Assessing Risk on High-Traffic Surfaces: Bacterial Burden and Antibiotic Resistance

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Abstract

Research has shown significant amounts of Staphylococcus species on non-living surfaces in health care environments. However, the door handles and handrails of other public places have not received much attention. This particular study focused on evaluating the prevalence and distribution of Methicillin-Resistant Staphylococcus aureus (MRSA) on door handles and handrails across three selected tertiary institutions. Ninety (90) samples were obtained from door handles and handrails of these strategically selected institutions roped in for this study, whereas ten (10) samples were obtained from the university's clinic used as a control to compare Staphylococcus species concentrations of both settings. Swab samples were aseptically collected and cultured on Mannitol salt agar. Incubation was carried out for 24 hours at 37 °C, after which purification was done for the antibiotic susceptibility test using disc-embedded antibiotics: Ampicillin, Oxacillin, Ciprofloxacin, and Sulfamethoxazole / Trimethoprim. Out of the total 100 samples collected from both settings, 73% showed no growth, while 27% exhibited microbial growth, of which 21% and 6% Staphylococcus aureus (SA) and Coagulase-Negative Staphylococci (CoNS) were isolated respectively. Among the Ninety (90) samples collected from the tertiary institutions, SA accounted for 20%, and CoNS made up 5.6%. In contrast, in the university clinic, 30% of the samples tested positive for SA, and 10% for CoNS out of the ten (10) samples collected. Out of the 21 cultured plates that indicated positive for SA, 4.8% were found to be MRSA due to their resistance to Oxacillin and Ampicillin. Other strains of SA show sensitivity of 95.2%, 85.7%, 95.2% and 81% to CIPROFLOXACIN (CIP), OXACILLIN (OX), AMPICILLIN (AM), and SULFAMETHOXAZOLE-TRIMETHOPRIM (SXT), respectively. All SA isolates were sensitive to CIP, while some were resistant to OX (4.8%), AM (4.8%), and SXT (4.8%). This study revealed that a significant percentage of the collected samples exhibited microbial growth (27%), with 21% showing SA and 6% showing CoNS. MRSA was found in 4.8% of SA isolates, which indicates the presence of antibiotic resistance in these strains. The prevalence of SA was higher in the university clinic (30%) compared to the tertiary institutions (20%). These findings highlight the potential risk of surface contamination by MRSA and other Staphylococcus species in both healthcare and non-healthcare environments, emphasizing the need for regular monitoring and preventive measures. Cleaning and disinfection should be targeted more on door handles and handrails to reduce the spread of MRSA.

Keywords: *Staphylococcus aureus, MRSA, Mannitol Salt Agar, Antibiotic resistance*

1.0 INTRODUCTION

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a group of gram-positive bacteria that are genetically distinct from other strains of *Staphylococcus aureus* bacteria that have developed resistance to multiple antibiotics, including methicillin. (Nandhini *et al.*, 2022). Strains of *Staphylococcus aureus* that have acquired multiple drug resistance to beta-lactam antibiotics through horizontal gene transfer or natural selection are referred to as MRSA, and this may account for several bacterial infections that pose treatment challenges. (Alghamdi *et al.*, 2023). These treatment challenges may be observed in some class of broad-spectrum antibiotics known as beta-lactams, including some penams (derivatives of penicillin such as methicillin and oxacillin) and cephems (such as the cephalosporins) (Lima *et al*., 2020). Strains that are unable to resist these antibiotics are classified as methicillin-susceptible *S. aureus* (MSSA). Although MRSA continues to cause infections in various body sites, its resistance to multiple classes of antibiotics significantly limits treatment options and increases morbidity and mortality, particularly in healthcare and community settings. (Gao *et al*., 2021).

