PANTAO
The International Journal of the Humanities and Social Sciences
Volume 5, Issue 1
ISSN 3028-0877 | DOI 10.69651/2022PIJHSS

BactoClean: A conceptual assessment of hygiene conditions in university restrooms and canteens.

Hugh Ariff M. Aserit
Bulacan State University
Malolos City, Bulacan, Philippines

Romer Cholo S. Cruz*
Bulacan State University
Malolos City, Bulacan, Philippines
Email: romercruz147@gmail.com

Denver Lyndon Aerol S. San Diego
Bulacan State University
Malolos City, Bulacan, Philippines

Allane Allan Paul N. Valenzuela
Bulacan State University
Malolos City, Bulacan, Philippines

Lech Walesa M. Navarra
Bulacan State University
Malolos City, Bulacan, Philippines

ABSTRACT

In public environments, cleanliness and hygiene is significant aspect to avoid diseases, especially in facilities like restrooms and canteens. Although some may appear visually clean, it may still harbor bacterial presence. The BactoClean research assessed and evaluated bacterial contamination in high-traffic facilities within Bulacan State University. Data samples were gathered from frequently touched areas like door handles, flush handles, faucets, utensils, dining tables, food preparation area, respectively form restroom and canteen facility. Bacteria levels were measured as colony forming units and evaluated as CFU/cm². The samples were gathered and observed utilizing agar plates, and collected from both female and male in restrooms to avoid data biasing and alteration. A quantitative descriptive research design was applied and observational assessments were conducted, evaluating hygiene supply availability, and environmental practices for each facility. Results shown that College of Engineering showed the highest CFU count, while the College of Social Sciences and Psychology restroom recorded the lowest. Faucets and flush handles specifically present consistent higher CFU/cm² rating, recognizing them as bacterial reservoir. All the facility has shown bacterial presence,

*Corresponding author
DOI: http://doi.org/10.69651/PIJHSS0501858

Recommended citation:
Aserit, H. A. M., Cruz, R. C. S., San Diego, D. L. A. S., Valenzuela, A. A. P. N., & Navarra, L. W. M. (2026). BactoClean: A conceptual assessment of hygiene conditions in university restrooms and canteens. Pantao (The International Journal of the Humanities and Social Sciences) 5 (1), 9666-9675. http://doi.org/10.69651/PIJHSS0501858

although it remained in low contamination spectrum. This study assists in continuous development of sanitation practices for maintaining a safe and healthy environment.

Keywords: Bacterial contamination, bacterial presence, sanitation practices, CFU/cm²

Date Submitted: January 28, 2026
Date Accepted: February 6, 2026
Date Published: February 26, 2026

INTRODUCTION

High human-traffic facilities in academic environments can be considered as potential vessels for harmful microorganisms, particularly in universities and school where cleanliness and hygiene is important to ensure the health and welfare of students, faculty and school personnel. As stated by Kramer et al., (2006), although routine cleaning practices are implemented, visual inspection alone cannot reliably detect the presence of bacterial contamination which often remains on surfaces. Poor maintenance of these facilities may lead to increased exposure to bacteria and other pathogens, jeopardizing student health.

According to the Germ Theory of Disease (Louis Pasteur, 1861), the main culprits behind infectious diseases are bacteria and other pathogens. These microorganisms are unnoticeable to the naked eye and can live long periods of time. Diseases can spread by contact with food, water, utensils, and other contaminated surfaces. The Chain of Infection Theory (Centers for Disease Control and Prevention (CDC), 1996) explains that infectious agent, reservoir, path of transmission, and vulnerable host are all elements that are interrelated, which contributes to the spread of infectious diseases. According to the notion, illness can be avoided by breaking any link in this chain, especially by practicing good hygiene and sanitation.

The literature objective was to examine the indoor air quality of educational facilities through identifying its existing bacterial contaminants. The research revealed the relation between bacterial contaminants and environmental conditions, the findings show that microbial contaminants are also present in the air, potentially increasing the risk of exposure (Jung, C. et al., 2024). According to Viegas et al. (2021), surface may reflect contamination in the air due to resuspension causing bacterial loads and antibiotic resistance, showing that environmental contamination can pose critical health risk. According to Glowicz et al. (2023), hands are the primary carrier of disease transmission in both healthcare and community settings, causing the transfer of microorganisms between individuals and environmental surfaces.

