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Mobile Phones: Breeding Ground for Microbes

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Abstract: **To identify bacteria present on mobile phones, and determine the effects of phone user practices on infection transmission and prevention.**
Research questions:
1. What are some categories of microbes that are present on cellular phones?
2. Where do persons use their mobile phones?
3. With what agents do participants routinely clean mobile phones?
4. How frequently do participants clean their mobile phones?
5. Does user knowledge and sensitivity to infection control practices make a difference in the occurrence of microbes on mobile phones?
Method: Mobile phones of 60 students and faculty from varying departments of a university in Jamaica were swabbed and cultured on MacConkey, blood and nutrient agar media. The *Habits of mobile phone usage questionnaire* was administered to each participant on the same day on which phones were swabbed.
Results: Microbes recovered included GPC (*S. pyogenes and S. epidermidis*), GNB (*K. pneumoniae*), GNC, and fungi. Participants reported unhealthy mobile usage habits ranging from using them in the bathroom to sleeping with them under their pillows. Differences in phone usage practices between participants with high infection prevention and control knowledge levels and others was not clear cut.
Conclusion: Mobile phones harbor pathogens, but can be routinely cleaned to reduce and control risk of infection to users.

Keywords: **Mobile phones, pathogens, bacteria, grow infections, prevention and control.**

I. INTRODUCTION

Almost everybody owns a mobile phone, the elderly, young and not so young. Mobile phones have revolutionized the way people communicate with each other. Even the most high-end smart phones with maximum snazzy features are very affordable these days[1]. However, with their prolific and ubiquitous usage, one wonders how clean are they? Are they colonized by microbes? If so, how much, and are they pathogenic? Since microorganisms are found almost everywhere, mobile phones are no exception. They are used with clean or dirty hands in everyday activities, including in the office, auto garage, supermarket, kitchen, classrooms, science laboratories in universities and even in the bathroom. The use of obile phones is one instance by which indirect-contact transmission could occur. Hence, it is likely that these devices can transmit infectious agents to unsuspecting persons thereby resulting in them acquiring infectious diseases.

Purpose:

To identify bacteria present on mobile phones, and determine the effects of phone user practices on infection transmission and prevention.

Research questions:

1. What are some categories of microbes that are present on cellular phones?
2. Where do persons use their mobile phones?
3. With what agents do participants routinely clean mobile phones?
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5. Does user knowledge and sensitivity to infection control practices make a difference in the occurrence of microbes on mobile phones?

II. METHODOLOGY

A. Part 1 Recovery and identification of microbes:

A stratified sample of 60 students and faculty was included in the study. Participants were adult students from a university in central Jamaica enrolled in the departments of Allied Health, Teacher Education, Mass Communication, Computer Science, Religion & Theology, Food Services, Janitorial Services, and members of faculty. Mobile phones were swabbed and cultured on the primary media MacConkey, blood and nutrient agar, then identified as follows:

1. Each mobile phone was taken from owner, swabbed with a distilled H_2O moistened cotton swab which was then inoculated into peptone water, then cultured onto the above mentioned primary agar media after 24 hours incubation at 37 °C.
2. Immediately after, each mobile phone was then wiped with dry paper towel, then swabbed, returned to owner and cultured as in step 1 above.
3. After 24 hours of growth on the above mentioned primary media, colonies were processed and some microbes identified using the Gram's staining, catalase, coagulase, and short-line biochemical tests for Gram negative bacilli.

B. Part 2 Mobile phone user practices:

1. To obtain data on mobile phone user practices, a 7-question researcher-developed *Habits of mobile phone usage questionnaire* was administered to each participant on the same day on which phones were swabbed. Questions included: How often do you clean your cell phone? What do you use to clean your phone? What do you do with your phone when you go to the bathroom?
2. Data were analysed using descriptive statistics.

III. RESULTS

A. Part 1 Microbes recovered:

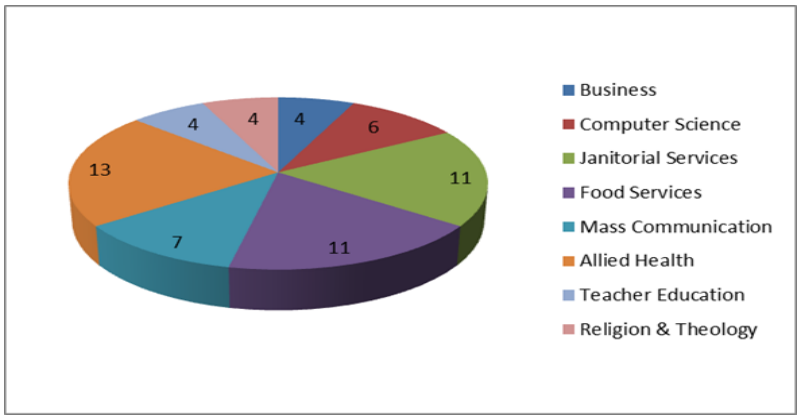

Fig. 1 Distribution of participants by department *n=60*

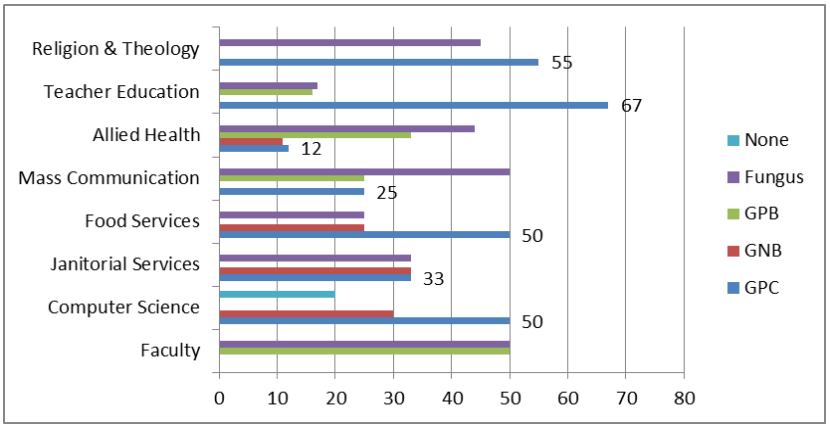

Fig. 2 Percentages of types of microbes recovered by department (*GPC= Gram positive cocci, GPB= Gram positive bacilli, GNB= Gram negative bacilli*)

