | Gram -ve short rod in singles | + ve | + ve | - ve | + ve | - ve | AG | A | A | A | - ve | *Pseudomonas* sp. |
| C | Large mucoid glistering pink on MacConkey agar | Gram -ve short rod in pairs | + ve | - ve | - ve | + ve | + ve | A | A | A | A | A | *Klebsiella* sp. |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | Opaque or black-centered colonies on SSA | Gram -ve short rod in singles | -ve | -ve | -ve | +ve | -ve | A | A | A | A | -ve | *Salmonella* sp. |
| E | Yellow coloured large colonies Mannitol salt agar | Gram +ve cocci in clusters | +ve | -ve | +ve | -ve | -ve | A | A | A | A | A | *Staphylococcus aureus* |

KEY: SSA = Salmonella Shigella Agar, Ind = Indole test, Ct = Citrate utilization Test, Cat = Catalase test, Coa = Coagulase test, Oxi = Oxidase test Ma = Mannitol, La = Lactose, Glu = Glucose, Fru = D-Fructose, Mal = Maltose, +ve = positive, -ve = negative, A = Acidic, AG = Acidic and Gas, G = Gas.

**Table 4: Percentage Distribution of Different bacterial isolates from various Departments and Palms of Students**

| Organisms identified | Office door handles (%) | Palms of ESUT students (%) |
|---|---|---|
| *Escherichia coli* | 16(27.1) | 20(31.8) |
| *Pseudomonas* spp. | 10(16.9) | 4(6.4) |
| *Klebsiella* spp. | 8(13.6) | 6(9.5) |
| *Salmonella* spp. | 6(10.2) | 9(14.3) |
| *Staphylococcus aureus* | 19(32.2) | 24(38.1) |
| **Total (%)** | **59(73.8)** | **63 (78.8)** |

## IV. Discussion

Palms of individuals are used to open doors by touching the door handles, thereby transmitting organisms from hand to door handles or from door handles to hand. This study was done to assess the bacteriological colonization of office door handles of some departments and palms of students of Faculty of Applied Natural Sciences (FANS) of Enugu State University of Science and Technology (ESUT). This study showed that the bacterial load across the selected departments and palms of students were high (Table 1). The bacterial load was higher in door handles of Microbiology department $6.6\times10^6$ cfu/ml and palms of students of Biochemistry $8.7\times10^6$ cfu/ml. Also the bacterial load was high in palms of students of Applied Biology and Biotechnology $7.1\times10^6$ cfu/ml and least in both Industrial Chemistry $2.8\times10^6$ cfu/ml and $1.4\times10^6$ cfu/ml respectively. The highest bacterial load observed in Microbiology, Biochemistry and Applied Biology and Biotechnology departments could be attributed to high population of staff, visitors and students in these departments. The more the people in contact with the door handles, the more chances of cross-contamination between hands and handle and vice versa. It could also be possible that the high bacteria load on the office door handles and palms of students is as a result of poor personal hygiene and poor hand washing procedure. Hands deposit bacteria on the door handles while opening them. When people visit convenience rooms or touch microbial hotspot areas and fail to wash or sanitize hand properly thereafter, they are likely to carry bacterial species to other surfaces they come in contact with. This study is in agreement with the work of Ayuba I *et al*.[1] who observed bacterial load of $7.05\times10^6$ cfu/ml in Biological Sciences, Microbiology ($5.33\times10^6$ cfu/ml) and Biochemistry ($2.7\times10^6$ cfu/ml). Kenndy D *et al*.[24] reported that levels of contamination of conveniences vary depending on traffic, exposure and environment. Umeanaeto PU *et al*.[11] stated that the high bacterial load could be as a result of unhygienic nature of some of the large number of people that make daily visits to schools for various programmes. It is therefore possible that the high bacteria on the office door handles and palms of students could be as a result of poor personal hygiene and poor hand washing procedure. Because of this, these hands deposit the bacteria on the door handles while opening them. Frequent handling of the door handles by many users with different hygienic profiles could be as a result of high bacterial load recorded in this study. Faecal-oral transmission may occur when individuals use the same unwashed or un-sanitized hands to eat food or shake hands thereby increasing the incidence of infection in the community. Therefore, frequent hand washing and disinfection of the office door handles are very paramount to minimize transfer of bacteria on the surfaces.

