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ISOLATION AND IDENTIFICATION OF BACTERIA ON TOILET DOOR HANDLES OF FEMALE HOSTELS OF ZAMFARA STATE UNIVERSITY TALATA MAFARA, ZAMFARA STATE.

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ABSTRACT

This study focused on the isolation and identification of bacteria from toilet door handles in female hostels at Zamfara State University. It highlights the risk of pathogenic microorganisms on frequently touched surfaces, aiming to isolate bacterial contaminants, identify species, determine bacterial load, compare contamination levels across hostels, and assess public health implications. A total of 200 samples were analyzed using standard microbiological techniques, including sterile swab collection, culturing, isolation, and biochemical identification. Descriptive statistics and various statistical tests, including Chi-square analysis and One-Way ANOVA, revealed that the mean bacterial count on toilet door handles was 115.34 CFU, with contamination levels between 5 and 250 CFU. The main bacterial isolates identified were Escherichia coli (30.0%), Staphylococcus aureus (27.5%), Klebsiella spp (17.5%), Pseudomonas spp (12.5%), and Salmonella spp (12.5%). Statistical analysis indicated significant contamination differences among hostels ($p < 0.05$), highlighting poor hygiene and sanitation. The study notes that toilet door handles in female hostels may contribute to microbial transmission and public health risks. Recommendations include enhanced sanitation practices, regular disinfection, proper hand hygiene, and ongoing health awareness campaigns to mitigate contamination and prevent disease spread.

KEYWORDS: Isolation, Bacteria, Toilet Door Handles, Female Hostels.

1. INTRODUCTION

Bacteria are microscopic organisms that are widely distributed in the environment and can be found on surfaces frequently touched by humans. High-contact surfaces such as toilet door

handles serve as important reservoirs for pathogenic microorganisms because they are constantly exposed to contamination through human contact. These surfaces can easily facilitate the transmission of infectious agents from one individual to another, especially in crowded environments such as schools, hospitals, and student hostels (Appiah et al., 2025). Public toilets are among the most contaminated environments due to poor sanitary practices, inadequate hand washing, and frequent usage by large numbers of people. Toilet door handles are particularly important in the spread of microorganisms because individuals often touch them before and after using the toilet. Studies have shown that bacteria such as *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella* species, and *Salmonella* species are commonly isolated from toilet door handles and other frequently touched surfaces. These organisms are associated with diseases such as urinary tract infections, diarrhea, skin infections, and respiratory tract infections (Olajubu, 2018).

Hostel environments in higher institutions provide favorable conditions for the spread of bacteria because many students share common facilities including toilets, bathrooms, and door handles. Female hostels are often characterized by heavy traffic and continuous use of sanitary facilities, increasing the likelihood of microbial contamination. Poor hygiene practices, improper cleaning methods, and inadequate disinfection of toilet facilities may further increase the presence and transmission of harmful bacteria within hostel environments (Nwinyi & Boluwatife, 2024).

Recent studies on microbial contamination of door handles revealed that toilet door handles possess higher contamination rates compared to many other public surfaces because of constant hand contact and exposure to fecal microorganisms. A global systematic review reported that toilet door handles had one of the highest contamination rates among public-contact surfaces, emphasizing the public health importance of monitoring such fomites (Appiah et al., 2025). The isolation and identification of bacteria from toilet door handles are therefore important in determining the level of contamination and the potential health risks associated with these surfaces. This study aims to isolate and identify bacteria present on toilet door handles of female hostels in Zamfara State University, Talata Mafara, Zamfara State. The findings of the study will help create awareness on personal hygiene, environmental sanitation, and infection prevention among students and hostel management.

1.1 Bacterial Contamination of Toilet Door Handles as a Public Health Concern

The transmission of infectious diseases through contaminated environmental surfaces remains a serious public health concern worldwide. Frequently touched objects, commonly

referred to as fomites, play a significant role in the spread of pathogenic microorganisms among humans (Flores et al., 2011). Among these fomites, toilet door handles have been identified as important reservoirs of microorganisms because they are constantly exposed to contamination through repeated human contact and poor hygienic practices (Baker & Bloomfield, 2000). Public toilets, especially those located in schools, universities, hospitals, and other crowded environments, are highly susceptible to bacterial contamination due to their frequent usage by large numbers of individuals (Nworie et al., 2012). Several studies have reported the presence of pathogenic bacteria on hard, non-porous surfaces such as kitchen counters, toilet seats, floor surfaces, sinks, and door handles, from where microorganisms can easily be transferred to unsuspecting individuals (Bright et al., 2010; Rusin et al., 1998). These contaminated surfaces may harbor bacteria associated with human skin flora and intestinal flora, indicating contamination from inadequate hand washing and fecal matter (Fierer et al., 2008). According to Maori et al. (2013), toilet door handles in public facilities often contain bacteria capable of causing infections, thereby posing health risks particularly to immunocompromised individuals.

