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Original article

Assessment of Microbial Contamination on Keyboards and Mice of Computers in Administrative Office in Surman City

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ABSTRACT

This study aimed to assess the level of microbial contamination on keyboards and mice used in administrative office in Sorman City. Samples were collected from 14 keyboards and 14 mice. Microbial analysis involved isolating and identifying bacteria using microscopic, cultural, and biochemical tests. A total of 28 samples were analyzed, revealing contamination with various bacteria. Staphylococcus aureus was the most prevalent, found in 96.42% of samples, with a higher contamination rate on keyboards (100%) compared to mice (92.85%). Other bacteria isolated included Staphylococcus epidermidis (28.57%), Streptococcus species (42.85%), Escherichia coli (14.28%), Klebsiella species. (10.71%), and Salmonella species. (21.42%). The high contamination rates, especially for Staphylococcus aureus, suggest that keyboards and mice are significant reservoirs for pathogens. Staphylococcus epidermidis and Streptococcus species were also commonly found, indicating potential routes of infection through contact with contaminated surfaces. Gram-negative bacteria such as Escherichia coli, Klebsiella species., and Salmonella species. were less prevalent but still notable, potentially due to fecal contamination or food residues. The study highlights the critical need for regular cleaning and disinfection of computer equipment to reduce microbial contamination. Improved hygiene practices are essential to prevent the spread of infections in office environments.

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INTRODUCTION

Computers have become an integral part of daily life, both in homes and commercial offices. With the increasing use of these devices, new challenges related to user health and safety have emerged. Computer keyboards and mice are among the most frequently touched surfaces and can become breeding grounds for microorganisms. Frequent contact with these devices by multiple users can lead to the accumulation of microbes, posing a potential health risk.

While some microbes may be harmless, others can cause serious infections, especially if surfaces are not regularly cleaned. The presence of these microorganisms is primarily due to direct transfer from the skin or mucous membranes of users, or through airborne particles.

Previous studies have indicated that computers, including keyboards and mice, can be contaminated with a variety of pathogenic bacteria. For instance, a study conducted by Gurung et al., found that *Staphylococcus aureus*, a major component of the skin and nasal flora, was frequently isolated from computer keyboards. This bacterium can easily be transferred to surfaces through actions such as sneezing, talking, or touching moist skin, and has been associated with various infectious diseases [1]. In another study by Simmonds et al., reported that computer mice in public settings

showed contamination with *Enterococcus species* and *Escherichia coli*, both of which can cause serious health issues, particularly in immunocompromised individuals. The study highlighted the importance of regular cleaning and disinfection of shared devices to minimize microbial contamination [2].
Moreover, Beckstrom-Sternberg et al., examined the prevalence of Gram-negative bacteria, such as *Klebsiella species* and *Pseudomonas aeruginosa*, on office equipment.These bacteria are known for their ability to survive on inanimate surfaces for extended periods, increasing the risk of nosocomial infections in environments with high human traffic [3].
Numerous studies have indicated that computer keyboards and mice can become contaminated with pathogenic bacteria. In healthcare settings, it is perhaps not surprising that such microorganisms would contaminate these common work surfaces. However, the present study shows that microbial contamination also occurs on computer keyboards and mice in a large university environment. For instance, anastasiades et al., reported the presence of *coagulase-negative staphylococci* (68.5%), *Staphylococcus aureus* (2.1%), *Gram-positive bacilli* (27.1%), and *Micrococcus* (0.6%) [4].
Similarly, EKluytmans et al. found that *Staphylococcus aureus* constituted 42.6% of the isolated bacteria [5].
Eltablawy and Elhifnawi, reported that all tested computer mice were positive for microbial contamination, with the percentages of pathogenic and non-pathogenic bacteria including *Bacillus species*. (66.6%), *Micrococcus species*. (4.2%), and *Staphylococcus epidermidis* (4.2%) [6].
In another study, bacterial swab specimens collected from the surfaces of 250 computer keyboards and mice revealed that all tested devices were positive for microbial contamination, with the percentages of isolated bacteria being 43.3% for *Staphylococcus species* and 40.9% for *Bacillus species* [7]. Tagoe & Kumi-Ansah, highlighted computer keyboards and mice as potential sources of disease transmission in schools and public places in Africa [8]. It identified several pathogenic microorganisms on these devices, emphasizing their role in the spread of infections. Thus, this study aimed to evaluate the microbial contamination on keyboards and mice in administrative office in Surman City.