MRSA was initially a hospital-acquired infection, but it has since spread to the community and been found in livestock (Fetsch *et al*., 2021). *Staphylococcus aureus* is a common microbe in humans that lives on skin, in the gut mucosa, and in the upper respiratory system (Abdulbaqi and Ibrahim, 2023). The resulting infection has been referred to as a "pathobiont"; however, together with similar bacterial species that can colonize and operate symbiotically, they might cause disease if they start to take over the tissues they have colonized or invade other tissues (Ganesan *et al.,* 2022). Small red bumps that resemble pimples, spider bites, or boils are the MRSA's primary symptom, and they occasionally come with fever and rashes (Shaheen Sharif *et al*., 2019). The lumps get larger and more painful over the course of a few days before eventually breaking open to reveal deep, pus-filled boils. "Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) refers to MRSA infections occurring in individuals without recent healthcare exposure." Skin and soft tissue infections caused by CA-MRSA account for about 75% of cases and are typically efficiently treated (Nakaminami *et al.,* 2020). MRSA may, however, be prevalent on door handles and handrails, which are High Human Contact Surfaces (HHCS) with the potential to harbour bacteria, including MRSA (Ashur *et al*., 2022). The extent of challenge posed will depend on how regularly these surfaces are cleaned and disinfected. MRSA can survive on surfaces for an extended period, making it possible for it to be present on door handles (Xiao *et al*., 2019). However, the actual prevalence of MRSA on door handles in a specific tertiary institution would depend on several factors, including the frequency of cleaning, the adherence to infection control protocols, and the overall hygiene practices followed by the individuals in that environment (Kociolek *et al.*, 2023). MRSA usually spreads in the community through contact with infected wounds and sharing of towels, sponges, and razor blades that have been infected as a result of usage by an infected person (Pujalte *et al.*, 2023). MRSA can take hold of the human tissues and cause severe infection, which may result in sepsis or even death, since it has resistance to a wide range of antibiotics. In diagnosing MRSA, various laboratory processes are taken into consideration in order to identify the different strains of *Staphylococcus aureus* (Guo *et al.*, 2020). Fluid samples such as blood, urine, sputum, or even body fluid samples are cultured using appropriate medium and are requested during diagnoses (Pujalte *et al.*, 2023). Since there is no quick and easy method for diagnosing, treatment is initially administered based on strong suspicion and techniques that may include quantitative PCR procedures (Oliveira *et al.*, 2023). Another common laboratory test is a rapid latex agglutination test that detects the PBP2a protein, which is a variant penicillin-binding protein that impacts the ability of *staphylococcus aureus* to be resistant to oxacillin (Pokhrel *et al*., 2020). The presence of MRSA on door handles can undermine infection control efforts, increase the risk of MRSA-related infections among students, staff, and visitors, and potentially lead to outbreaks. MRSA is responsible for several difficult-to-treat infections in humans. In 2019, MRSA caused more than 100,000 deaths attributable to antimicrobial resistance (Tsuzuki *et al*., 2021).

This study aims to assess the ubiquity of Methicillin-Resistant *Staphylococcus aureus* among some selected highly populated tertiary institutions within Kumasi. The likelihood of MRSA occurring and its prevalence rate in all of the selected schools could be dangerous to the health of staff, students, and visitors to the institution if not assessed and curtailed.

2.0 MATERIALS AND METHODS

2.1 Study area

Three tertiary education institutions in Kumasi, located in the heart of the Ashanti region, were selected for the study: Kwame Nkrumah University of Science and Technology (KNUST), Kumasi Technical University (KsTU), and Ghana Baptist University College (GBUC). Kumasi (Figure 1) is situated roughly 200 kilometres (125 miles) north of the Gulf of Guinea and 500 kilometres (312 miles) north of the Equator. Kumasi, the commercial, industrial, and cultural centre of the medieval Ashanti Empire, was located in a marsh close to Lake Bosomtwe. Due to the numerous flower and plant species that once grew in Kumasi, the city is also known as “The Garden City.” The name Oseikrom was given to it in honour of Osei Kofi Tutu I. After Accra, the Nation’s capital, Kumasi is the second-largest city in Ghana. Areas like Adum, Bantama, Kejetia, Asawasi, Pampaso, and Bompata (commonly known as Roman Hill) are part of Kumasi’s Central Business District, which has a concentration of banks, department stores, and hotels. There are 1,254 health facilities comprising 1,120 CHPS facilities, 29 clinics, 71 maternity homes, 165 health centres, 5 polyclinics, 26 district hospitals, 1 Regional hospital, 1 University hospital, 1 Teaching hospital, and 125 hospitals in the Ashanti Region, where Kumasi is situated. In Kumasi, there are 108 Senior Secondary Schools (SHS) and Primary schools put together. The tertiary schools of Kumasi are represented by 5 universities, which offer 55 study programs. **[Source; Statsghana.gov.gh, https://en.wikipedia.org/wiki/Kumasi]**