In Nigeria, studies conducted in various public institutions have demonstrated a high prevalence of bacterial contamination on toilet door handles. Nworie et al. (2012) observed that door handles in public conveniences within Abuja metropolis served as potential sources of infectious disease transmission. Similarly, Odigie et al. (2017) reported that contaminated door handles contributed significantly to the spread of microorganisms of public health importance in hospital environments. The constant touching of toilet door handles before and after toilet use increases the possibility of transferring pathogens from one person to another, thereby facilitating disease spread within the community. Another major concern associated with bacterial contamination of public surfaces is the increasing resistance of microorganisms to commonly used antibiotics. Antibiotic-resistant bacteria have become a global public health crisis, reducing the effectiveness of antimicrobial therapy and increasing the risk of treatment failure (Rawat & Nair, 2010; Ventola, 2015). Studies have shown that some bacterial isolates recovered from public surfaces exhibit resistance to multiple antibiotics, thereby complicating infection management and control (Ying et al., 2015; Mirela et al., 2017). Maintaining proper hygiene and regular disinfection of public toilets and their surfaces is therefore essential in reducing microbial contamination and preventing disease transmission. Ojima et al. (2002) emphasized that proper hygiene measures, including routine cleaning and effective hand washing practices, can significantly reduce the spread of microorganisms in public environments. Consequently, there is a need for continuous

monitoring of bacterial contamination on toilet door handles to improve sanitation standards and increase public awareness regarding personal hygiene practices.

This study on the isolation and identification of bacteria on toilet door handles of female hostels in Zamfara State University, Talata Mafara, Zamfara State, is therefore important in determining the types of bacteria present and their possible public health implications. The findings of the study will contribute to existing knowledge on environmental contamination and provide useful information for improving hygiene and infection control practices within hostel environments.

1.2 Objectives

The aim of this research is to investigate the isolate and identify bacterial contaminants on toilet door handles in female hostels of Zamfara State University.

Specific Objectives

1. To isolate bacteria, present on toilet door handles.
2. To identify bacterial species associated with toilet handles.
3. To determine bacterial load levels across hostels.
4. To compare contamination levels among hostels.
5. To assess public health implications.

2. Literature Review

2.1 Environmental Surfaces and Door Handles as Reservoirs of Pathogenic Bacteria

Environmental surfaces play a major role in the survival and transmission of microorganisms, making them important factors in public health and disease control. The transfer of microorganisms from surfaces to humans depends on several conditions, including the type of microorganisms present, environmental moisture, humidity, temperature, and the degree of contact or friction between surfaces (Mendel & Mirer, 2009). Among the commonly touched environmental surfaces, door handles are recognized as important fomites that facilitate the spread of pathogenic microorganisms through frequent human contact. Door handles are mechanical devices designed to open and close doors and are available in various forms such as round knobs, lever handles, and oval-shaped designs. Beyond their mechanical functions, door handles serve as contact points for numerous individuals daily, making them highly susceptible to microbial contamination. Human hands naturally harbor resident flora and transient microorganisms acquired from contact with contaminated objects, surfaces, food, water, and other individuals (Lindberg et al., 2004). Consequently, microorganisms are

continuously deposited on door handles through repeated touching, thereby increasing the possibility of indirect transmission of infectious agents. Several studies have demonstrated that contaminated door handles can harbor pathogenic bacteria capable of causing infections in humans. According to Amala and Ade (2015), door handles in public toilets and offices are frequently contaminated with microorganisms associated with poor hygiene and environmental contamination. Similarly, Augustine et al. (2017) reported that door handles in public institutions serve as reservoirs for microorganisms of public health importance because of constant exposure to users with inadequate hand hygiene practices. The high prevalence of *Bacillus* species commonly isolated from door handles may be attributed to their ability to form spores, enabling them to survive harsh environmental conditions, dry heat, and exposure to disinfectants for extended periods (Brooks et al., 2007). Sammy et al. (2012) also identified *Bacillus* species as one of the predominant bacterial isolates recovered from door handles in public environments. In addition, the frequent isolation of *Staphylococcus aureus* from door handles is associated with its presence as part of the normal flora of the human skin and nasal cavity, making it easily transferable through hand contact and other human activities.