METHODS

Sample Collection

A total of 28 samples were collected from computer keyboards (14) and mice (14) in staff office at the administrative office in Surman City. Sterile swabs moistened with saline were used to firmly wipe the entire surface of each object. Each swab was placed in 2 ml of nutrient broth (Hi-Media, India) and incubated overnight at 37°C.

Bacterial Cultivation and identification

After incubation, the samples were vortexed for one minute and cultured on blood agar, MacConkey agar, Salmonella-Shigella agar, and mannitol salt agar (Hi-Media, India). These cultures were incubated aerobically at 37°C for 24 hours [9]. Bacteria were identified based on their Gram reaction and morphology using the Gram staining technique.

Biochemical Testing

Catalase Test

This test was used to distinguish catalase-positive from catalase-negative bacteria by observing oxygen bubble production after exposure to hydrogen peroxide.

Coagulase Test

Used to differentiate *Staphylococcus aureus* (coagulase-positive) from other *Staphylococci*.

Analytical profile Index (API 20E) Biochemical Strip

This system was employed for the identification of Gram-negative bacteria. The strips were inoculated with bacterial suspensions, incubated, and analyzed based on the color changes and reactions within each compartment.

Data analysis

Descriptive statistics such as frequency (%), mean and standard deviation were used to present the characteristics of the samples as appropriate. The results of the study and its characteristics were compared with the standard numbers of the analyses.

RESULTS

A total of 28 samples were collected and analyzed from computer keyboards (CK) and computer mice (CM) across various administrative offices. The results of this study indicate microbial contamination on keyboards and mice in administrative offices in Surman City. The findings reveal that most samples were contaminated with various types of bacteria, including *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus species*, *Salmonella species*, *Escherichia coli*, and *Klebsiella species*. These results are consistent with previous studies that have reported the

potential for computer equipment to harbor microbial contaminants, table (1) shows the type and percentage of isolated bacteria.

Table 1. Type and percentage of isolated bacteria

Types of Bacteria	Percentages (n=28)
Staphylococcus aureus	*n=27 (96.42%)*
Staphylococcus epidermis	*n=8 (28.57%)*
Streptococcus species.	*n=12 (42.85%)*
Salmonella species	*n=6 (21.42%)*
Klepsiella species	*n=3 (10.71%)*
Escherichia coli	*n=4 (14.28%)*

In comparing the microbial contamination rates between computer keyboards and mice, the data reveals notable differences. *Staphylococcus aureus* was found to contaminate all keyboard samples (100%) and nearly all mouse samples (92.85%), indicating a slightly higher contamination rate on keyboards.

For *Staphylococcus epidermidis*, the contamination rate was significantly higher on keyboards at 42.85% compared to just 14.28% on mice, suggesting that keyboards are more susceptible to this particular bacterium. Conversely, *Streptococcus species* showed a higher contamination rate on mice (50%) than on keyboards (35.71%), pointing to a greater likelihood of contamination on mice. *Salmonella species* exhibited an equal contamination rate of 21.42% on both keyboards and mice, suggesting no significant difference in contamination levels between the two devices for this bacterium. The study also found that *Klebsiella species* were more prevalent on keyboards (14.28%) than on mice (7.14%), while *Escherichia coli* was only detected on mice (28.57%) and was entirely absent from keyboards. These findings underscore the varying degrees of microbial contamination between computer peripherals, with keyboards generally showing higher contamination rates for several bacterial species, except for Streptococcus and *Escherichia coli*, which were more prevalent on mice.