Based on the study, Microbiological Contamination in Different Food Service Units Associated with Food Handling by Alves et al. (2021), the prevalence of microbiological contamination of food handlers' hands and kitchen utensils in various food service units, including university canteens located in Northeast Portugal, was examined. Based on the article, a high percentage of "unsatisfactory" samples of hand hygiene that reached 40%, were found in university canteens. It was also found that more than one-third of the canteen utensils were "unsatisfactory" or "bad". Almatawah et al., (2024) research centers its focus on analyzing microorganisms in food preparation areas. The study displays how improper sanitation and food handling aid harmful bacteria development, through examining contamination levels in prepared food, food-contact surfaces, and the surrounding areas. The Factors That Trigger Cockroach Density: A Literature Review of Abudin et al., (2023) shows that cockroaches thrive in humid environments with high organic content, which is normally found in poorly maintained restroom and food preparation areas, specifically with structural deterioration, moisture buildup, and poor waste management of food products. The study further emphasized

ISSN 3028-0877 | DOI 10.69651/2022PIJHSS

the role of human contributions, especially with regard to food handling and ineffective pest control, which contributed to the spread of disease-carrying pests.

Surveillance of Bacterial Load and Multidrug-Resistant Bacteria on Surfaces of Public Restrooms (Ibrahim, K. et al., 2024). The research examines the bacterial contamination on frequently contact surfaces in public restrooms including door knobs, faucets, toilet seats, and sinks. The researchers identified both Gram-positive and Gram-negative bacteria, with some strains exhibiting multidrug resistance. According to Per and Keleş Dinç (2024), high-touch surfaces in university toilets act as important reservoirs of opportunistic pathogens, demonstrating that routine contact with shared facilities can facilitate bacterial transmission even in the absence of obvious hygiene failures. According to Al-Abady (2022), diverse aerobic microorganisms are present on multiple toilet surfaces in university dormitories, demonstrating widespread environmental contamination. According to Yuan et al. (2021), bacterial contamination in public restrooms, both on surfaces and in the air, poses significant infection risks, particularly in poorly ventilated areas. According to Wongsawan et al. (2020), public restroom surfaces including faucets, sinks, and door handles harbor contaminating bacteria, suggesting that routine cleaning may be insufficient without microbial monitoring.

The study of Kabir et al., (2021) focuses on the discrepancy between knowledge and practice among university students' hygiene and sanitation. The researchers found that the poor state of the facilities, specifically inconsistent water supply, and dirty public places like restrooms were the cause of their improper behavior, even though the students knew the importance of proper hygiene. According to Rahmiwati et al. (2025), the frequency of infectious disease occurrence and absenteeism is strongly correlated with the increase of bacterial contamination and infection caused by the frequent use of areas such as toilets. According to Tunio et al. (2025) educational institutions, particularly those serving vulnerable populations, require systematic hygiene monitoring to reduce disease vulnerability due to lack of sanitation practices. According to Chijioke, I., & Adaeze, C.N. (2024), the insufficiency of hygiene support within learning environments including; the absence of microbial surveillance and immediate response strategies in protecting student's welfare, contributes to the increase of possible infectious outbreaks. This emphasizes the need for sanitation and monitoring strategies that extend beyond individual hygiene behavior.

This research aims to: 1) Assess the hygiene and cleanliness conditions of selected facilities at Bulacan State University. Through examining bacterial contamination as an indicator of sanitation effectiveness, the researchers will be able to contribute to identifying the causes of student's absenteeism and possible infectious outbreaks at Bulacan State University and 2) Highlight the limitations of visual inspection in cleanliness assessment and emphasize the importance of objective hygiene monitoring. Lastly 3) Identify the facility and area where it shows the highest bacterial contamination frequency while observing it's environment. The rationale behind this study is to promote a safer and healthier learning environment for Bulacan State University's students.

Statement of the problem

1. To determine the bacterial contamination levels in selected university restrooms and canteens.
2. To identify the areas that show the highest risk of microbial exposure.
3. To evaluate the effectiveness of the current sanitation practices in controlling bacterial contamination.

