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# Hand Carriage of Microorganisms by Students of Federal University of Lafia, Nasarawa State, Nigeria

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## Abstract

Microbes from the body's regular flora and transient microorganisms from the environment are found on human hands. Hands can also be used to spread disease from one person to another, especially among close persons. This study aimed to isolate and identify microorganisms from students' hands and assess the occurrence of these bacteria based on gender, level of study, faculty, and hand area (palm and nails swab). Using the pour plate method, a total of sixty (60) hand swab samples (thirty (30) from both palm and nails) were collected and tested for bacterial and fungal presence. Bacteria isolated were *Staphylococcus epidermidis* (80.00%), *Staphylococcus aureus* (75.00%), *Enterococcus* spp (50.00 %), *Micrococcus* spp (46.67%), *Escherichia coli* (45.00%), *Klebsiella* spp (45.00%), *Bacillus* spp (30.00%), *Salmonella* spp (13.33%) and *Streptococcus* spp (10.00%). The fungi isolated were *Aspergillus niger* (45.00%), *Penicillium* spp (23.33%), *Mucor* spp (21.67%), *Candida* spp (20.00 %) and *Saccharomyces* spp (15.00 %). Gender, level of study, faculty, and area of hand swab revealed no statistically significant variation in the presence of numerous bacterial and fungal species at $p<0.05$. These findings revealed that the microbial burden on students' hands was significant and was unaffected by gender, level of study, or faculty. To improve students' overall health, appropriate hygiene, including regular handwashing practice, and public education about the importance of hands in disease transmission should be supported.

**Keywords:** Hands, flora, transient, students, palm, nails

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## Introduction

There are over 100 trillion cells in the human body. However, even one-tenth is hardly natural human cells. The human body is home to and harbours trillions of bacteria, viruses, fungi and other tiny organisms known as microbes or microorganisms. These microbes belonging to different communities are collectively called the microbiome, and they play an important role in maintaining human health under normal conditions. However, a deviation in these conditions can result in the organisms becoming pathogenic to humans. Microorganisms inhabit various human body sites, including skin, nose, mouth, digestive gut, and genitourinary tract [1]. For the past 6 million years, microorganisms are evolving together with humans, and they have formed complex relationships with each other. To stay healthy, humans need microorganisms, and many microorganisms need specific environment provided by the human body to survive. All vertebrates and most invertebrates are endowed with a large and varied microbial biota [2] with different species of microorganisms living at different places in and on the human body to which they are adapted [3]. The population of these microorganisms may be dense as in the mouth or large intestine, of moderate size as on the skin or virtually absent as in deep tissues. Although most of these organisms are harmless commensals or even participate in symbiotic relationships, many of them can turn on the host and cause diseases [4].

Skin is the largest organ of the human body and provides ideal habitats for various microorganisms [5]. The human skin may be open to colonization from the environment, but it is thought to be a strong selective filter, largely unsuitable for most microorganisms to permanently reside [6]. The healthy or normal skin microbiota is composed of a limited number of bacterial species, mainly Gram-positive species [7, 8]. The three significant skin habitats, sebaceous, dry and moist skin and the gradual changes of environmental conditions within and between them, largely determine the microbial community living in a particular skin site [8]. Dry regions, including the forearm and the palm, are often the richest in bacterial diversity. Thus, they are generally easier to be colonized by microorganisms and more susceptible to temporal variability. At the same time, the sebaceous sites are usually poorer in bacterial diversity and dominated by *Propionibacterium acnes*, presumably due to high sebaceous gland activity that may result in more exclusivity [1, 7 – 9].

The human hand is home to many microorganisms. The microorganisms found on the human hand are usually resident on the skin, and since the hand is always in direct contact with the skin, it makes transmission from the skin to the hand easy [10].