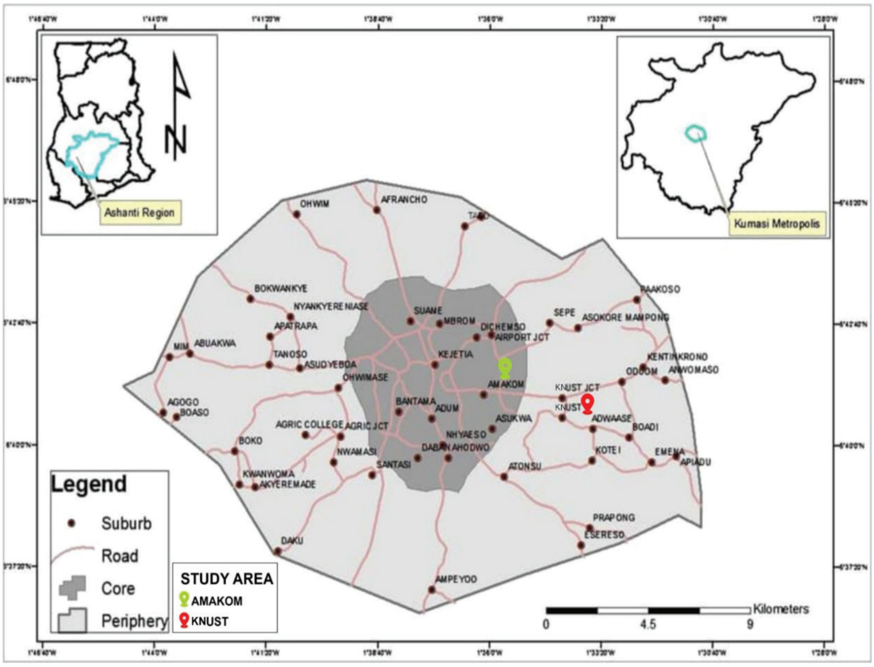

Figure 1: Map of Kumasi external from the map of Ghana, indicating individual study areas; Amakom (Green symbol) and KNUST (Red symbol) ***[Source: Cartography Unit, University of Cape Coast, 2010]***

2.2 Study design

The study was a cross-sectional investigation to determine the distribution of Methicillin-Resistant *Staphylococcus aureus* on door handles and handrails at the selected tertiary institutions included in the study. The areas studied were purposively sampled. Lecture halls, frequently used doors, and handrails were included in the investigation study. The personal hygiene practices of the institutions were assessed using a questionnaire. Thirty (30) individuals were selected from each of the tertiary institutions, and ten (10) from the clinical setting that participated in the study through interviews, assisted by well-structured, pre-tested questionnaires. In all, one hundred (100) participants were interviewed.

2.3 Study Size

The study was conducted among three highly recognized and populated tertiary institutions in Kumasi. Using the *Infinite population proportion formula*, the study employed a practical sample size of one hundred (100) based on the selection of regularly used door handles and handrails on the campus of these Universities. Hundred (100) questionnaires were also administered to individuals within the tertiary institutions under the study who consented to complete them with assistance from the field personnel. The sample size was estimated using the Cochran (1977) formula.

$$n = \frac{Z^2.p.(1-p)}{E^2}$$

Where n is the sample size, Z is the Z-score corresponding to the desired confidence level (of 95%, it's approximately 1.96), p is the estimated population prevalence of MRSA (7%, or 0.07 as a decimal), and E is the margin of error (5% or 0.05 as a decimal).

$$n = \frac{(1.96)^2.0.07.(1-0.07)}{(0.05)^2}$$

A minimum of 100 samples was obtained.

2.4 Laboratory analysis

2.4.1 Sample collection

Door handles and handrail were aseptically swabbed with a sterile cotton swab stick and carefully inserted into a container containing brain heart infusion to preserve the viability of the test organism within the sample during transportation. These were then kept in a cooling chamber and, without wasting time, transported to the microbiology laboratory of the Department of Laboratory Technology for analysis.

2.4.2 Culture and Identification

Aseptic techniques were strictly adhered to to prevent contamination during sample handling during laboratory investigation. Samples on sterile swabs were streaked aseptically on Mannitol Salt Agar, which is selective for *Staphylococcus species,* and incubated for 24 hours at 37°C. Culture plates were then observed for growth after this period of incubation, and in the absence of growth, re-incubation was done for the same period and at the same temperature, after which the final reading was recorded as presence or absence of growth. With plates that presented considerable growth, colonies were counted, and later confirmation tests were conducted.

2.4.3 Confirmatory Test

Morphological identification and Gram staining processes were carried out to ascertain the type of microorganisms as confirmation of the test microorganism. Immediately, the Gram staining procedure was conducted to determine if the test microorganism was a Gram-positive bacterium in the first place to be considered for the next step of identification. When this process was ascertained, the species confirmatory test was conducted. The coagulase test was used to distinguish *Staphylococcus aureus* from the other *Staphylococcus species.* Coagulase enzyme produced by *S. aureus* is one of the important confirmatory tests used to definitively ascertain the test organism *(S. aureus)* in a sample or a culture. The slide agglutination test was initially carried out for easy and fast confirmation; however, if the results indicated negative, then the tube agglutination test, which provided a definitive result, was run. With the slide agglutination method, which provided a very quick result on the same day, a thick, waxy pencil was used to make a mark of at least a 1.5-inch diameter circle on a sterile glass slide. About 0.5 ml of rabbit plasma stock was dropped on the demarcated circle, and a loopful of inoculum containing the test organism was placed into the plasma and carefully emulsified. If the test organism is *S. aureus,* within 10-20 seconds, a visible dumping of the cells was observed, indicating a bound coagulase enzyme. However, if, after this period, no such observations were made, then the tube coagulase test was run. In this case, inoculation was done by putting about 0.5 ml of the rabbit plasma stock into the test organism and incubating at 37 °C. This was observed on the following day for any degree of coagulation, which indicated a positive result for free coagulase enzyme.

2.4.4 Antibiotic sensitivity testing

Antibiotic sensitivity testing was carried out on culture plates that were purified and confirmed as containing *S. aureus.* Purely confirmed plates were used to prepare culture on Muller-Hinton agar and incubated at 37^0C for 24 hours. Beta-lactam antibiotic wafers were added to the culture plates. These plates were then inverted and incubated overnight at 37^0C for 24 hours where the results were read as sensitive or resistant based on the reference values provided in the table by the manufacturer.