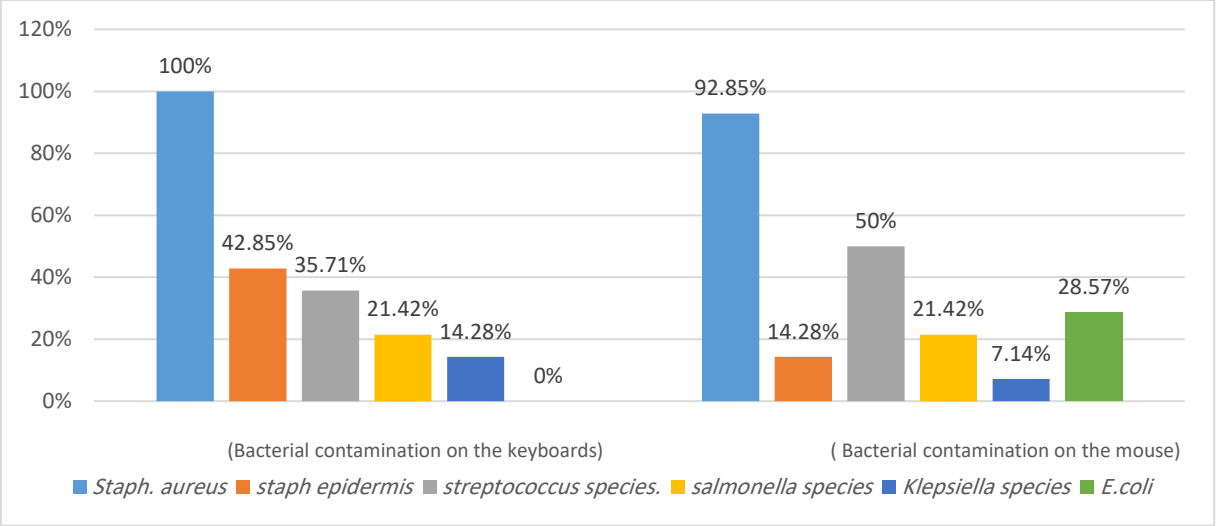

Figure 1. Bacterial species and the relative percentage of bacterial contamination on both keyboards and mice.

DISCUSSION

The results of this study highlight the significant microbial contamination present on keyboards and mice in administrative offices in Sorman City. The contamination rates for various bacteria were notably high, emphasizing the role of these surfaces as potential reservoirs for pathogens. Contamination with *Staphylococcus aureus*, the isolation rate of *Staphylococcus aureus* from keyboards was 100%, compared to 92.85% from mice, indicating a higher level of contamination on keyboards. *Staphylococcus aureus* is part of the normal flora of the human skin and nasal passages, and it can be associated with various diseases. The anterior nares are a common ecological niche for this bacterium, with approximately one-quarter to one-third of healthy individuals carrying it in their noses at any given time. This bacterium can easily be transferred to the hands, especially through actions such as touching the nose, which contributes

to its presence on shared surfaces. These findings are consistent with studies such as those by Hartmann et al, which also reported high contamination rates of *Staphylococcus epidermidis* and other bacteria on computer equipment [10]. Similar to this study, Tagoe & Kumi-Ansah found that computer peripherals are significant reservoirs for bacteria, which aligns with those findings of high contamination rates, particularly with *Staphylococcus aureus* and Streptococcus species. Both studies suggest the necessity of regular cleaning and disinfection practices to minimize infection risks. Itah & Ben identified enteric bacteria and *Staphylococcus aureus* on computer keyboards and mice in a Nigerian university, suggesting a significant risk of spreading enteric infections in academic settings [11].

The presence of *Staphylococcus aureus* in both studies reinforces the idea that this bacterium is a common contaminant on computer equipment, especially in environments with high human interaction. The study also detected *Escherichia coli*, similar to the enteric bacteria found by Itah and Ben, indicating a comparable risk in different geographical and institutional settings. Curtis and Baird [12] focused on the microbial contamination of electronic devices in workplaces, highlighting the often-overlooked threat of infection from these commonly used devices. Comparison Curtis & Baird's findings support this study's conclusion that computer equipment, including keyboards and mice, can harbor significant microbial contamination, underscoring the importance of workplace hygiene. The results further confirm the necessity for increased awareness and preventive measures in office environments.

Sullivan et al., conducted a systematic review that assessed the risk of bacterial contamination on office computer equipment, finding consistent evidence of contamination across various studies and suggesting potential nosocomial infections [13]. Sullivan et al.'s review aligns with this study's findings by documenting the widespread nature of bacterial contamination on computer equipment in office settings. The study adds to this body of evidence, particularly by quantifying the contamination rates in a specific location (Surman City), thus contributing valuable data to the broader understanding of this issue. Pal et al. Study highlighted the role of computer keyboards and mice as reservoirs for pathogens in hospitals, particularly emphasizing the risks posed by *Staphylococcus aureus* and other nosocomial pathogens [14]. Pal et al.'s findings are highly relevant to this study, as both identify *Staphylococcus aureus* as a predominant contaminant. However, your study extends the investigation to an administrative office setting, showing that the risk of contamination is not limited to hospitals but is also prevalent in non-clinical environments. Narayana et al, this research focused on the microbial contamination of computer peripherals in hospitals, finding significant contamination that could contribute to hospital-acquired infections (HAIs). The contamination rates and types of bacteria found in this study, including Salmonella and *Klebsiella species*, mirror those in hospital settings as documented by Narayana et al [15]. This comparison emphasizes the potential for administrative office equipment to serve as reservoirs for bacteria typically associated with HAIs. Rusin et al., examined the survival of bacteria on computer keyboards and mice in workplaces, suggesting these devices as potential sources of nosocomial infections. Comparison this findings corroborate Rusin et al.'s research, particularly regarding the persistence of bacteria like *Staphylococcus aureus* on surfaces like keyboards and mice. The similarity in results further highlights the ongoing risk posed by these devices in transmitting bacteria in various environments. [16].