Studies conducted in university environments revealed that hostel door handles often carry higher microbial loads compared to other locations due to the large number of users and visitors who frequently touch these surfaces without proper hand hygiene. Environmental factors such as high humidity, temperature, and moisture content further enhance the survival and spread of microorganisms on fomites (Mendel & Mirer, 2009). The isolation of fecal-associated bacteria such as *Escherichia coli* and *Salmonella* species from door handles indicates poor sanitary conditions and inadequate hand washing practices among users (Zhad et al., 1998). This observation agrees with findings by Amala and Ade (2015), who noted that high-traffic surfaces commonly accumulate enteric pathogens when hygiene standards are poor. The predominance of *Staphylococcus aureus* observed in many studies can be explained by its widespread occurrence on human skin and mucous membranes. Since it is easily shed through direct contact, contaminated hands readily transfer the organism to door handles and other frequently touched surfaces. This supports findings from earlier studies that identified *Staphylococcus aureus* as one of the most common bacterial contaminants of public surfaces (Lindberg et al., 2004). The presence of pathogenic bacteria on door handles therefore presents a serious public health concern because these microorganisms can be transmitted indirectly from person to person through contact with contaminated surfaces. Regular cleaning and disinfection of door handles, improved personal hygiene practices, and public

health awareness are essential measures for reducing the spread of infections. The use of antimicrobial materials such as copper or silver-coated handles and the installation of automatic doors in high-traffic areas have also been recommended as effective preventive measures against microbial transmission in public environments.

2.2 Microbial Contamination of Door Handles and Its Public Health Implications

Microorganisms are ubiquitous in nature and play essential roles in maintaining ecological balance and supporting the functioning of ecosystems. They exist in diverse environments either as free-living organisms or as parasites, contributing significantly to natural biological processes (Singh et al., 2018). Despite their beneficial roles, some microorganisms become transient contaminants on inanimate surfaces, also known as fomites, and on human hands, thereby constituting important sources of community-acquired and hospital-acquired infections (Kramer & Assadian, 2014; Pittet et al., 1999). The ability of microorganisms to survive and proliferate on hands and environmental surfaces has made public places such as schools, hospitals, restaurants, transportation systems, and research institutions important centers for microbial transmission among individuals (Abdulai et al., 2020).

In recent years, the increasing occurrence and rapid spread of infectious diseases within communities and institutions have become major public health concerns globally (Nworie et al., 2012). Contact with contaminated environmental surfaces has been identified as one of the major routes through which infectious agents are transmitted. Such contaminated surfaces include door handles, sinks, tables, chairs, lockers, faucets, thermometers, and other frequently touched objects commonly found in public facilities (Osman et al., 2024). Among these fomites, door handles are particularly important because they are touched repeatedly by numerous individuals every day, making them effective reservoirs and vehicles for the spread of pathogenic microorganisms (Fakhoury & Nawas, 2018). Door handles in public institutions, offices, hospitals, hostels, and educational facilities serve as contact points linking large populations of people daily. Although they often appear clean externally, these surfaces may harbor potentially harmful microorganisms, including pathogenic bacteria (Al-Harmoosh et al., 2019). The bacterial contaminants found on door handles can survive temporarily on these surfaces and on human hands, thereby increasing the risk of indirect transmission of infectious diseases. Several factors influence the survival and transfer of bacteria between hands and environmental surfaces, including the bacterial species involved, the amount of microbial inoculum deposited, moisture content, pressure, and friction between contact surfaces (Kramer et al., 2006). The risk associated with contaminated door handles is further increased when bacterial pathogens develop resistance to commonly used antibiotics

and disinfectants. Antimicrobial resistance has become one of the most serious public health challenges globally, reducing the effectiveness of available treatment options and increasing morbidity and mortality associated with bacterial infections (Osman et al., 2023). O'Neill (2014) estimated that antimicrobial-resistant infections may account for approximately 10 million deaths annually by the year 2050 if effective control measures are not implemented. Similarly, Stanton et al. (2022) reported that environmental exposure to antibiotic-resistant bacteria significantly contributes to the spread of resistant infections among humans.