2.5 Data input, validation, and analysis

As soon as the results were obtained from the laboratory investigations, the data were promptly, precisely, and accurately entered into Microsoft Excel version 2019. After that, the data was cleaned and its accuracy and ranges checked. A clean, valid, and high-quality result for analysis was obtained by correcting errors or discrepancies that were found and rectifying inconsistencies. Following data analysis, the results were presented as tables, graphs, and charts with descriptive data where appropriate.

3.0 RESULTS

3.1 Number of plates indicating microbial growth from the total samples inoculated

Out of the total of one hundred plates inoculated with the swab samples from the field, of which Ninety (90) were samples from the tertiary institutions and ten (10) from the health facility serving as a control, 27% indicated bacterial growth and 73% had no growth (Figure 2)

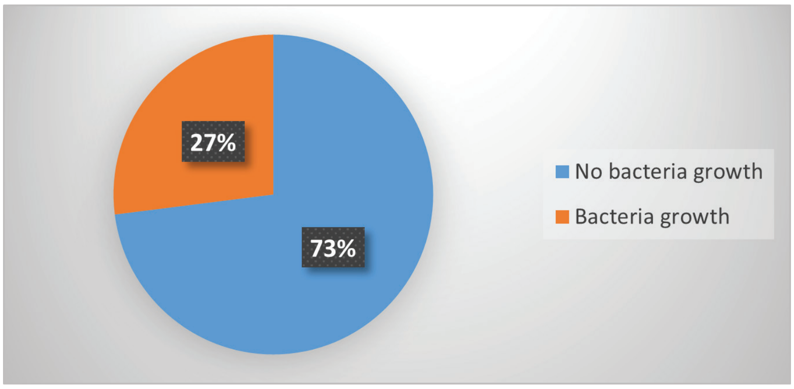

Figure 2: Showing bacteria growth after culture

3.2 Prevalence of bacteria after a confirmatory test

Generally, it was revealing to establish that, within the Ninety (90) samples collected from the tertiary institutions, coagulase-positive *Staphylococcus aureus* accounted for 20% (Figure 3), whereas coagulase-negative *Staphylococcus species* (CoNS) accounted for 5.6%. The health facility of one of the tertiary institutions, where ten (10) samples were obtained and used as a control, which indicated 30% and 10% for coagulase-positive *Staphylococcus aureus* and CoNS, respectively

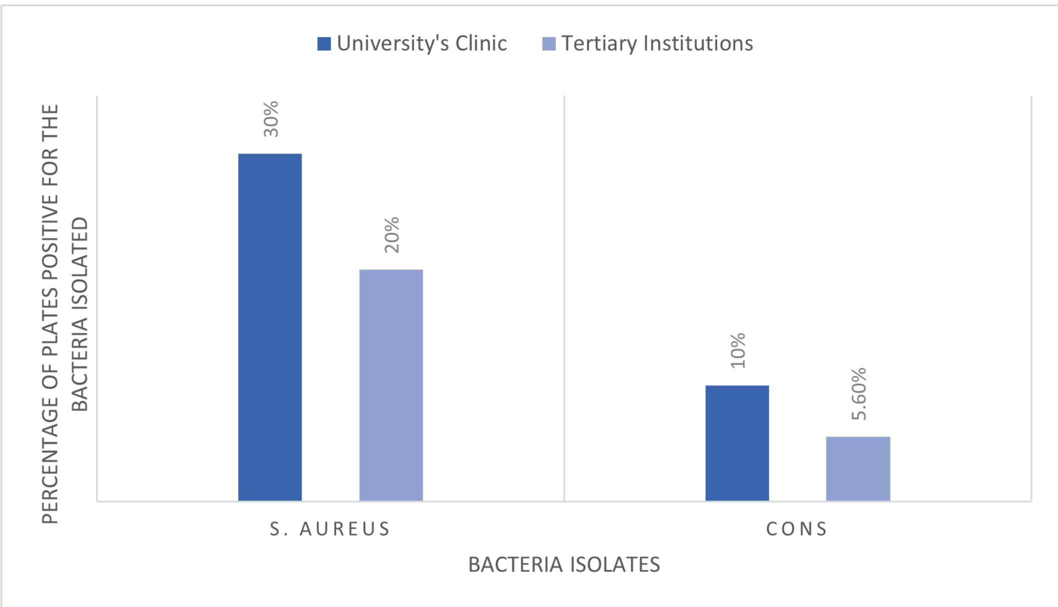

Figure 3: prevalence of bacteria isolated from the tertiary institutions and the University clinic(Control).

3.4 Prevalence of bacteria isolated from the various tertiary institutions

Out of the 27 plates that indicated growth of bacteria, GBUC recorded the highest number of plates with microbial growth, followed by KsTU and then KNUST. These were recorded as: GBUC (30%, 13%), KsTU (26%, 4.3%), KNUST (22%, 4.3%) for *Staphylococcus aureus* and CoNS, respectively (Figure 4).