Table 2 shows the percentage occurrence of bacterial growth in office door handles and palms of students in the Faculty of Applied Natural Sciences (FANS). A total of 58.8% and 51.3% of the samples of the office door handles and palms of student were positive with bacterial counts, respectively. The results revealed that bacterial growth was high in Microbiology 25(72%), Applied Biology and Biotechnology 7(70%) and Industrial Chemistry 7(63.6%) while on the palms of students, the bacterial growth was high in palms of students of Applied Biology and Biotechnology 12(66.7%), Industrial Mathematics and Statistics 3(60%), Industrial Physics 5(45.5%), Applied Microbiology and Brewing 16(53.3%) while the least bacterial growth was on the palms of students in Biochemistry 2(25%). The results on the office door handles were less than what the following authors got: 64.5% bacterial contamination recorded by Abiose OF[25] in Adekunle-Ajasin University, Akungba-Akoko, Ondo State, Nigeria; 75.29% reported by Tiku DR *et al*. [16] in door handles in University of Calabar community, 86.7% by Nworie A *et al.* [15] in door handles of public conveniences in Abuja; 87.1% reported by AI-Harbi M *et al*. [26] in frequently used formites in Kuwait. However, it was higher than 43.5% of the bacterial contamination recorded by Hishami AAS[27] in office door handles of different Universities in Khartoum State and 20.39% by Omololu-

Aso J *et al.* [28] in door knobs in Obafemi Awolowo University Teaching Hospital complex, Ife, Nigeria. The present result is in agreement with the work of Ikede RexE *et al.* [8] who observed 60% of bacterial growth on the door handles. The reason for the differences on the values may be as a result of differences in location as well as hygienic nature of individuals and office door handles. The high bacterial growth observed in Microbiology department could be as a result of the nature of the department. They handle microorganisms in the laboratory, thereby transmitting the organisms to door handles when hands are not washed properly. The bacterial growths on other departments could be as a result of high population of students and visitors coming from outside with their indigenous organisms. Contamination on the door handles may have been as a result of touching the door handles with an already contaminated hand [11]. The bacterial growth observed from the palms of students is in agreement with the work of Vishisanath R *et al.* [29] who isolated varying growth of bacteria from hands of school children. From their result, it showed that most people harbour bacteria on their hands and thereafter deposit them on the door handles. This can lead to respiratory and gastrointestinal infections through faecal-oral transmission.

Table 4 of this study showed high incidence of bacterial contaminants on office door handles and palms of students of Faculty of Applied Natural Sciences (FANS) of Enugu State University of Science and Technology (ESUT) which were contaminated with considerable number of pathogenic bacteria most of which are Gram-negative bacteria. The high incidence observed may be attributed to poor sanitary and hygienic practices. The bacteria may have found their way onto the surfaces through cross contamination, poor personal hygiene of the users [30].

The results of this study also showed that *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* spp., *Salmonella* spp. and *Pseudomonas* spp. are the main bacterial isolates frequently associated with the office door handles and palms of students (Table 4). These organisms probably have found their entry on the office door handles through the skin and hand to hand mechanism, as these microbes are subset of the normal microbiota of the skin[31]. Furthermore, in this study, *Staphylococcus aureus* 19(32.2%) and24(38%) on both door handles and palms of student, respectively were the most frequently isolated bacterium as shown in Table 4. This is may be due to the fact that they are the major components of the normal flora of the skin and nose, which probably explains its high prevalence as it can easily be discharged by several human activities. Contamination by *Staphylococcus aureus*, a bacterium of the skin flora, suggests direct contact of the doors by individual handlers[32]. This observation is in conformity with the finding of Nworie A *et al.* [15]. *Staphylococcus aureus* is the most important potential pathogen that cause boils, abscesses, wound infections toxic shock syndrome and pimples. Also, the result of this study is also in agreement to that of Abiose OF[25], who also recorded 32% *Staphylococcus* from toilet door handles whereas in contrast with the work Mensha O *et al.* [33] that observed high number of *E. coli* 67% on door handles.