METHODOLOGY

The study employed a quantitative descriptive approach to objectively assess bacterial contamination levels and sanitation effectiveness in selected university restrooms and canteens. A purposive sampling technique was utilized, focusing on selected university facilities, specifically restrooms and canteen areas within Bulacan State University, Malolos City, Bulacan. The respondents of the study were not human participants but rather environmental surfaces located in these facilities, including frequently touched areas such as door handles, flush handles, faucets, dining tables, utensils, and food preparation areas. The research instrument consisted of environmental swabbing procedures and nutrient agar plate culturing to measure bacterial contamination levels in the selected facilities. Surface swabbing was selected due to its accessibility and reliability as a standard method for assessing bacterial contamination in public environments, as supported by Dancer (2004) and World Health Organization (WHO, 2020). Sterile cotton tipped swabs were used to collect samples, ensuring consistency and contamination control during the data collection process. Each collected sample was streaked onto nutrient agar plates using the streak plate method within a fixed area of 27.2 cm^2, ensuring uniformity across all samples and compliance with environmental hygiene standards as indicated by Lei et al. (2020). Nutrient agar plates were utilized as the culture medium due to their effectiveness in supporting the continuous growth of various microorganisms commonly found on environmental surfaces, as noted by Cappuccino and Welsh (2017).

To facilitate bacterial growth, the inoculated agar plates were incubated under controlled conditions. The incubation was conducted at a controlled room temperature of 35–37°C for a duration of 24–48 hours, allowing sufficient time for colony development. Throughout the sampling and laboratory procedures, the researchers wore personal protective equipment, including sterile gloves, face masks, and head coverings, to ensure both safety and accuracy of the samples. After incubation, visible bacterial colonies were counted manually, with merged colonies considered as a single unit. The results were recorded as Colony Forming Units (CFU) and expressed as CFU/cm^2, which is a standard metric for evaluating environmental contamination levels based on WHO (2020). The study employed descriptive statistical treatments, including frequency, mean, and range, along with data standardization and comparative analysis, to interpret the CFU results and determine contamination levels across different sampled surfaces. These analyses provided a basis for identifying areas requiring targeted improvements to prevent or minimize the risk of exposure to harmful bacteria.

The data gathering procedure was conducted in a systematic and ethical manner to ensure accuracy and unbiased data collection. Prior to the commencement of data collection, a letter of consent validated by the facilitator was secured and signed by the concerned university authorities, granting permission to conduct environmental sampling within the selected facilities. All necessary materials and equipment were prepared and sterilized in advance, including personal protective equipment, cotton tipped swabs, and nutrient agar plates. Each agar plate was properly labeled according to the specified facility using purposive sampling. During data collection, facilitators were informed prior to sampling activities, and all procedures were carried out within restroom and canteen facilities of Bulacan State University. Researchers ensured proper use of personal protective equipment at all times and strictly followed the protocol of using one sterile swab per surface to avoid cross contamination. Each collected sample was streaked onto a labeled agar plate within a fixed area of 27.2 cm^2 using the streak plate method, applying both vertical and horizontal strokes to ensure even distribution, consistency, and maximization of bacterial growth. Each plate was labeled with the college department code, facility type, surface area, and date of collection. After incubation at 35–37°C for 24–48 hours, bacterial colonies were counted manually and recorded as Colony Forming Units (CFU), which were then used to determine bacterial contamination levels across the sampled environments.

Fundamental ethical standards were strictly observed throughout the study to ensure responsible data collection, institutional integrity, public health considerations, and research safety. Formal consent was obtained from university authorities prior to conducting environmental surface sampling in selected facilities. To prevent stereotyping of specific departments and avoid potential reputational harm, facility identities were generalized using labels such as COE restroom and CSSP restroom. The study did not involve the collection of personal information from students, staff, or facility personnel, as data collection was limited strictly to environmental samples. Surface swabbing procedures did not involve any human biological microcosm, thereby minimizing ethical risks associated with human subjects research. Researcher safety was ensured through the consistent use of personal protective equipment, including sterile gloves, face masks, and head dress, during both sampling and laboratory procedures. Each surface was sampled using a single sterile cotton tipped swab to prevent cross contamination. All bacterial sampling, handling, and culturing procedures adhered to established microbiological safety protocols. Following the completion of analysis, all contaminated materials, including cotton swabs, agar plates, and personal protective equipment, were properly sterilized and disposed of in accordance with laboratory waste management guidelines.