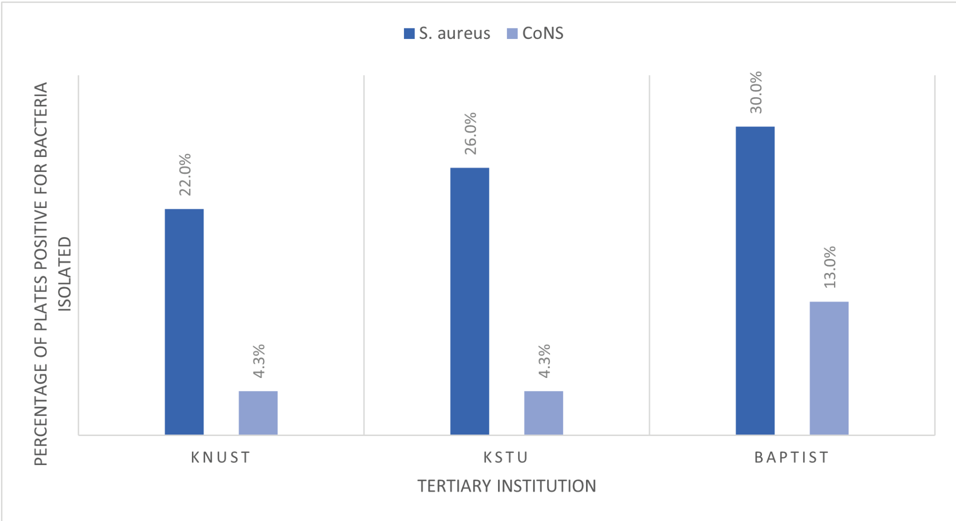

Figure 4: Bacteria prevalence from the various institutions

3.5 Antibiotic susceptibility test for S. aureus

S. aureus isolates from the laboratory preparations were subjected to broad-spectrum susceptibility testing using antibiotic-embedded wafers of Ciprofloxacin, Oxacillin, Ampicillin, and Trimethoprim, among others. One sample containing *S. aureus* was resistant to both Oxacillin and Ampicillin, indicating 1/21 (4.8%) in each case (Figure 5).

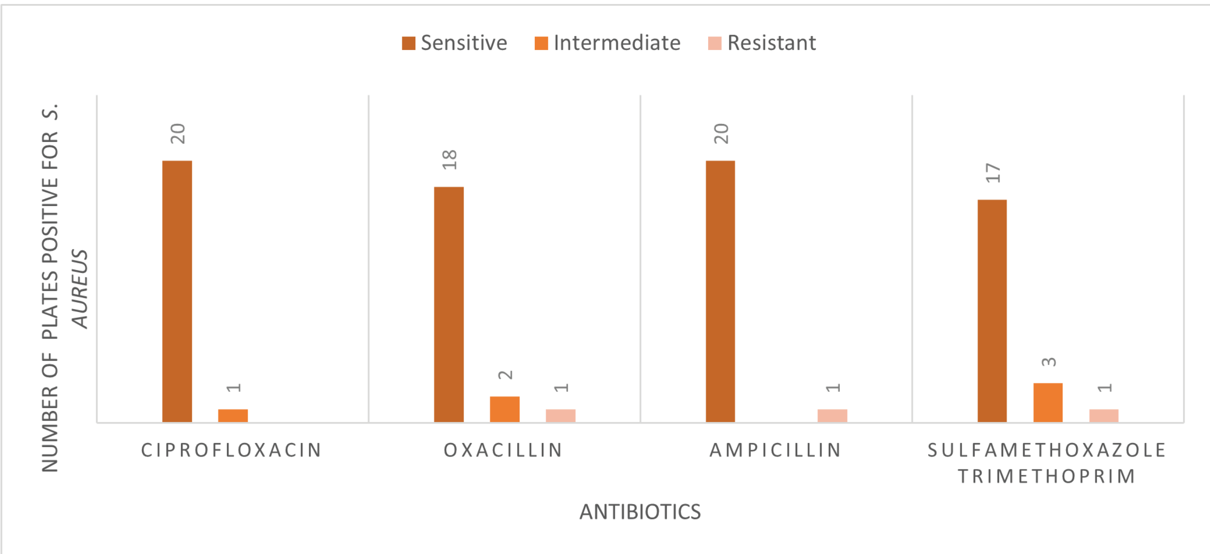

Figure 5: Susceptibility patterns exhibited by the S. aureus to the various antibiotics.

3.6 Knowledge and perception of participants on MRSA

This study established that the majority of the participants (61%) interacted with were not aware of the medical importance of MRSA (Figure 6). A higher number of participants (85%) had limited knowledge about the infection transmission and the associated health risk of MRSA. After careful explanation, 89% expressed the possibility of the potential virulence of MRSA.

