



MICROBIOLOGICAL ASSESSMENT OF COMPUTER KEYBOARDS IN EDUCATIONAL LABORATORIES: A STUDY FROM AL-HIGHER INSTITUTE OF SCIENCE AND TECHNOLOGY / TAMAZAWA – AL-SHATI

Adam Abubaker Mussa Jumh 1*

^{1*} Libyan Authority for Scientific Research

*Corresponding author: E-mail addresses: Adam-ju33@gmail.com



Volume: 5

Issue: 2

Page Number: 128 - 132

Keywords:

Fomites; Bacterial Contamination;
Educational Laboratories; Libya.

Copyright: © 2025 by the authors. Licensee The Derna Academy for Applied Science (DAJAS). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) License (<https://creativecommons.org/licenses/by/4.0/>).



Received: 12\11\2025

Accepted: 14\12\2025

Published: 15\12\2025

DOI: <https://doi.org/10.71147/dqcxdp24>



ABSTRACT

Computer keyboards are frequently touched surfaces that may act as fomites for the transmission of microorganisms, particularly in educational laboratory environments. This study aimed to assess the level of bacterial contamination on computer keyboards used in university laboratories in the Tamazawa–Alshati region, Libya. A total of 30 computer keyboards from two university laboratories were sampled using sterile swabs. Samples were cultured on standard bacteriological media, and bacterial isolates were identified using conventional microbiological methods. Bacterial contamination was estimated semi-quantitatively based on colony-forming unit (CFU) counts and categorized into four contamination levels. All sampled keyboards showed bacterial growth, indicating a contamination rate of 100%. A total of 42 bacterial isolates were recovered, with coagulase-negative staphylococci (CoNS) being the most prevalent organisms. Other isolated bacteria included *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. Most keyboards demonstrated moderate to heavy levels of contamination. Conclusion, computer keyboards in university laboratories may serve as reservoirs for opportunistic and potentially pathogenic bacteria. The implementation of regular disinfection protocols, improved hand hygiene practices, and increased user awareness is recommended to reduce microbial contamination and potential health risks.

1. INTRODUCTION

Computer keyboards are widely used electronic devices in educational and laboratory environments and are frequently handled by multiple users throughout the day. Due to repeated contact with hands, keyboards may act as fomites capable of harboring and transmitting microorganisms (Kramer et al., 2006). Several studies have demonstrated that computer keyboards can be contaminated with a wide range of microorganisms, including normal skin flora and potential pathogens. Such contamination is often associated with inadequate hand hygiene practices, insufficient cleaning protocols, and the shared nature of these devices (Neely and Maley, 2000).

In laboratory and academic settings, microbial contamination of frequently touched surfaces may pose an increased risk of indirect transmission, particularly for opportunistic pathogens. This concern is greater in environments where individuals may have varying levels of immunity (Otter et al., 2011). Previous investigations conducted in hospitals, universities, and office environments have reported the isolation of bacteria such as *Staphylococcus aureus*, coagulase-negative staphylococci, and Gram-negative enteric bacteria from computer keyboards. These findings emphasize the importance of routine surface disinfection and environmental hygiene measures (Pal et al., 2015). Despite the growing body of international research, limited data are available regarding bacterial contamination of shared electronic devices in Libyan educational institutions. Local studies are necessary to understand contamination patterns and to support the development of effective infection prevention strategies (Elkholy and Ewees, 2010). Therefore, the present study aimed to assess the level of bacterial contamination on computer keyboards used in university laboratories in the Tamazawa–Alshati region, Libya, and to identify the predominant bacterial species present (Rutala and Weber, 2001).

2. MATERIALS AND METHODS

A cross-sectional study was conducted to assess bacterial contamination of computer keyboards used in university laboratories in the Tamazawa–Alshati region, Libya. A total of 30 shared computer keyboards were randomly selected from two university laboratories. Sampling was performed using sterile cotton swabs moistened with sterile normal saline. For each keyboard, a standardized area of approximately 10×10 cm, including frequently touched keys such as the spacebar and enter key, was swabbed for about 10 seconds (Kramer et al., 2006).

Swabs were immediately inoculated onto Blood agar and MacConkey agar plates and incubated aerobically at 37°C for 24–48 hours. Bacterial growth was examined, and isolates were identified using standard microbiological techniques, including Gram staining and conventional biochemical tests such as catalase, coagulase, oxidase, and IMViC tests where appropriate (Cheesbrough, 2006).

Bacterial contamination was estimated using a semi-quantitative colony-forming unit (CFU) method based on visible colony counts from primary culture plates. Contamination levels were categorized as low (<10 CFU), mild (10–100 CFU), moderate (101–1000 CFU), or heavy (>1000 CFU), as commonly applied in surface contamination studies (Otter et al., 2011). Data were analyzed descriptively using frequencies and percentages.