RESULTS AND DISCUSSION

The results and discussion of this study are based on environmental samples collected from selected university facilities, with n = 6 facilities and n = 3 sampled surfaces per facility, yielding a total of 18 sampled surface points. The study employed a quantitative descriptive research design using purposive sampling to assess bacterial contamination levels in restrooms and canteens within Bulacan State University, Malolos City, Bulacan. Data were collected through standardized surface swabbing procedures and nutrient agar plate culturing, with bacterial growth quantified as Colony Forming Units (CFU) and contamination density expressed as CFU/cm² based on a fixed sampling area of 27.2 cm². Descriptive statistical techniques, including frequency, mean, and standard deviation, were used to analyze the data. The interpretation of contamination levels was grounded in an established scale, where 0–10 CFU/cm² corresponds to low contamination, 11–50 CFU/cm² to moderate contamination, and >50 CFU/cm² to high contamination, as adapted from Dancer (2004) and World Health Organization (WHO, 2020). The discussion that follows is strictly based on the data gathered and is interpreted in direct relation to the objectives of assessing hygiene conditions and sanitation effectiveness across selected facilities.

The analysis of CFU values per facility revealed notable differences in bacterial presence and variability across sampled environments. The COE restroom recorded CFU values of 60, 14, and 9, resulting in a mean CFU of 27.67 and a standard deviation of 28.12, indicating both relatively higher bacterial presence and substantial variability among sampled surfaces. Similarly, the CON restroom exhibited CFU values of 40, 30, and 10, with a mean CFU of 26.67 and a standard deviation of 15.29, reflecting consistently elevated bacterial counts but with less variability compared to the COE restroom. In contrast, the CSSP restroom demonstrated significantly lower CFU values of 3, 4, and 2, yielding a mean CFU of 3.00 and a standard deviation of 1.00, which indicates both low contamination and high consistency across sampled surfaces. The Laboratory High restroom recorded CFU values of 3, 3, and 9, with a mean CFU of 5.00 and a standard deviation of 3.46, suggesting low contamination with moderate variability. Canteen facilities also exhibited relatively lower contamination levels, with the CON Canteen showing CFU values of 4, 3, and 11, resulting in a mean CFU of 6.00 and a standard deviation of 4.36, while the Valencia Canteen recorded CFU values of 16, 1, and 11, yielding a mean CFU of 9.33 and a standard deviation of 7.64. These findings indicate that restroom facilities, particularly COE and CON, tend to have higher bacterial loads and greater variability compared to canteen environments. This pattern supports the premise that sanitation practices and frequency of use influence microbial accumulation, aligning with Florence Nightingale's Environmental Health Theory (1859), which emphasizes the critical role of environmental cleanliness in reducing microbial presence and associated health risks.

Further analysis using CFU/cm² measurements provided a standardized assessment of bacterial density across surface areas. The COE restroom recorded CFU/cm² values of 2.21, 0.51, and 0.33, resulting in a mean CFU/cm² of 1.02 and a standard deviation of 1.04, indicating uneven microbial distribution across surfaces. The CON restroom exhibited CFU/cm² values of 1.97, 1.48, and 0.49, with a mean CFU/cm² of 1.31 and a standard deviation of 0.75, reflecting relatively higher and more consistent contamination levels. In contrast, the CSSP restroom showed CFU/cm² values of 0.15, 0.20, and 0.10, with a mean of 0.15 and a standard deviation of 0.05, indicating low and stable bacterial presence. The Laboratory High restroom recorded CFU/cm² values of 0.11, 0.11, and 0.33, resulting in a mean of 0.18 and a standard deviation of 0.13. Canteen facilities maintained low contamination densities, with the CON Canteen showing CFU/cm² values of 0.15, 0.11, and 0.41, yielding a mean of 0.22 and a standard deviation of 0.16, while the Valencia Canteen recorded values of 0.59, 0.04, and 0.41, resulting in a mean of 0.35 and a standard deviation of 0.28. These findings consistently demonstrate that restroom environments exhibit higher contamination density and variability than canteen facilities, although all recorded values remain within the low contamination range of 0–10 CFU/cm². The relatively higher variability in the COE restroom suggests localized contamination hotspots, while the low variability in CSSP indicates effective and consistent sanitation practices.