Contamination with *Staphylococcus epidermidis*, the isolation rate of *Staphylococcus epidermidis* was 28.57%, with a higher contamination rate observed on keyboards (42.85%) compared to mice (14.28%). Although *Staphylococcus epidermidis* is a normal skin inhabitant, it can act as an opportunistic pathogen, causing infections such as endocarditis. This variation in contamination levels between keyboards and mice may reflect differences in the frequency and effectiveness of cleaning practices. Contamination with *Streptococcus species*, the isolation rate of *Streptococcus species* was 42.85%, with a higher contamination rate found on mice (50%) compared to keyboards (35.71%). This suggests a possible route of contamination from the mouth, as *Streptococcus species* are commonly found in the oral cavity. This highlights the risk of transferring pathogens via hands to other individuals, particularly in shared environments such as university offices. Contamination with Gram-Negative Bacteria, *Escherichia coli*, the contamination rate of *Escherichia coli* was 14.28%, with a significant presence on mice (28.57%) but absent on keyboards. This bacterium is typically associated with fecal contamination, which may be a result of inadequate hygiene practices. *Klebsiella species*, the isolation rate of *Klebsiella species* was 10.71%, with a higher contamination rate on keyboards (14.28%) compared to mice (7.14%). The presence of *Klebsiella species* also suggests fecal contamination. *Salmonella species*, the contamination rate for *Salmonella species*, was 21.42% for both keyboards and mice.

This level of contamination could be linked to the presence of leftover food or inadequate cleaning practices.

CONCLUSION

The high levels of microbial contamination on keyboards and mice in administrative offices highlight the need for improved cleaning and disinfection practices. These surfaces, being frequently touched and shared, can act as reservoirs for pathogens and contribute to the spread of infections. Regular and thorough cleaning, along with effective hand

hygiene, are crucial in minimizing the risk of microbial transmission in such environments. The findings of this study underscore the importance of maintaining good hygiene practices to reduce the risk of infection associated with computer equipment.

Conflict of interest. Nil

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تقييم التلوث الميكروبي على لوحات المفاتيح والفأرات لأجهزة الحاسب الآلي في مكاتب الإدارة في مدينة صرمان

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المستخلص

هدفت هذه الدراسة إلى تقييم مستوى التلوث الميكروبي على لوحات المفاتيح والفأرات المستخدمة في المكاتب الإدارية في مدينة صـــرمان. حيث تم جمع عينات من 14 لوحة مفاتيح و14 فأرة. شـــمل التحليل الميكروبي عزل وتحديد البكتيريا باسـتخدام الفحوصـات الميكروسـكوبية والبيوكيميائية. وكشـفت النتائج تحليل 28 عينة عن تلوث بكتيري بأنواع مختلفة. كانت Staphylococcus aureus هي الأكثر انتشـــارًا، حيث وجدت في 96.42% من العينات، مع معدل تلوث أعلى على لوحات المفاتيح (100%) مقارنة بالفأرات (92.85%). كما تم عزل بكتيريا أخرى تشـــمل Staphylococcus epidermidis (28.57%)، وStreptococcus species (42.85%)، وEscherichia coli (14.28%)، وKlebsiella species (10.71%)، وSalmonella species (21.42%). وتشير معدلات التلوث العالية، خاصة لـ Staphylococcus aureus، إلى أن لوحات المفاتيح والفأرات تشـــكل مصـــدر هامة للميكروبات. كما تم العثور على Staphylococcus epidermidis وStreptococcus species بشـكل شـائع، مما يدل على احتمال انتقال العدوى من خلال الأســـطح الملوثـة. بينمـا كـانـت البكتيريـا الســـالبـة الجرام مثـل Escherichia coli وKlebsiella species. وSalmonella species. أقل شـــيوعًا، إلا أن وجودها لا يزال ملحوظًا، وربما يكون بســـبب التلوث البرازي أو بقايا الطعام. وتسـلط الدراســة الضـــوء على الحاجة الملحة لتنظيف وتعقيم معدات الكمبيوتر بانتظام لتقليل التلوث الميكروبي. تعتبر تحسينات ممارسات النظافة أساسية للوقاية من انتشار العدوى في بيئات المكاتب.

مفاتيح الكلمات. التلوث الميكروبي، لوحة المفاتيح، الفأرة، البكتيريا الموجبة الجرام، البكتيريا السالبة الجرام.