3. ETHICS APPROVAL

Ethical approval for this study was obtained from the relevant institutional authority prior to sample collection. Permission was granted to collect environmental samples from computer keyboards used in university laboratories. The study did not involve human participants, animals, or personal data, and all procedures were conducted in accordance with institutional ethical and laboratory safety guidelines.

4. RESULTS

A total of 30 computer keyboards were examined in this study, and bacterial growth was detected on all sampled keyboards, indicating a contamination rate of 100%. From these samples, a total of 42 bacterial isolates were recovered, with some keyboards yielding more than one bacterial species.

Coagulase-negative staphylococci (CoNS) were among the most frequently isolated organisms. Other bacteria identified included *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* (Table 1).

Based on semi-quantitative CFU estimation, most keyboards demonstrated moderate to heavy levels of bacterial contamination. Keyboards from Laboratory A showed a higher proportion of heavy contamination compared to Laboratory B; however, this difference was not statistically significant ($p > 0.05$) (Table 2).

1. Table 1. Contamination levels by laboratory

Lab	CFU Category	Percentage of Keyboards
Lab A	10–100 CFU	30%
Lab A	101–1000 CFU	30%
Lab A	>1000 CFU	40%
Lab B	<10 CFU	20%
Lab B	10–100 CFU	30%
Lab B	101–1000 CFU	50%

2. Table 2. Distribution of bacterial isolates

Bacterial Species	Number of Isolates	Percentage
Coagulase-negative Staphylococcus	11	26.2%
Bacillus spp.	10	23.8%
Escherichia coli	5	11.9%
Micrococcus luteus	5	11.9%
Staphylococcus aureus	4	9.5%
Klebsiella pneumoniae	3	7.1%
Enterococcus faecalis	3	7.1%
Pseudomonas aeruginosa	1	2.4%

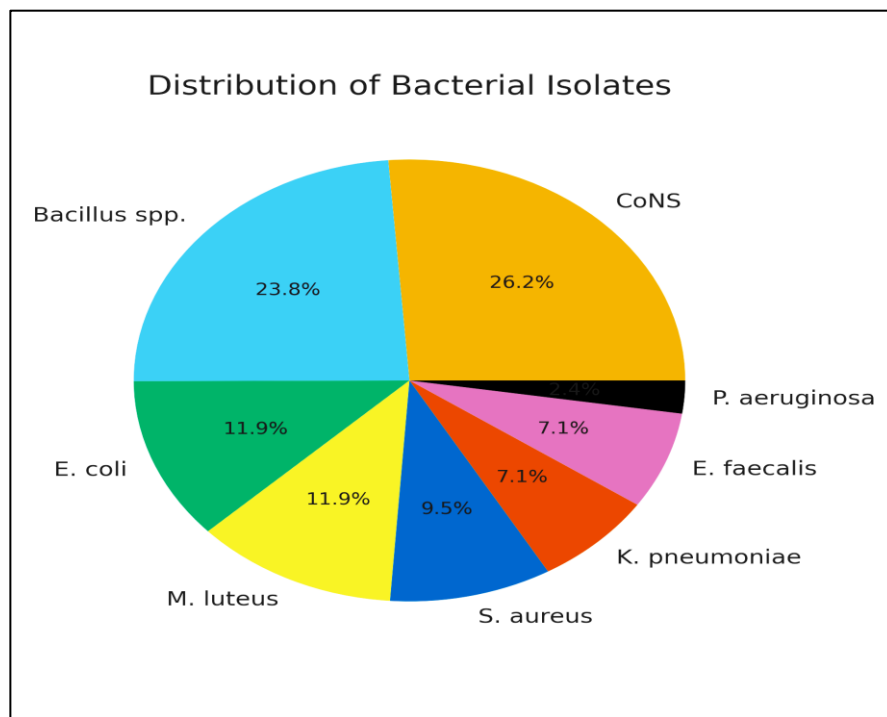


Figure 1. Distribution of bacterial isolates across all keyboards.