The transfer of pathogenic bacteria from contaminated door handles to humans commonly occurs through hand contact followed by touching the mouth, nose, eyes, or food materials. Studies have shown that contaminated hands play a major role in foodborne disease transmission and environmental contamination (Mensah et al., 2002; Alum et al., 2016). This highlights the importance of maintaining proper hand hygiene and regular disinfection of frequently touched surfaces in preventing the spread of infectious diseases. Although numerous studies have investigated microbial contamination in hospitals, schools, and public environments, limited research has focused on teaching and research institutions where pathogenic microorganisms are frequently handled for academic and laboratory purposes. Consequently, there is insufficient information regarding the level of bacterial contamination present on door handles within such facilities and the associated health risks to staff, students, and visitors. Therefore, this study aims to isolate, quantify, and characterize bacterial contaminants present on door handles in teaching and research facilities in order to provide scientific evidence that may guide public health policies and infection control measures.

2.3 Bacterial Contamination of Toilet Door Handles as a Public Health Risk in Institutional Settings

Microorganisms are ubiquitous in the environment and play essential roles in ecosystem functioning; however, many also act as transient contaminants on inanimate objects (fomites) and human hands, thereby contributing to the transmission of infectious diseases (Reynolds & Hurst, 2005; Kramer & Assadian, 2004). The ability of microorganisms to survive on environmental surfaces and hands has made public environments such as schools, hospitals, restaurants, transport systems, and educational institutions important hubs for microbial transmission (Bright, Boone, & Gerba, 2010; Abdulai et al., 2020). Increasing outbreaks of infectious diseases and their rapid spread within and between communities continue to pose significant global public health challenges (Nworie et al., 2012; Osman et al., 2024). Fomites such as door handles, faucets, tables, chairs, and sinks are frequently touched surfaces that can harbor pathogenic microorganisms capable of causing infections (Bright et al., 2010).

Among these, toilet door handles are particularly significant because they are repeatedly contacted by different individuals under conditions that often promote microbial survival and transfer. Studies have shown that poor hygiene practices and inadequate handwashing contribute significantly to contamination of these surfaces, making them potential reservoirs for disease-causing organisms (Fakhoury & Nawas, 2018; Nworie et al., 2012).

Common bacterial pathogens associated with contaminated environmental surfaces include *Salmonella* species, *Escherichia coli*, and *Staphylococcus aureus*, all of which are implicated in gastrointestinal and systemic infections. *Salmonella* spp., a Gram-negative bacterium, is a major cause of typhoid fever and gastroenteritis, with the World Health Organization estimating approximately 11–21 million cases and over 100,000 deaths annually worldwide (World Health Organization, 2023). *Escherichia coli* ranges from harmless commensals to pathogenic strains capable of causing diarrhea, hemorrhagic colitis, and hemolytic uremic syndrome, and is commonly transmitted through contaminated surfaces and poor hygiene practices (Bright et al., 2010; Mensah et al., 2002). Similarly, *Staphylococcus aureus*, a Gram-positive bacterium found on human skin and mucous membranes, is associated with skin infections, pneumonia, and bloodstream infections, including methicillin-resistant strains (MRSA) which pose serious therapeutic challenges (Chinakwe et al., 2012; Ventola, 2015).

Several studies have demonstrated high levels of bacterial contamination on door handles in public and institutional settings. For example, Nworie et al. (2012) reported significant contamination of door handles in public conveniences in Abuja, Nigeria, with organisms such as *Staphylococcus aureus*, *E. coli*, and *Klebsiella pneumoniae*. Similarly, Maori et al. (2011) found a 50% contamination rate of toilet door handles in secondary schools in Plateau State, Nigeria, while Sabra (2013) reported high bacterial prevalence (71.9%) on surfaces in public female restrooms in Saudi Arabia. These findings highlight the role of toilet door handles as reservoirs of pathogenic bacteria in both developing and developed settings. Environmental and behavioral factors such as humidity, temperature, frequency of contact, and poor sanitation practices influence the survival and transmission of bacteria on fomites (Kramer et al., 2006; Mendel & Mirer, 2009). In crowded environments such as hostels, where shared sanitation facilities are common, the risk of cross-contamination is even higher due to frequent usage and inadequate hand hygiene. Studies in university and healthcare settings have similarly reported high bacterial loads on frequently touched surfaces, reinforcing their role in disease transmission (Oranusi et al., 2013; Hedieh et al., 2012).