People use their hands for various activities; it is therefore extremely easy to contact and transfer different microorganisms from and to objects like door knobs, pencils, seats, and other people. Surprisingly, fingernails harbour the most bacteria found on human hands [11], with long nails harbouring microorganisms than short nails [12]. Artificial nails also carry greater quantities of pathogenic organisms on their surface than the surface of native nails [13]. Thus, hands serve as the vehicle of infectious disease transmission, especially amongst people living and working in close proximity to one another, such as dormitories, classrooms, camps etc. Close environments, doorknobs and other inanimate objects serving as resting vehicles of transmission all contribute to increased infection rates among these groups [14]. Human hands usually constitute microorganisms both as part of the body's normal flora and transient microorganisms contracted from the environment [15]. Although it is nearly impossible for the hands to be free of microorganisms and usually harbour microorganisms both as residents and transients, the presence and transfer of pathogenic microorganisms could occur between people who access the same areas or surfaces may lead to chronic or acute illnesses [15, 16]. Therefore, the study aimed to investigate the microorganisms isolated from the hands of students of the Federal University of Lafia, Nasarawa State, Nigeria.

## Materials and Methods

### Sample collection and preparation

Sixty (60) swab samples were collected from the palms and nails of students of the Federal University of Lafia. Sterile cotton swabs dampened in 0.85% sterile saline were used to obtain samples from the nails and the palms of students [17]. Sample collection was based on sex, level of study, and faculty of the students. The samples were immediately taken to the Microbiology laboratory of Federal University of Lafia, for further analysis. The swab samples were placed in test tubes containing 10 mL sterile distilled water, vortexed gently, and left standing for 30 min.

### Isolation and identification of bacterial species

For bacterial isolation, 1 mL aliquots was inoculated using pourplate method with nutrient agar and incubated at 37$^{o}$C for 24 h. After growth, the suspected colonies of interest were sub-cultured. Sub-culturing was done by transferring a little portion of growth of the colonies from the mixed culture using a sterile wire loop by streak plate method and the plates were incubated at 37$^{o}$C for 24 h. Gram staining and biochemical tests were done on plates that showed pure culture. The cultural characteristics of the colonies like shape, size, and elevation were also noted.

### Isolation and identification of fungal species

Isolation of fungal isolates was carried out as described by Akharenegbe *et al*. [18] with slight modifications using potato dextrose agar (PDA). Briefly, 1mL of inoculum was pour-plated and incubated for 3 days at 25$^{o}$C. Identification of fungal isolates was done macroscopically and microscopically as described by Chuku *et al*. [19].

### Statistical analysis

All data generated were analyzed using Statistical Package for Social Science (SPSS) software. The chi-square test was used to investigate the statistical significance of the associations between two qualitative variables and this was done at a 5% level of significance.

## Results and Discussion

The total frequency of bacterial species isolated from students concerningthe area of hand swabbedis as shown in Table 1. From the result, *Staphylococcus epidermidis* had the highest occurrence in both nails and palm regions with a value of 80.00%. The least occurrence was observed in *Salmonella* spp and *Streptococcus* spp with a total of 8 (13.33 %) and 6 (10.00 %) respectively. Statistically, the occurrence of the various bacterial species from the palm and nails regions had no significant difference ($p$<0.05).

**Table 1: Occurrence of bacterial species concerning the area of hand swabbed**

| Bacterial isolates | Nails N=30 n(%) | Palm N=30 n(%) | Total N=60 n(%) |
|---|---|---|---|
| *Staphylococcus aureus* | 22 (73.33) | 23 (76.67) | 45 (75.00) |
| *Staphylococcus epidermidis* | 23 (76.67) | 25 (83.33) | 48 (80.00) |
| *Micrococcus* spp | 18 (60.00) | 10 (33.33) | 28 (46.47) |
| *Escherichia coli* | 16 (53.33) | 11 (36.67) | 27 (45.00) |
| *Bacillus* spp | 13 (43.33) | 5 (16.67) | 18 (30.00) |
| *Enterococcus* spp | 14 (46.67) | 16 (53.33) | 30 (50.00) |
| *Klebsiella*spp | 12 (40.00) | 15 (50.00) | 27 (45.00) |
| *Streptococcus* spp | 5 (16.67) | 1 (3.33) | 6 (10.00) |
| *Salmonella* spp | 7(23.33) | 1(3.33) | 8(13.33) |