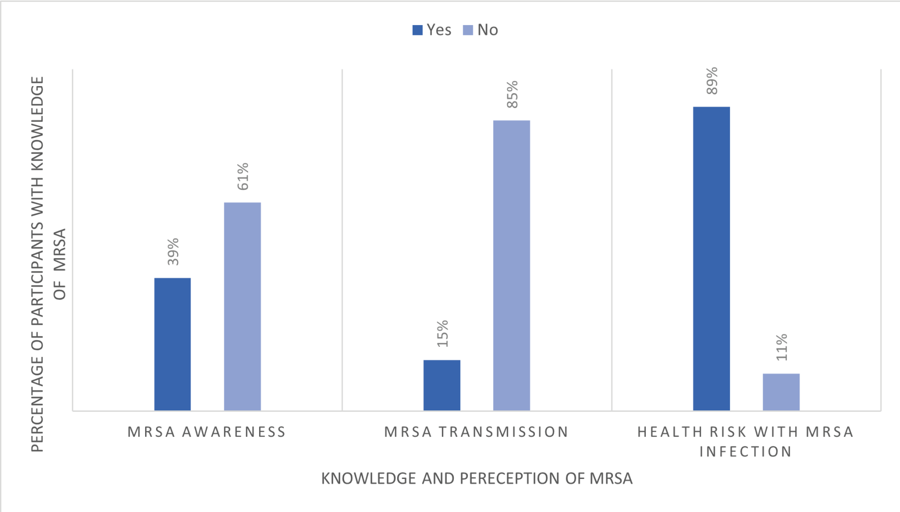

Figure 6: Knowledge and perception of MRSA

3.7 Adherence to proper hand hygiene

Participants' hand washing assessment revealed that 21% regularly wash their hands after coming into contact with door handles and handrails, whereas 40% were inconsistent in these areas (Figure 7). About 92% wash their hands after visiting the toilet, while 8% did not mind washing their hands. Among the 100 participants, 52% occasionally wash their hands with soap under running water, compared to 29% who do so regularly. 25% indicated that they use hand sanitizers frequently, while 28% were recorded as havingn't cultivated the habit of making hand sanitizers their companion.

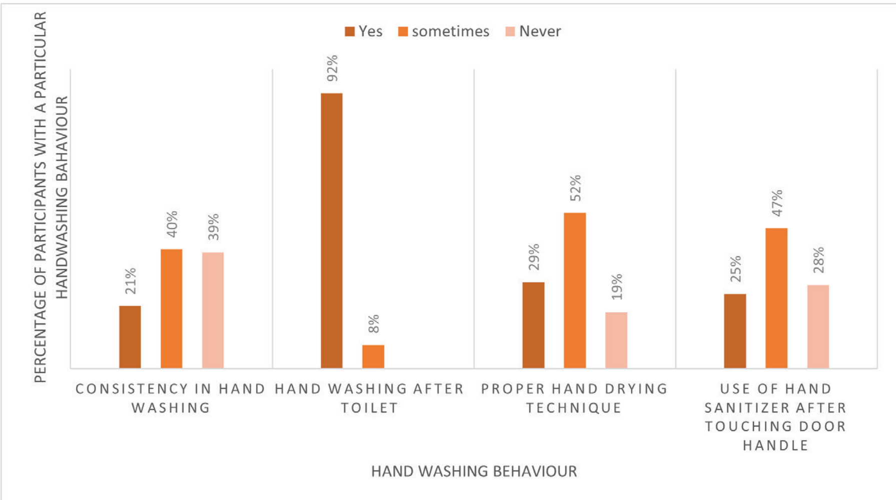

Figure 7: Participants' hand washing behaviour

4.0 DISCUSSION

The increasing difficulty in identifying effective antibiotics for the treatment of MRSA infections has become a major public health concern (Pierre et al., 2023). This is so because of its persistent resistance to antimicrobial activity of most conventional antibiotics, including penicillin derivatives such as oxacillin or methicillin (Nandhini *et al.,* 2022; Alghamdi *et al.,* 2023). The use of door handles and other human contact surfaces enhance the persistence and transmission from person to person (Chu *et al*., 2022). Moreover, poor hand hygiene behaviours substantially contribute to its perpetuation, hence undermining efforts to contain the spread and infections associated with these bacteria (Papadimos *et al*., 2020). Though *S. aureus* is regarded as part of the normal microflora in certain parts of the body, including the upper respiratory tract, gut mucosa, and skin (Abdulbaqi and Ibrahim, 2023), they are capable of causing disease when they invades other tissues. Moreover, MRSA was mostly considered as a hospital-acquired infection, but has increasingly become a community and livestock–acquired infection currently (Mouftah and Elhadidy, 2020). This current study, therefore, assessed the prevalence of MRSA among selected tertiary institutions, taking into account the potential places of harbour and transmission of the bacteria, including door handles and handrails. The personal hygiene behaviour of participants and knowledge of MRSA and its medical importance were further assessed.