Given the increasing concern of antimicrobial resistance, contaminated surfaces also pose an additional threat by facilitating the spread of multidrug-resistant organisms (Osman et al.,

2023; Stanton et al., 2022). This underscores the need for continuous monitoring of microbial contamination in high-contact surfaces such as toilet door handles, especially in institutional environments.

Therefore, this study aims to isolate and identify bacterial contaminants present on toilet door handles in selected female hostels of Zamfara State University, Talata Mafara. The findings are expected to provide baseline data for improving sanitation practices, enhancing infection control measures, and promoting awareness of personal hygiene among students and hostel management.

3. METHODOLOGY

3.1 **Research Area**

The research was conducted in the female hostels of Zamfara State University. The study focused specifically on toilet door handles within the hostel environments because they are frequently touched surfaces and potential reservoirs for pathogenic bacteria.

3.2 Research Technique

The study employed an experimental laboratory-based microbiological design involving sample collection with sterile swab sticks, isolation of bacterial organisms via culturing techniques, identification of bacterial isolates using standard microbiological and biochemical methods, and statistical analysis utilizing descriptive and inferential statistics.

3.3 Data Collection Method

Samples collected from toilet door handles in female hostels were analyzed microbiologically under aseptic conditions. Bacterial cultures were performed to isolate colonies, followed by biochemical tests for species identification. Laboratory data included bacterial counts, contamination levels, bacterial isolate frequency, and hygiene ratings. Statistical analysis utilized descriptive statistics, chi-square tests, one-way ANOVA, and Tukey HSD post hoc tests.

4. RESULTS AND DISCUSSION

Table 1: Reliability Statistics of Research Instrument.

Cronbach Alpha	N of Items
0.861	8

Table 2: Descriptive Statistic of Bacterial Count, Contamination Level, and Hygiene Rating.

Variable	N	Min	Max	Mean	Std Dev
Bacterial Count	200	5	250	115.34	42.18
Contamination Level	200	1	3	2.31	0.68
Hygiene Rating	200	1	5	2.84	0.73

Table 3: Frequency Distribution of Isolates.

Organism	Frequency	Percent	Valid Percent	Cumulative Percent
E. coli	60	30.0	30.0	30.0
Staphylococcus aureus	55	27.5	27.5	57.5
Klebsiella spp	35	17.5	17.5	75.0
Pseudomonas spp	25	12.5	12.5	87.5
Salmonella spp	25	12.5	12.5	100

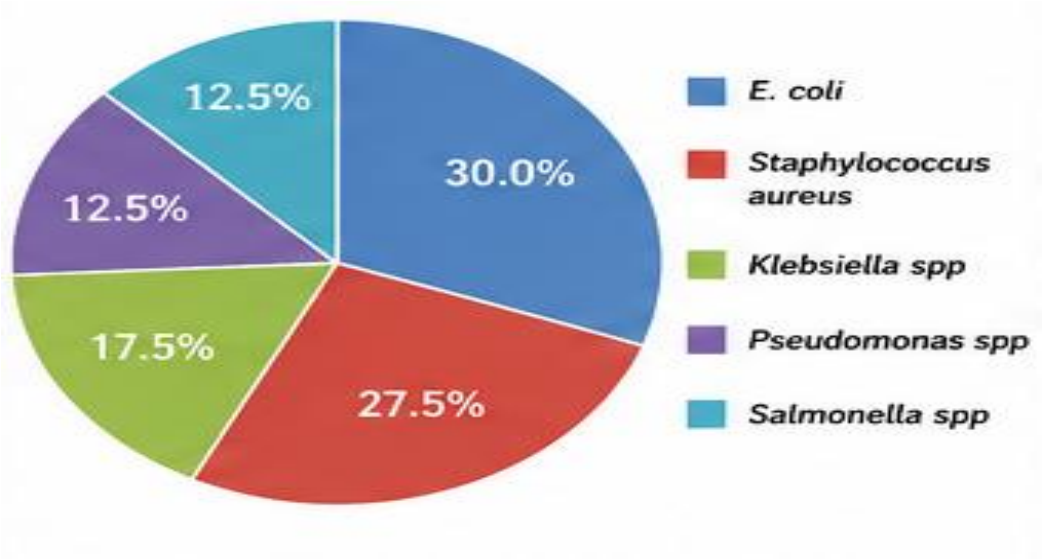

Figure 1: Percentage Distribution of Bacterial Isolates Recovered from Toilet Door Handles in Female Hostels.