N= Total number of samples, n= Number of positive samples

Table 2 illustrates the overall frequency of bacterial species isolated from palm and nail swabs of students concerning gender, level of study, and faculty. Concerning gender, *S. epidermidis* exhibited the highest occurrence among male students, with a total value of 22 (18.49%), while the least occurrence was observed in *Streptococcus* spp, totaling 1 (3.33%). Similarly, among female students, *S. epidermidis* demonstrated the highest frequency, totaling 23 (76.67%), and the least occurrence was noted in *Salmonella* spp, totaling 3 (10.00%). The results indicate no significant difference between the two genders at p<0.05.

Concerning the level of study, *S. aureus* demonstrated the highest occurrence, totaling 14 (93.33%), while the least occurrence was observed in *Salmonella* spp, with a total value of 0 (0.00%). No significant difference based on the level of study was identified at p<0.05.

In terms of faculty, the highest occurrence was noted in *S. aureus*, totaling 18 (90.00%), and the least occurrence was recorded in *Streptococcus* spp and *Salmonella* spp, each with a total value of 2 (10.00%). Statistically, there was no significant difference based on faculty at p>0.05.

**Table 2: Occurrence of bacterial species in relation to gender, level of study and faculty**

| Factors | N 60 | SA n (%) | SE n (%) | MS n (%) | EC n (%) | BS n (%) | EF n (%) | KS n (%) | St S n (%) | SS n (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Sex** | | | | | | | | | | |
| Male | 30 | 20(66.67) | 22 (73.33) | 20(66.67) | 16(53.33) | 9 (30.00) | 15(50.00) | 12 (40.00) | 1(3.33) | 4 (13.33) |
| Female | 30 | 20(66.67) | 23(76.66) | 15(50.00) | 16(53.33) | 13(43.33) | 13(43.33) | 9(30.00) | 6(20.00) | 3(10.00) |
| **Level of Study** | | | | | | | | | | |
| 100 | 15 | 6(40.00) | 8(53.33) | 8(53.33) | 6(40.00) | 1(6.67) | 4(26.67) | 2(13.33) | 2(13.33) | 2(13.33) |
| 200 | 15 | 12(80.00) | 15(100.0) | 7(46.67) | 7(46.67) | 3(20.00) | 3(20.00) | 4(26.67) | 1(6.67) | 0(0.00) |
| 300 | 15 | 12(80.00) | 10(66.67) | 9(60.00) | 7(46.67) | 9(60.00) | 7(46.67) | 9(60.00) | 3(20.00) | 0(0.00) |
| 400 | 15 | 14(93.33) | 12(80.00) | 9(60.00) | 12(80.00) | 7(46.67) | 11(73.33) | 7(46.67) | 2(13.33) | 6(40.00) |
| **Faculty** | | | | | | | | | | |
| Science | 20 | 12(60.00) | 14(70.00) | 14(70.00) | 7(35.00) | 7(35.00) | 6(30.00) | 6(30.00) | 2(10.00) | 2(10.00) |
| Arts | 20 | 18(90.00) | 16(80.00) | 5(25.00) | 14(70.00) | 8(40.00) | 12(60.00) | 9(45.00) | 2(10.00) | 5(25.00) |
| Social sciences | 20 | 11(55.00) | 16(80.00) | 15(75.00) | 7(35.00) | 8(40.00) | 8(40.00) | 7(35.00) | 3(15.00) | 3(15.00) |

*P<0.05*, F-value 2.29, P-value 0.096

N= Total number of samples; n= Number of positive samples; SA: *Staphylococcus aureus*; SE: *Staphylococcus epidermidis*; MS: *Micrococcus* spp; EC: *Escherichia coli*; BS: *Bacillus* spp; EF: *Enterococcus faecalis*; KS: *Klebsiella* spp; St S: *Streptococcus* spp; SS: *Salmonella* spp

The cumulative frequencies of different fungal species isolated from students, categorized by the area of hand swab, are documented in Table 3. *Aspergillus niger* emerged as the most prevalent fungus, accounting for a total frequency of (45.00%), closely followed by *Penicillium* spp with (23.33%). *Mucor* spp exhibited a frequency of (21.67%), while *Candida* spp (20.00%) and *Saccharomyces* spp (15.00%) were also identified. The results indicate that there was no significant difference in their occurrence among the various hand regions at $p<0.05$.