4.1 Prevalence of *S. aureus* and MRSA

Globally, the prevalence of *S. aureus* and methicillin-resistant *Staphylococcus aureus* varies across the regions. This may be due to variations with the use and misuse of antibiotics, medical care-seeking habits for screening and treatment of microbial infections, availability and affordability of healthcare, incidence and management of other infections known to be markers for MRSA colonization, as well as sanitation and hygiene practices. (Shiadeh *et al.,* 2022). Studies conducted in Southeast Asian and Western Pacific Nations established that between 2 and 69 percent of people presenting with *S. aureus* infections exhibited MRSA to some extent. (Shiadeh *et al*., 2022). In contrast, this current study presented a low level of bacteria growth (27%) according to Figure 2, but further coagulase tests indicated the presence of *S. aureus* (20%)*, which* was high compared with CoNS (5.6%) among the positive samples from the tertiary institutions. A key limitation of this study was the relatively small sample size, as only ten samples were analyzed, which may have introduced sampling bias and limited the generalizability of the findings. The healthcare setting, which was used as a control, indicated high percentages of bacterial growth, and subsequent analysis also revealed a high percentage of *Staphylococcus aureus* compared to the tertiary community, though variations were observed among the communities. These observations suggest that contextual and environmental factors may have influenced bacterial distribution, and future studies with larger sample sizes and broader sampling frameworks are needed to validate these findings. (Boswihi and Udo, 2018). Generally, *Staphylococcus aureus* is a common bacterium considered as a normal flora and can colonize the skin and mucous membranes of humans without causing illness. (Pal *et al*., 2020). Asymptomatic healthcare workers and patients can carry these bacteria, increasing the risk of transmission in clinical settings. However, Methicillin-Resistant *Staphylococcus aureus* (MRSA) has developed resistance to multiple antibiotics, rendering treatment regimens ineffective and cumbersome. (Gopikrishnan and Haryini, 2024). Due to the function of the hospitals and clinical settings, coupled with numerous frequently touched surfaces, the risk of contamination with *Staphylococcus aureus* is high compared to the environment of educational institutions. (Facciolà *et al*., 2019). *Staphylococcus aureus* normally presents itself as a common workplace bacterium in the out-patient department (OPD) of the hospitals. (Nwabuife *et al*., 2021). As a result of invasive medical procedures in the hospitals, such as surgical, indwelling devices like catheters and central lines, *Staphylococcus aureus* can gain easy access into the body and even the bloodstream, resulting in sepsis (Lee *et al*., 2018). This study revealed different prevalence rates of *Staphylococcus aureus* among the tertiary institutions under study.

Inaccessibility to clean and well-maintained sanitary facilities and inadequate hygiene infrastructure can increase the risk of contamination and transmission of bacteria. (McGinnis *et al*., 2019). Smaller institutions might have a higher student-to-space ratio, resulting in crowded classrooms and common areas. Overcrowding could be a risk factor for the spread of infections, and also, smaller institutions may have limited access to healthcare or well-resourced medical services, making it challenging to screen, manage, or treat *Staphylococcus aureus* infections promptly. (Xu and Liu, 2018).

This current study, which focused on investigating the ubiquity of MRSA on door handles and handrails, is in agreement with the study by Ashur and colleagues, who reported that bacteria, including MRSA harboured on inanimate contact surfaces, including door handles (Ashur *et al*., 2022). Compared to the prevalence rate of *S. aureus* in this current study, a consistently increasing rate was reported by Bustamante (2014) (Morgan Bustamante *et al*., 2024). In Ghana, about five (5) years ago, a similar study was conducted agrees with this current study's result (Donkor *et al*., 2024). Methicillin Resistance *Staphylococcus aureus* pose serious antimicrobial challenges and if an individual faced with this fall in the category of immunocompromised, then it may result in fatality (Fu *et al*., 2021). The low prevalence of MRSA (4.8%) recorded in this study in Figure 5 may be due to the fact that tertiary institutions typically consist of a younger and healthier population compared to clinical settings (control), which recorded a higher prevalence. Young adults tend to have better immune systems, making them less susceptible to infections (Weatherhead *et al.*, 2020). Moreover, tertiary institutions often have different environmental conditions than clinical settings, which are designed to manage and treat patients with various illnesses, which can contribute to a higher rate of bacterial contamination (Shafran *et al.*, 2021). Unlike clinical settings, where invasive medical procedures are common, tertiary institutions do not typically perform surgical or indwelling devices (catheters, vascular access devices, endotracheal tubes, tracheostomies, enteral feeding tubes, and wound drains) services, which provide risk for infection (de Oliveira Santos et al., 2022). In clinical settings, antibiotics are frequently prescribed, contributing to antibiotic-resistant strains like MRSA (Li and Webster, 2018). Tertiary institutions may have less antibiotic use, reducing the selection pressure for resistant bacteria. Clinical settings often have a higher density of individuals with underlying health conditions, which can lead to increased transmission of bacteria (Baker-Austin et al., 2018). These infections can vary in severity from mild to life-threatening. Infections with *Staphylococcus aureus*, especially antibiotic-resistant strains like MRSA, can lead to prolonged hospital stays, increased healthcare costs, and higher morbidity and mortality rates, particularly in vulnerable populations (Li and Webster, 2018).