The reliability analysis presented in Table 1 indicates that the instrument used for evaluating bacterial contamination and hygiene-related variables possesses a high level of internal consistency and reliability. The Cronbach Alpha coefficient of 0.861 obtained from the 8 measurement items exceeds the recommended threshold value of 0.70, confirming that the research instrument is reliable and suitable for microbiological assessment. This suggests that the variables used in measuring contamination levels, bacterial count, and hygiene conditions consistently captured the intended constructs and produced dependable responses for analysis. Furthermore, the descriptive statistics in Table 2 reveal that the mean bacterial count was 115.34 CFU, with observed values ranging from 5 to 250 CFU, indicating substantial

microbial presence on toilet door handles across the sampled female hostels. The relatively high standard deviation (42.18) further suggests noticeable variation in contamination levels among sampling points. Similarly, the contamination level mean score of 2.31 (on a 3-point scale) indicates that contamination was generally within the moderate-to-high range, while the hygiene rating mean score of 2.84 (on a 5-point scale) suggests that hygiene conditions within the sampled locations were only moderately satisfactory. In relation to the study area, these findings imply that toilet door handles within female hostels of Zamfara State University, Talata Mafara serve as important contact surfaces capable of harboring significant microbial loads, potentially facilitating the transmission of pathogens among students.

The frequency distribution of bacterial isolates shown in Table 3 further reveals the diversity and prevalence of microorganisms identified from the sampled surfaces. Escherichia coli (E. coli) recorded the highest occurrence with 60 isolates (30.0%), followed closely by Staphylococcus aureus with 55 isolates (27.5%), while Klebsiella spp accounted for 17.5%, and both Pseudomonas spp and Salmonella spp recorded 12.5% each. The predominance of E. coli is particularly important because it is commonly associated with fecal contamination, suggesting possible poor hand hygiene practices after toilet use among hostel residents. Likewise, the substantial presence of Staphylococcus aureus, which is often linked to human skin and respiratory contamination, indicates frequent surface contact and inadequate sanitation practices. The implication of these findings for the study area is significant because female hostel environments involve high population density and repeated contact with shared facilities, thereby increasing the possibility of cross-contamination and disease transmission. The presence of potentially pathogenic organisms on toilet door handles suggests a public health concern within the university environment and highlights the need for improved sanitation measures, routine disinfection of frequently touched surfaces, provision of hand hygiene facilities, and intensified health awareness campaigns among students in Zamfara State University, Talata Mafara.

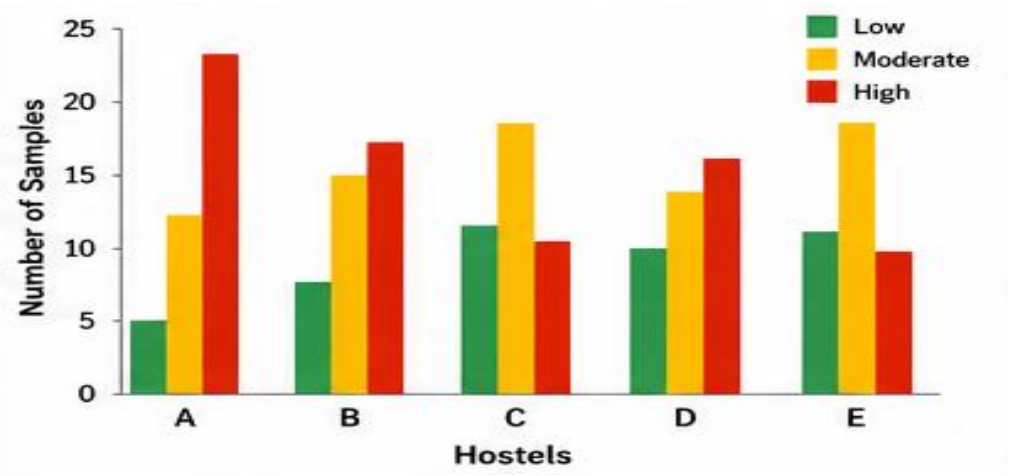

Figure 2: Levels of Bacterial Contamination Across Selected Female Hostels.