Table 4 presents the overall frequency of fungal species isolated from palm and nail swabs, categorized by gender, level of study, and faculty. Regarding gender, *A. niger* exhibited the highest occurrence, totaling 14 (46.67%), while *Candida* spp had the least occurrence, with a total value of 0 (0.00%). No statistical difference in occurrence concerning gender was observed at $p>0.05$.

Concerning the level of study, *A. niger* demonstrated the highest occurrence, totaling 8 (53.33%), while the least occurrence was recorded in *Saccharomyces* spp, with a total value of 0 (0.00%). Statistically, there was no significant difference concerning the level of study at $p>0.05$. In relation to faculty, *A. niger* showcased the highest occurrence, totaling 11 (55.00%), whereas *Saccharomyces* spp had the least occurrence, with a total value of 2 (10.00%). Statistically, the occurrence of fungal species concerning faculty demonstrated no significant difference at $p>0.05$.

**Table 3: Occurrence of fungal species in relation to area of hand swabs**

| Fungalisolates | Nails N=30 n(%) | Palm N=30 n(%) | Total N=60 |
|---|---|---|---|
| *Candida spp* | 6(20.00) | 6(20.00) | 12(20.00) |
| *Mucor spp* | 6(20.00) | 7(23.33) | 13(21.67) |
| *Saccharomyces spp* | 4(13.33) | 5(16.67) | 9(15.00) |
| *Aspergillus niger* | 13(43.33) | 14(46.67) | 27(45.00) |
| *Penicillium* spp | 6(20.00) | 8(26.67) | 14(23.33) |

Key: N= Total number of samples, n= Number of positive samples

**Table 4: Occurrence of fungal species in relation to gender, level of study and faculty**

| Factors | N | CS n (%) | MS n (%) | SS n (%) | AN n (%) | PS n (%) |
|---|---|---|---|---|---|---|
| **Sex** | | | | | | |
| Male | 30 | 0(0.00) | 10(33.33) | 3(10.00) | 13(43.33) | 8(26.67) |
| Female | 30 | 12(40.00) | 3(10.00) | 6(20.00) | 14(46.67) | 6(20.00) |
| **Level of study** | | | | | | |
| 100 | 15 | 2(13.33) | 3(20.00) | 0(0.00) | 8(53.33) | 6(40.00) |
| 200 | 15 | 2(13.33) | 5(33.33) | 1(6.67) | 7(46.67) | 5(33.33) |
| 300 | 15 | 5(33.33) | 2(13.33) | 3(20.00) | 5(33.33) | 2(13.33) |
| 400 | 15 | 3(20.00) | 3(20.00) | 5(33.33) | 7(46.67) | 2(13.33) |
| **Faculty** | | | | | | |
| Science | 20 | 6(30.00) | 3(15.00) | 4(20.00) | 8(40.00) | 5(25.00) |
| Arts | 20 | 4(20.00) | 4(20.00) | 3(15.00) | 8(40.00) | 3(15.00) |
| Social Sciences | 20 | 4(20.00) | 6(30.00) | 2(10.00) | 11(55.00) | 6(30.00) |

*P<0.05*, F-value 1.016, P-value 0.7402

Key: N=Total number of samples, n= Number of positive samples; CS: *Candida* spp; MS: *Mucor*spp; SS: *Saccharomyces* spp; AN: *Aspergillus niger*; PS: *Penicillium* spp.