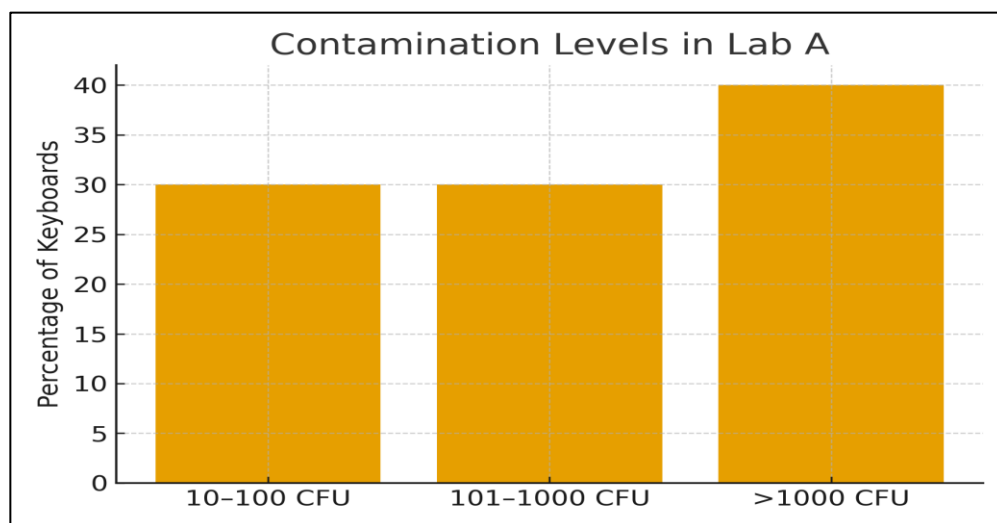


Figure 2. Contamination levels in Lab A keyboards.

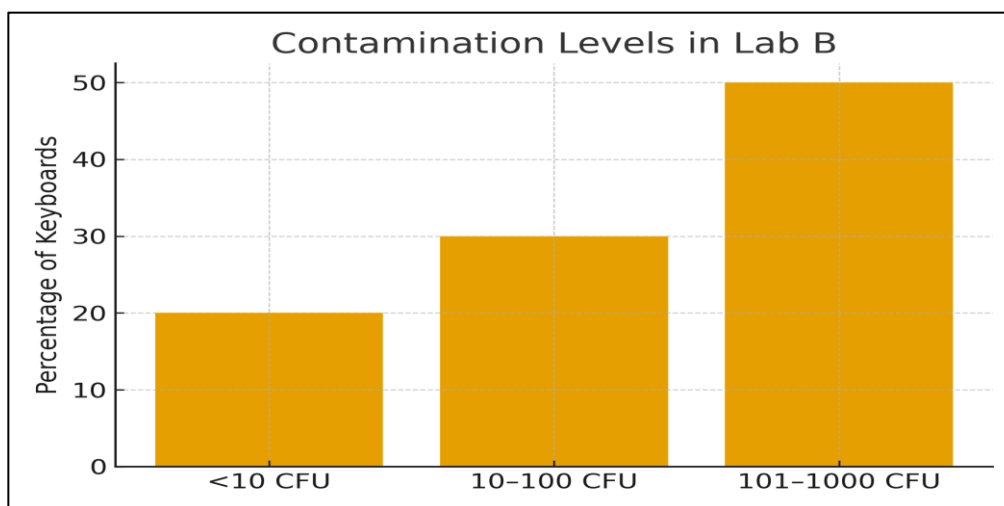


Figure 3. Contamination levels in Lab B keyboards

5. DISCUSSION

The present study demonstrated a high level of bacterial contamination on computer keyboards used in university laboratories, with all sampled keyboards showing microbial growth. This finding reinforces the role of frequently touched electronic devices as potential reservoirs for microorganisms and highlights their contribution to indirect microbial transmission in shared educational environments (Boyce, 2016; Wilson et al., 2020).

The predominance of coagulase-negative staphylococci (CoNS) among the isolated bacteria is consistent with their role as common skin flora and their frequent transfer through direct hand contact. Similar observations have been reported in studies conducted in hospital, university, and office settings, where CoNS were identified as the most prevalent contaminants on keyboards and other electronic devices (Neely and Maley, 2000).

The isolation of *Staphylococcus aureus* in the present study is of particular concern, as this organism is a well-recognized opportunistic pathogen capable of causing a wide range of infections. The presence of *S. aureus* on shared keyboards has been widely documented and is often associated with inadequate hand hygiene and insufficient surface disinfection practices (Elkholy and Ewees, 2010; Ulger et al., 2009).

Furthermore, the detection of Gram-negative bacteria such as *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* suggests possible contamination from environmental or fecal sources. These organisms have been frequently reported on electronic devices and commonly touched surfaces, indicating lapses in hand hygiene and environmental sanitation (Bhoonderowa et al., 2014; Brady et al., 2011).

The semi-quantitative assessment of bacterial load revealed that most keyboards exhibited moderate to heavy contamination levels. Similar variability in contamination levels between different locations has been reported and may reflect differences in user behavior, frequency of use, and surface cleaning practices rather than structural differences between environments (Rutala and Weber, 2001; Smith et al., 2018).