Table 4: Chi-Square Tests.

Test	Value	df	Asymp Sig
Pearson Chi-square	21.564	8	.006
Likelihood Ratio	24.128	8	.002
Linear-by-linear	10.231	1	.001

ONE-WAY ANOVA

Table 5: Bacterial Count by Hostel.

Source	SS	df	MS	F	Sig
Between Groups	10235.22	4	2558.81	8.943	.000
Within Groups	55789.61	195	286.10		
Total	66024.83	199			

Post Hoc Test (Tukey HSD)

Table 6: Multiple Comparisons

Hostel Comparison	Mean Difference	Sig
A vs C	18.43	.001
A vs E	16.21	.004
B vs C	9.32	.081
D vs E	10.54	.039

4.2 DISCUSSION

The cross-tabulation results presented in Table 4 reveal variations in contamination levels across the sampled female hostels in Zamfara State University, Talata Mafara. Hostel A recorded the highest number of samples with high contamination levels (23 samples), followed by Hostel B (17 samples) and Hostel D (16 samples), whereas Hostels C and E exhibited relatively lower levels of high contamination with 11 and 10 samples respectively. Conversely, Hostels C and E recorded higher frequencies within the moderate and low

contamination categories, indicating comparatively better sanitary conditions. These differences suggest that contamination is not uniformly distributed among the hostels and may be influenced by factors such as sanitation practices, frequency of toilet usage, population density, availability of cleaning materials, and adherence to personal hygiene measures by residents. Within the study area, the higher contamination burden observed in Hostels A and B may indicate increased exposure risks for students residing in these facilities due to more frequent contact with contaminated surfaces such as toilet door handles.

The Chi-square results presented in Table 5 further confirm the existence of a statistically significant relationship between hostel location and contamination level. The Pearson Chi-square value of 21.564 ($p = 0.006$), together with the Likelihood Ratio value of 24.128 ($p = 0.002$) and Linear-by-Linear Association value of 10.231 ($p = 0.001$), all recorded significance levels below 0.05, leading to the rejection of the null hypothesis and confirming that contamination levels significantly differ across the hostels. This implies that hostel environment and conditions have a measurable influence on bacterial contamination patterns. In relation to the study area, this finding suggests that environmental management practices within individual hostels may contribute differently to microbial contamination. Hostels with inadequate cleaning schedules, poor hand hygiene compliance, overcrowding, or limited sanitation facilities may be more vulnerable to higher contamination levels. Consequently, targeted intervention strategies rather than general sanitation policies may be required to address contamination challenges within specific hostels of the university. The One-Way ANOVA result shown in Table 6 further supports this variation by indicating a statistically significant difference in bacterial counts among the hostels ($F = 8.943$; $p = 0.000$). Since the significance value is less than 0.05, the result confirms that bacterial loads differ considerably across hostel locations. The Post Hoc Tukey HSD test (Table 4.7) identified significant differences between Hostel A and Hostel C (Mean Difference = 18.43; $p = 0.001$), Hostel A and Hostel E (Mean Difference = 16.21; $p = 0.004$), and Hostel D and Hostel E (Mean Difference = 10.54; $p = 0.039$), while the difference between Hostel B and Hostel C ($p = 0.081$) was not statistically significant.

These findings imply that some hostels experience substantially greater bacterial contamination than others. For the female hostels in Zamfara State University, Talata Mafara, the implication is that students in highly contaminated hostels may face elevated risks of exposure to pathogenic microorganisms through repeated contact with contaminated toilet surfaces. Therefore, the university management may need to strengthen routine disinfection protocols, improve environmental sanitation monitoring, provide adequate hand hygiene

facilities, and intensify health education campaigns aimed at reducing microbial transmission within hostel environments.

4.2.1 FINDINGS

The findings of this study revealed substantial bacterial contamination on toilet door handles within the female hostels of Zamfara State University, Talata Mafara, indicating that these frequently touched surfaces may serve as reservoirs for pathogenic microorganisms. The reliability analysis confirmed that the research instrument was highly dependable, with a Cronbach Alpha value of 0.861, demonstrating strong internal consistency among the variables measured. The descriptive analysis further showed a relatively high mean bacterial count of 115.34 CFU, with contamination levels ranging from 5 to 250 CFU, suggesting considerable microbial presence across the sampled hostels. Additionally, the contamination level mean score of 2.31 indicated moderate to high contamination, while the hygiene rating mean score of 2.84 reflected only moderately satisfactory sanitary conditions. These findings suggest that despite existing hygiene measures, environmental sanitation within the female hostels may not be sufficiently effective to prevent microbial accumulation on shared contact surfaces. The high bacterial load observed implies increased opportunities for pathogen transmission among students through repeated contact with contaminated toilet facilities.