In this investigation, the findings reveal a substantial diversity of microorganisms in hand swab samples obtained from students. Nine distinct species were isolated, including *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Micrococcus spp*, *Escherichia coli*, *Klebsiella* spp, *Bacillus* spp, *Salmonella spp*, and *Streptococcus* spp. These results align with prior studies [20–24]. Notably, the presence of *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Micrococcus spp*, and *Streptococcus* spp is attributed to their classification as resident flora on human skin, making them prone to contaminating hands and surfaces [25–26]. Additionally, these microorganisms, being opportunistic human pathogens, pose implications for food safety, particularly in the case of enterotoxin-producing strains of staphylococci linked to food poisoning [27]. *Bacillus* spp, known for bearing resistant spores, was also prevalent and has implications for human pathogenesis and food spoilage [15]. The presence of *Klebsiella* spp, *Escherichia coli*, *Salmonella* spp, and *Enterococcus faecalis* might suggest compromised personal and domestic hygiene, especially concerning hand contamination after restroom visits, thereby potentially predisposing individuals to diseases [15].

The total occurrence of bacterial species concerning the area of hand swabs reveals varying prevalence across regions, with a higher prevalence observed in the nail region. However, these differences lack statistical significance. It is noteworthy that previous studies [11, 28, 29] have reported significant associations between the prevalence of bacteria and swab regions, emphasizing the greater prevalence of bacteria in nails, particularly in individuals with longer nails [24, 28, 29].

Examining bacterial occurrence concerning gender, level of study, and faculty, no significant differences were observed. However, regarding gender, bacterial prevalence was higher in males, a trend that may be associated with reported differences in hand hygiene practices, with females generally exhibiting more frequent and thorough hand washing [11, 30 – 33].

Similarly, concerning level of study and faculty, the results demonstrated no significant differences. This finding may be attributed to the inherent microbial nature of human hands, coupled with the likelihood of bacterial transfer among individuals sharing common surfaces, particularly in close living environments such as dormitories [14, 16].

Regarding fungi, a total of five species were isolated, including *Aspergillus niger*, *Penicillium* spp, *Mucor* spp, *Candida* spp, and *Saccharomyces* spp. These results concur with the findings of Oniya *et al*. [22], Oranusi *et al*. [23], and Finley *et al*. [34] all of whom reported the presence of similar fungal species.

Analyzing fungal occurrence concerning gender, level of study, and faculty similarly revealed no significant differences. This pattern aligns with the nature of human hands as reservoirs of microorganisms and the potential transfer of fungi among individuals sharing common environments such as dormitories [14, 16]. As a learning facility environment, constant student interaction with fomites or each other facilitates the exchange of fungi, resulting in a lack of statistical disparity in the observed fungal occurrences.

This study offers several recommendations to enhance hand hygiene practices among students at Federal University of Lafia. Firstly, the installation of functional sinks equipped with soaps or hand sanitizers in or around lecture halls is suggested to promote regular handwashing. Secondly, there is a strong recommendation for advocating hand hygiene, particularly after using restrooms, to curb potential microbial transmission. Lastly, the study proposes the organization of a school campaign aimed at raising awareness about the potential consequences associated with the use of contaminated hands. Implementing these recommendations is essential in fostering a hygienic environment and minimizing the risks of pathogen transmission within the university community.

## Conclusion

The findings of this study underscore a noteworthy contamination of students' hands at the Federal University of Lafia with a diverse array of bacterial and fungal species. Considering the pivotal role hands play as vectors for pathogen transmission among students, there exists a heightened risk of escalated incidences of enteric diseases. Furthermore, the elevated prevalence of normal skin microorganisms observed raises concerns about the potential for opportunistic infections.

In light of these findings, it is imperative to advocate for and implement measures pertaining to proper hand hygiene. Public awareness campaigns within the Federal University of Lafia should emphasize the critical role of hands in disease transmission. Promoting hygienic practices among students can contribute significantly to mitigating the risk of enteric diseases and limiting the occurrence of opportunistic infections. This proactive approach aligns with broader public health initiatives, fostering a healthier and safer environment within the university community.

**Conflict of interest:** The authors declared no competing interest.

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