The present study demonstrated that majority of the bacteria, transmitted through door handles are Gram negatives. *Staphylococcus* and *Escherichia* species were predominant bacteria encountered while *Pseudomonas* species (6.4% ) was the least on palms of students, respectively. This is in line with the works of Alonge OO *et al.* [12] in Baze University Abuja who reported: *Staphylococcus aureus* 42.9%, *Salmonella* species 21.4%, *Escherichia coli* 9.5%, *Pseudomonas aeruginosa* 9.5%, and *Klebsiella* species 2.3%, as predominant bacterial species isolated from toilet door handles, Odigie AB *et al.* [34] in Benin City and Bhatta DR *et al.* [35] in Nepal. This present study is in line with the work of Ikede RexE *et al.* [8] who reported *Staphylococcus aureus* 43.3%, *Escherichia coli* 23.3% and *Klebsiella* species 20%. The presence of *Escherichia* spp., *Salmonella* spp. and *Klebsiella* spp. infers contamination by faecal matter, suggesting poor hygienic practices of improper washing of hands before opening the office doors. The presence of *Pseudomonas* spp. a predominant soil bacterium, suggest transmission brought in from foot wears and settling of dust suspensions [36, 12, 37].

The isolated bacterial pathogens on door handles and student's palms in this study are consistent with the findings of other researchers [31, 22, 38, 39, 16], with *Staphylococcus* spp. being the most prevalent. *Staphylococcus* and *Pseudomonas* have been linked to urinary tract infections, bacterial diarrhoea, bacterial meningitis and bacterial pneumonia [21.]

This is also in agreement with Fakhoury and Nawas [41], who attested that the frequently or heavily used fomites are most likely contaminated and therefore carry higher heterotrophic bacterial loads and also sanitary conditions in public places have always been a major problem, especially in the offices since some organisms are able to survive for weeks and months in dry areas. The fact that these contaminants were at high level in these environments is of great concern, especially with the increasing number of immuno-compromised individuals.

Contaminated and improperly washed hands contaminate door handles, that is to say there is a high level of bacterial contamination which may lead to high level prevalence of the bacterial infectious disease due to contaminants. The isolation of pathogenic bacteria from the office door handles and students palms in this study indicates that they could be vehicle of disease transmission as microbial contamination of office door handles and students palms may be a common means of transfer of potentially pathogenic bacteria among users.

## V. Conclusion

This study has revealed that office door handles and palms of students of Faculty of Applied Natural Sciences (FANS) of Enugu State University of Science and Technology (ESUT) are contaminated by a variety of pathogenic and non-pathogenic bacteria. The bacterial species: *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas* spp., *Salmonella* spp. and *Klebsiella* spp. were isolated from office door handles and palms of students of Faculty of Applied Natural Sciences (FANS) of Enugu State University of Science and Technology (ESUT). The presence of the aforementioned bacterial species is an indication that public contact surfaces such as door handles and human palms are often colonized by pathogenic bacteria and may serve as a reservoir of bacteria and potential source of infections. It was observed that many students harbour some bacteria on their palms without knowing, hence transmitting varying degree of bacteria to door handles or to other individuals. It is therefore a necessity that personal hygiene be made a priority so as to help curb the public health hazards that may be associated with these contaminated door handles. It is therefore recommended that sanitizers and disinfectants should be provided to cleaners to disinfect door handles at any intervals to reduce bacterial load. Students should also sanitize their palms at intervals to reduce transmitting their indigenous bacteria to door handles. Washing hand basins should be provided for visitors, staff and students to wash their hands to minimize cross contamination of bacteria. Personal hygiene and handwashing practice should be a routine to all individuals to avoid transmitting pathogenic organisms.

**Conflict of interest:** There was no conflict of interest declared.

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