The study also identified diverse bacterial species associated with the sampled toilet door handles, with Escherichia coli (30.0%) and Staphylococcus aureus (27.5%) emerging as the predominant isolates. The occurrence of E. coli is particularly important because it is commonly linked with fecal contamination and poor hand hygiene practices, while Staphylococcus aureus is associated with skin and respiratory contamination. The presence of other organisms such as Klebsiella spp, Pseudomonas spp, and Salmonella spp further demonstrates the microbiological diversity existing within the hostel environment. These findings indicate that toilet door handles within the study area may function as potential transmission points for infectious agents. In a university setting characterized by shared facilities and high student interactions, the persistence of these organisms may increase the risk of cross-contamination and spread disease. Therefore, the findings highlight the importance of improving sanitation practices, encouraging proper hand hygiene behaviors, and strengthening environmental health measures within the hostels.

Furthermore, the inferential analysis established significant differences in contamination levels and bacterial counts across the hostels. The Chi-square analysis confirmed a significant relationship between hostel location and contamination level ($p < 0.05$), indicating that

bacterial contamination patterns vary significantly among the hostels. Similarly, the One-Way ANOVA result ($F = 8.943$; $p = 0.000$) revealed significant differences in bacterial counts between hostels, while the Tukey Post Hoc analysis identified specific hostel pairs with significantly different contamination burdens. The higher contamination levels observed in some hostels, particularly Hostel A, suggest that environmental conditions, sanitation practices, student population density, and maintenance procedures may differ across hostel locations. The implication of these findings is that contamination control strategies should not be generalized but rather tailored to the conditions of specific hostels. Consequently, university management should prioritize targeted sanitation interventions, regular microbial monitoring, enhanced disinfection schedules, provision of hand hygiene facilities, and sustained public health awareness programs to reduce contamination risks and improve the overall health conditions of students residing in the female hostels of Zamfara State University, Talata Mafara.

5. CONCLUSION

The study successfully isolated and identified bacterial contaminants present on toilet door handles within female hostels of Zamfara State University, Talata Mafara. The findings revealed significant microbial contamination on these frequently touched surfaces, indicating that toilet door handles may serve as important reservoirs for pathogenic microorganisms. The predominant bacterial isolates identified were Escherichia coli and Staphylococcus aureus, which are associated with fecal contamination, poor hand hygiene, and human skin contact. Other bacterial species identified included Klebsiella spp, Pseudomonas spp, and Salmonella spp, all of which possess potential public health significance.

The statistical analyses further demonstrated significant differences in contamination levels among the sampled hostels, suggesting variations in hygiene practices, sanitation conditions, and environmental management. The high bacterial load observed in some hostels indicates increased risks of microbial transmission and possible disease outbreaks among students through indirect contact with contaminated surfaces. Overall, the study established that inadequate sanitation practices, poor hand hygiene, overcrowding, and insufficient disinfection of hostel facilities contribute significantly to bacterial contamination of toilet door handles. Therefore, improving environmental sanitation and promoting personal hygiene are essential for reducing microbial contamination and safeguarding public health within the university environment.

6. Recommendations

- University management should ensure regular cleaning and disinfection of toilet door handles and other frequently touched surfaces within hostel environments.
- Adequate handwashing facilities such as running water, soap, and hand sanitizers should be provided in all hostel toilets.
- Students should be educated continuously on the importance of proper hand hygiene and personal sanitation practices through awareness campaigns and health education programs.
- Hostel sanitation should be monitored regularly by environmental health officers to ensure compliance with hygiene standards.
- Overcrowding within hostel facilities should be minimized to reduce excessive usage and contamination of shared facilities.
- Antimicrobial door handles or touch-free systems should be considered in high-traffic hostel areas to minimize direct hand contact.
- Routine microbiological surveillance should be conducted periodically to monitor bacterial contamination levels and identify emerging public health risks.
- Waste disposal and toilet maintenance systems within the hostels should be improved to prevent environmental contamination and disease transmission.

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