A more detailed examination of CFU/cm² distribution across specific surfaces further highlights patterns of contamination associated with high touch areas. In the COE restroom, the flush handle recorded the highest CFU/cm² value of 2.21, followed by the faucet at 0.51 and the door handle at 0.33. Similarly, in the CON restroom, the flush handle registered 1.97 CFU/cm², the faucet 1.48 CFU/cm², and the door handle 0.49 CFU/cm². In canteen facilities, lower values were observed, with the CON Canteen recording 0.15 CFU/cm² for utensils, 0.11 for kitchen surfaces, and 0.41 for tables, while the Valencia Canteen showed 0.59 for kitchen surfaces, 0.04 for utensils, and 0.41 for tables. The Laboratory High restroom recorded 0.11 CFU/cm² for both faucet and door handle, and 0.33 for the flush handle, while the CSSP restroom exhibited 0.15 for the faucet, 0.20 for the door handle, and 0.10 for the flush handle. Despite all values being classified as low contamination, flush handles and faucets consistently demonstrated higher bacterial density compared to other surfaces. This pattern suggests that high touch surfaces in restrooms are more prone to microbial accumulation due to frequent contact and potentially inconsistent cleaning practices, supporting the findings of Ibrahim et al. (2024), which indicate that high traffic environments can become reservoirs for microbial transmission when sanitation is not consistently applied.

The facility wide assessment of total microbial load further reinforces these observations. The COE restroom recorded a total CFU count of 83 and an estimated CFU/cm² of 3.05, while the CON restroom recorded a total CFU of 80 and an estimated CFU/cm² of 3.94, representing the highest contamination levels among all facilities. In contrast, the CSSP restroom recorded a total CFU of 9 and an estimated CFU/cm² of 0.44, and the Laboratory High restroom recorded a total CFU of 15 and an estimated CFU/cm² of 0.55, indicating significantly lower microbial accumulation. Canteen facilities also showed low total contamination, with the CON Canteen recording a total CFU of 18 and an estimated CFU/cm² of 0.66, and the Valencia Canteen recording a total CFU of 28 and an estimated CFU/cm² of 1.03. Although variations in bacterial density are evident across facilities, all recorded values fall within the low contamination range of 0–10 CFU/cm², indicating that current sanitation protocols are generally effective in maintaining microbial levels within acceptable safety limits. However, the presence of higher CFU values in specific restroom surfaces highlights the need for targeted sanitation strategies to address localized contamination hotspots.

Observational findings complement the quantitative results by identifying environmental factors that may influence bacterial presence. The presence of broken faucets in the COE restroom, insufficient handwashing supplies in certain restrooms, and noticeable odor in CSSP and Laboratory High School restrooms suggest gaps in facility maintenance and hygiene practices. These conditions may contribute to microbial persistence and highlight the limitations of relying solely on visual cleanliness as an indicator of hygiene. The detection of measurable bacterial presence across all sampled surfaces, despite classification under low contamination levels, underscores the importance of objective microbial monitoring in assessing sanitation effectiveness.

Overall, the findings demonstrate that while all sampled facilities fall within the low contamination range of 0–10 CFU/cm², significant variations exist in bacterial distribution across facilities and surfaces. Restroom environments consistently exhibit higher contamination levels and variability compared to canteen facilities, with flush handles and faucets identified as the most contaminated surfaces. The COE restroom recorded the highest total CFU count of 83 and the highest surface contamination value of 2.21 CFU/cm², while the CSSP restroom recorded the lowest total CFU count of 9, and the Valencia Canteen utensil surface recorded the lowest CFU/cm² value of 0.04. These findings reinforce the importance of sanitation practices, environmental maintenance, and targeted hygiene interventions in reducing microbial presence. Grounded in the principles of Environmental Health Theory and germ theory, the results highlight that even low levels of bacterial contamination warrant continuous monitoring and improvement. The study contributes to the understanding of environmental hygiene in institutional settings by providing empirical evidence on microbial distribution patterns and emphasizing the need for proactive sanitation strategies, thereby setting the stage for recommendations and further research in subsequent sections of the manuscript.