In surgical settings, *Staphylococcus aureus* infections can lead to surgical site infections, wound complications, and the need for additional procedures to treat and control the infection. (Kawakita and Landy, 2017). High prevalence of *Staphylococcus aureus* increases the risk of nosocomial (hospital-acquired) outbreaks. These outbreaks can result in the temporary closure of hospital units, patient transfers, and the diversion of resources to control the spread. (Denis, 2017). The treatment of *Staphylococcus aureus* infections, particularly antibiotic-resistant strains, can place a substantial economic burden on healthcare systems due to longer hospitalizations, the use of expensive antibiotics, and the need for infection control measures. (Nanayakkara *et al.*, 2021). Notwithstanding, students and staff members in the institutions under study may be at a higher risk of *Staphylococcus aureus* infections, including skin and soft tissue infections, respiratory infections, and other health issues due to the prevalence of *Staphylococcus aureus* and MRSA (Hindy *et al*., 2022) recorded in this current study. Clusters of *Staphylococcus aureus* infections can occur within the institution, leading to outbreaks that may disrupt regular academic activities and require public health interventions, resulting in student absenteeism, decreased academic performance, and physical discomfort, affecting the overall well-being of students (Piret and Boivin, 2021).

4.2 Knowledge and Perception (KAP) and Hand Hygiene Pattern (HHP) of participants

Due to the key involvement of human interaction with inanimate surfaces involved in this study, further evaluation of the Knowledge and Perception (KAP) of participants was conducted(Al-Qahtani, 2023). This included the hygiene practices of the participants interviewed for the study (Figure 6) to ascertain their understanding of the existence of multiple-drug resistant bacteria, such as MRSA, in relation to KAP and HHP behaviour, which could influence the perpetuation of the bacteria and bacterial infection(Finlayson *et al*., 2019). The high prevalence of bacterial infection, coupled with inadequate medical infrastructure in this part of the Globe, the best method to reduce the chances of microorganisms of medical importance surviving and proliferating is the extent of KAP and HHP (Hulme, 2022). When these areas are well understood by the populace, and some minimal preventive measures are put in place, then the majority of these challenges may be reduced to the barest minimum (Mburu and Odame, 2019). This study established that the majority of the participants are not aware of MRSA or its association with multiple-drug resistance challenges (Garoy *et al*., 2019). Again, an equally high percentage of the participants expressed no knowledge of the mode of transmission and patterns of MRSA (Gurung *et al.*, 2020). However, the majority of participants agreed upon indicating to them the challenges associated with MRSA, the possibility of potential health risks associated with it (Mascaro *et al*., 2019). These findings imply that, though the majority of the participants may not have clear knowledge of the prevalence and mode of transmission of MRSA, the majority of them accept its potential medical importance (Jaber *et al.*, 2023). Though personal hygiene and handwashing behaviour play a crucial role in bacterial contamination and perpetuation, this study established that, majority of participants most often do not wash their hands, while only a few participants engaged in that (Budge *et al.*, 2019). However, in the event of visiting the toilet, almost all participants reported frequent washing of their hands, while a few admitted inconsistencies (Hammerschmidt and Manser, 2019). The method of handwashing by participants was varied; some used soap and water, others used only water, another group showed inconsistency, and the last group indicated that they only rely on hand sanitizers are a means of getting rid of germs from their hands after visiting the toilet (Singh *et al*., 2020). Some studies have proven that hand sanitizers are equally effective in maintaining hand hygiene, though the efficiency may vary from product to product (Zimmerman *et al*., 2022).

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The ubiquity of Methicillin Resistant *Staphylococcus aureus* study on Door Handles and Handrails carried out revealed that MRSA strains are not only present in hospital settings, as the majority have fathomed. Educational settings have indicated the presence of these medically investigated microorganisms, which may be equally present in other geographical areas and places of proximity, and attention should be extended to all these places. The mode of transmission is not well understood by the majority, and therefore, a link for cross-contamination and risk of infection. Though after the "COVID-19" pandemic, Institutions have been involved in training their employees on good hand hygiene protocols by demonstrations to the individuals in the institutions, which is a positive step; however, its effectiveness in minimizing *Staphylococcus aureus* and MRSA transmission needs to be evaluated

5.2 Recommendations

The clinical and tertiary community should enhance environmental cleaning and disinfection practices targeting inanimate objects to minimize the reservoirs of *Staphylococcus aureus* and MRSA. Regulations and guidelines for infection control in clinical settings and educational institutions, with a focus on MRSA prevention, should be developed and enforced. Educational programs should be implemented to raise awareness about MRSA transmission, prevention, and hygiene practices. This training and education could be done through television programmes, workshops through face-to-face and virtual, distribution of information through flyers, among others. Research outcomes should be shared with policymakers, healthcare providers, and educational institutions to inform evidence-based decision-making.

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Institutional Review Board Statement

Ethical review and approval did not apply to this study.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study

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Authors Conflict of Interest

Authors declare no conflict of interest.

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