Overall, the findings of this study emphasize the importance of routine disinfection of shared electronic devices and the reinforcement of hand hygiene practices in university laboratory settings. Simple infection control measures, including regular surface cleaning, user awareness, and adherence to hygiene protocols, may significantly reduce microbial contamination and limit the potential for indirect transmission (Kampf et al., 2017; Boyce, 2016).

6. LIMITATIONS AND RECOMMENDATIONS

This study did not include fungal or viral detection, antimicrobial susceptibility testing, or longitudinal sampling; therefore, temporal dynamics of contamination and antimicrobial resistance patterns could not be assessed. Future studies should incorporate molecular identification methods and antimicrobial resistance profiling. In addition, extending sampling to other shared devices such as computer mice, headphones, and touchscreens is recommended.

7. CONCLUSION

Computer keyboards used in university laboratories were found to be widely contaminated with various bacterial species, including opportunistic pathogens. These findings highlight the potential role of shared electronic devices as reservoirs for microbial contamination. Implementing routine disinfection measures and improving hand hygiene practices may reduce bacterial contamination and limit the risk of indirect transmission in educational laboratory environments.

8. References

- AlGhazali, M. A., & Eljamay, S. M. (2025). THE ROLE OF TEMPERATURE IN MICROBIAL GROWTH: A DISCUSSION AND META-ANALYSIS. *Derna Academy Journal for Applied Sciences*, 4(1), 34-44.
- Bhoonderowa, A., Gookool, S. and Biranjia-Hurdoyal, S.D. (2014) The importance of mobile phones in the possible transmission of bacterial infections in the community. *Journal of Community Health*, 39(5), pp. 965–967.
- Boyce, J.M. (2016) Modern technologies for improving cleaning and disinfection of environmental surfaces in hospitals. *American Journal of Infection Control*, 44(5 Suppl), pp. e38–e46.
- Brady, R.R.W., Hunt, A.C., Visvanathan, A., Rodrigues, M.A., Graham, C., Rae, C. and Kalima, P. (2011) Mobile phone technology and hospitalized patients: A cross-contamination risk? *Journal of Hospital Infection*, 77(4), pp. 362–365.
- Cheesbrough, M. (2006) *District Laboratory Practice in Tropical Countries*. 2nd edn. Cambridge: Cambridge University Press.
- Elkholy, M.T. and Ewees, I.E. (2010) Mobile phones are reservoirs of nosocomial pathogens. *African Journal of Biotechnology*, 9(3), pp. 346–351.
- Elzouki, E. M., Eljamay, S. M., & Alshilwi, Y. A. (2024). Isolation and Identification of Escherichia Coli in Uropathogenesis. *Derna Academy Journal for Applied Sciences*, 2(2), 103-110.
- Kampf, G., Todt, D., Pfaender, S. and Steinmann, E. (2017) Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *Journal of Hospital Infection*, 104(3), pp. 246–251.
- Kramer, A., Schwebke, I. and Kampf, G. (2006) How long do nosocomial pathogens persist on inanimate surfaces? *BMC Infectious Diseases*, 6, p. 130. <https://doi.org/10.1186/1471-2334-6-130>
- Neely, A.N. and Maley, M.P. (2000) Survival of enterococci and staphylococci on hospital fabrics and plastics. *Journal of Clinical Microbiology*, 38(2), pp. 724–726.
- Otter, J.A., Yezli, S. and French, G.L. (2011) The role of contaminated surfaces in the transmission of nosocomial pathogens. *Infection Control & Hospital Epidemiology*, 32(7), pp. 687–699. <https://doi.org/10.1086/660363>
- Pal, S., Juyal, D., Adekhandi, S., Sharma, M., Prakash, R., Sharma, N. and Rana, A. (2015) Mobile phones: Reservoirs for the transmission of nosocomial pathogens. *Advanced Biomedical Research*, 4, p. 144. <https://doi.org/10.4103/2277-9175.161553>
- Rutala, W.A. and Weber, D.J. (2001) Surface disinfection: Should we do it? *Journal of Hospital Infection*, 48(Suppl A), pp. S64–S68. <https://doi.org/10.1053/jhin.2001.0884>
- Smith, S.J., Young, V., Robertson, C. and Dancer, S.J. (2018) Where do hands go? An audit of sequential hand-touch events on a hospital ward. *Journal of Hospital Infection*, 100(1), pp. 75–81.
- Ulger, F., Dilek, A., Esen, S., Sunbul, M., Leblebicioglu, H. and Saniç, A. (2009) Are healthcare workers' mobile phones a potential source of nosocomial infections? *Infection Control & Hospital Epidemiology*, 30(3), pp. 290–292.
- Wilson, J.A., Loveday, H.P., Hoffman, P.N. and Pratt, R.J. (2020) The role of environmental contamination in the transmission of healthcare-associated infections. *Journal of Infection Prevention*, 21(3), pp. 105–112.