CONCLUSION

The findings of this study provide a comprehensive assessment of bacterial contamination levels and sanitation effectiveness across selected university restrooms and canteens within Bulacan State University. Based on CFU/cm² readings, all sampled facilities were classified within the low contamination range, indicating that current sanitation conditions generally meet acceptable environmental hygiene standards. Despite this classification, measurable bacterial presence was detected across all facilities, demonstrating that microbial contamination persists even in environments that appear visually clean. Among the sampled locations, the COE restroom exhibited the highest level of contamination, while the CSSP restroom recorded the lowest levels. These results confirm that visual cleanliness alone is not a sufficient indicator of microbiological safety and highlight the importance of objective microbial assessment in evaluating hygiene conditions.

The study further identified specific areas that present higher microbial exposure risk. High touch surfaces, particularly flush handles and faucets in the COE and CON restrooms, consistently recorded the highest CFU/cm² values, with the COE flush handle showing the highest contamination level among all sampled surfaces. These findings can be attributed to frequent human contact and moisture exposure, which create favorable conditions for microbial accumulation. In contrast, utensils and selected surfaces within canteen facilities demonstrated the lowest contamination levels, suggesting that sanitation practices in food preparation and dining areas are more consistently implemented and effective. This contrast between restrooms and canteens underscores the influence of usage patterns and maintenance practices on bacterial distribution across different facility types.

The effectiveness of current sanitation practices was also examined, revealing that while overall contamination levels remain within acceptable low level thresholds, inconsistencies persist across different surfaces and facilities. Variations in contamination levels indicate that sanitation practices are not uniformly applied or maintained, particularly in high traffic restroom environments. Observational findings, including the presence of broken faucets, insufficient handwashing supplies, and persistent odors in certain restrooms, further suggest that facility maintenance and infrastructure conditions play a critical role in supporting effective hygiene management. These issues indicate that sanitation effectiveness extends beyond routine cleaning and requires sustained attention to facility functionality and environmental conditions.

Overall, the study concludes that hygiene management within the university is generally effective in maintaining bacterial contamination within low risk levels, yet targeted improvements are necessary to further reduce the risk of exposure to harmful microorganisms. To address these concerns, it is essential for university administration to increase the frequency of cleaning for high touch surfaces such as flush handles and faucets and to implement targeted disinfection protocols in moisture prone areas. Immediate repair of broken fixtures and continuous provision of handwashing supplies must be ensured to support proper hygiene practices. The establishment of periodic microbial monitoring and the development of an institutional hygiene monitoring framework that incorporates regular environmental assessments are also recommended to provide objective evaluation of sanitation effectiveness.

In addition, students and staff play a vital role in maintaining a hygienic campus environment by consistently practicing proper hand hygiene, promptly reporting facility issues such as broken fixtures or lack of supplies, and actively participating in hygiene awareness programs. Future research is encouraged to expand the scope of investigation by including additional university facilities such as dormitories and classrooms and by conducting longitudinal studies to examine changes in contamination levels over time. Further studies may also focus on identifying specific bacterial species to assess potential pathogenic risks, incorporating airborne microbial assessments to evaluate overall environmental hygiene, comparing the effectiveness of different sanitation products or cleaning protocols, and utilizing advanced molecular detection techniques for more precise microbial identification. Through these combined efforts, the study contributes to a deeper understanding of environmental hygiene in institutional settings and provides a foundation for enhancing sanitation practices and public health safety in university environments.

REFERENCES

Abudin, S., Martini, M., & Nurjazuli, N. (2023). Factors that trigger cockroach density: A literature review. Majalah Kesehatan Indonesia, 4(2), 71–76. https://doi.org/10.47679/makein.2023155

Al-Abady, A. J. (2022). A study of microbial contamination of toilets in the girls' dormitory in Al-Qadisiya University. Journal of Wasit for Science and Medicine, 2(2). https://doi.org/10.31185/jwsm.59

Almatawah, Q., Al-Mutairi, S., & Varghese, J. (2024). Monitoring foodborne pathogens of food served at an institutional cafeteria. Applied Food Research, 4(2), 100497. https://doi.org/10.1016/j.afres.2024.100497

Alves, A., Viveiros, C., Lopes, J., Nogueira, A., Pires, B., Afonso, A. F., & Teixeira, C. (2021). Microbiological contamination in different food service units associated with food handling. Applied Sciences, 11(16), 7241. https://doi.org/10.3390/app11167241

Cappuccino, J. G., & Welsh, C. T. (2017). Microbiology: A laboratory manual (11th ed.). Pearson Education.

Chijioke, I., & Adaeze, C. N. (2024). Evaluation of Salmonella species, Escherichia coli, and Staphylococcus aureus associated with toilet door handles at girls and boys hostels in Federal Polytechnic of Oil and Gas Bonny. International Journal of Innovative Biochemistry & Microbiology Research, 12(2), 46–55. https://www.seahipublications.org/wp-content/uploads/2024/04/IJIBMR-J-4-2024.pdf

Dancer, S. J. (2004). How do we assess hospital cleaning? A proposal for microbiological standards for surface hygiene in hospitals. Journal of Hospital Infection, 56(1), 10–15. https://doi.org/10.1016/j.jhin.2003.09.017

Glowicz, J. B., Landon, E., Sickbert-Bennett, E. E., Aiello, A. E., deKay, K., Hoffmann, K. K., & Ellingson, K. D. (2023). SHEA/IDSA/APIC practice recommendation: Strategies to prevent healthcare-associated infections through hand hygiene: 2022 update. Infection Control & Hospital Epidemiology, 44(3), 355–376. https://doi.org/10.1017/ice.2022.304

Ibrahim, K., Tahsin, M., Rahman, A., Rahman, S. M., & Rahman, M. M. (2024). Surveillance of bacterial load and multidrug-resistant bacteria on surfaces of public restrooms. International Journal of Environmental Research and Public Health, 21(5), 574. https://doi.org/10.3390/ijerph21050574

International Organization for Standardization. (2019). ISO 18593: Microbiology of the food chain: Horizontal methods for surface sampling. ISO.

Jung, C., Samanoudy, G. E., & Alqassimi, N. (2024). Indoor air quality in educational institutions: A comparative study of VOCs and bacterial contaminants in Dubai schools. Frontiers in Built Environment, 10. https://doi.org/10.3389/fbuil.2024.1478681

Kabir, A., Roy, S., Begum, K., Kabir, A. H., & Miah, M. S. (2021). Factors influencing sanitation and hygiene practices among students in a public university in Bangladesh. PLOS ONE, 16(9), e0257663. https://doi.org/10.1371/journal.pone.0257663

Kramer, A., Schwebke, I., & Kampf, G. (2006). How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infectious Diseases, 6, Article 130. https://doi.org/10.1186/1471-2334-6-130

Nightingale, F. (1859). Notes on nursing: What it is, and what it is not. Harrison.

Pasteur, L. (1861). Mémoire sur les corpuscules organisés qui existent dans l'atmosphère. Comptes Rendus de l'Académie des Sciences.

Per, S., & Keleş Dinç, Y. (2024). Microbiological examination of washbasin, faucet heads, and toilet door handles of the students' toilets at a state university. Celal Bayar University Journal of Science, 20(2), 19–27. https://doi.org/10.18466/cbayarfbe.1432698

Rahmiwati, A., Febry, F., Etrawati, F., et al. (2025). Food hygiene and sanitation of the university canteens in South Sumatra Province, Indonesia. Kesmas: National Public Health Journal, 20(2). https://doi.org/10.7454/kesmas.v20i2.2221

Triola, M. F. (2018). Elementary statistics (13th ed.). Pearson Education.

Tunio, A., Ahmed, J., Shaikh, M. Z., Channa, N., Hussain, S., & Baro, E. N. (2025). Impact of hand hygiene interventions on handwashing practices and microbial risk: A study in an orphanage-based school in Pakistan. American Journal of Infection Control, 53(1), 44–52. https://doi.org/10.1016/j.ajic.2024.09.008

Viegas, C., Pimenta, R., Dias, M., Gomes, B., Brito, M., Aranha Caetano, L., Carolino, E., & Gomes, A. Q. (2021). Microbiological contamination assessment in higher education institutes. Atmosphere, 12(8), 1079. https://doi.org/10.3390/atmos12081079

Wongsawan, K., et al. (2020). Existence of bacterial contamination on inanimate surfaces and equipment in sub-district health-promoting hospitals in Chiang Rai, Thailand. Journal of Current Science and Technology, 10(1), 55–63. https://ph04.tci-thaijo.org/index.php/JCST/article/view/320

World Health Organization. (2017). Guidelines on sanitation and health. World Health Organization.