Major bacteria recovered:

Streptococcus pyogenes, Klebsiella pneumoniae, Staphylococcus epidermidis

B. Part 2 Mobile phone user practices:

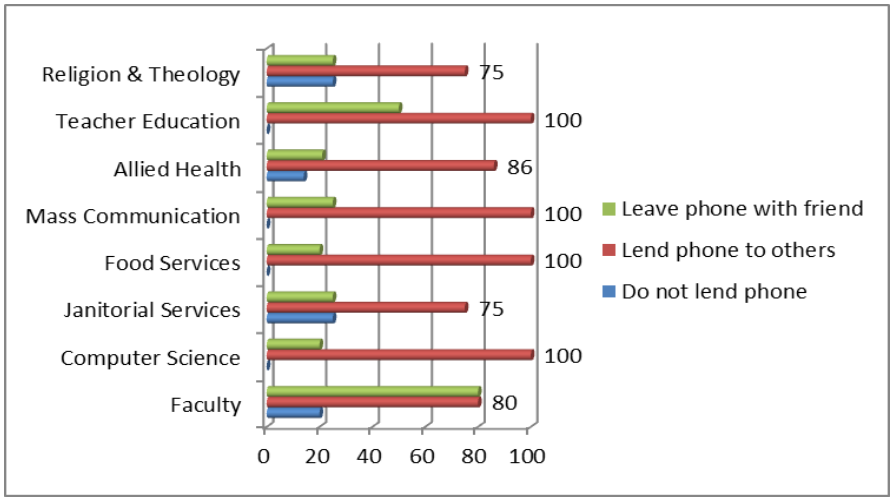

Fig. 3 Lending practices of mobile phone owners by department (%)

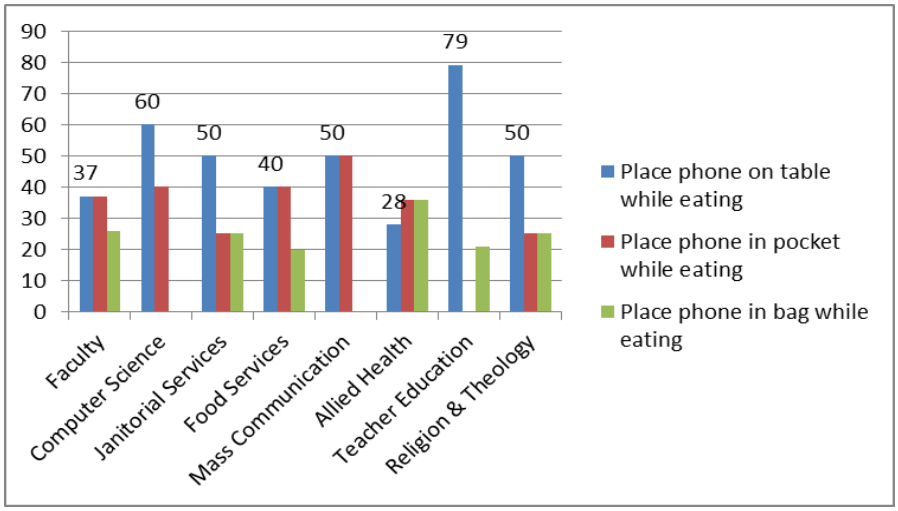

Fig. 4 Placement of mobile phone while eating (%)

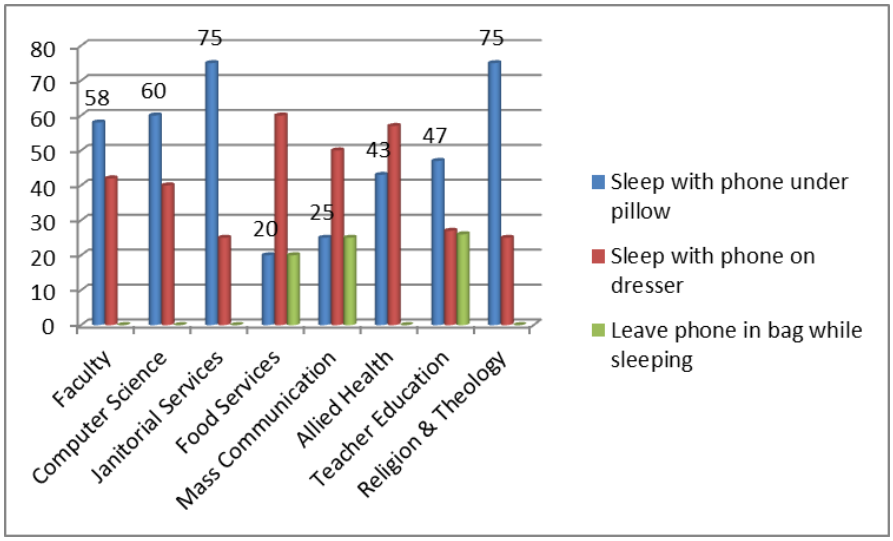

Fig. 5 Placement of mobile phone while sleeping (%)

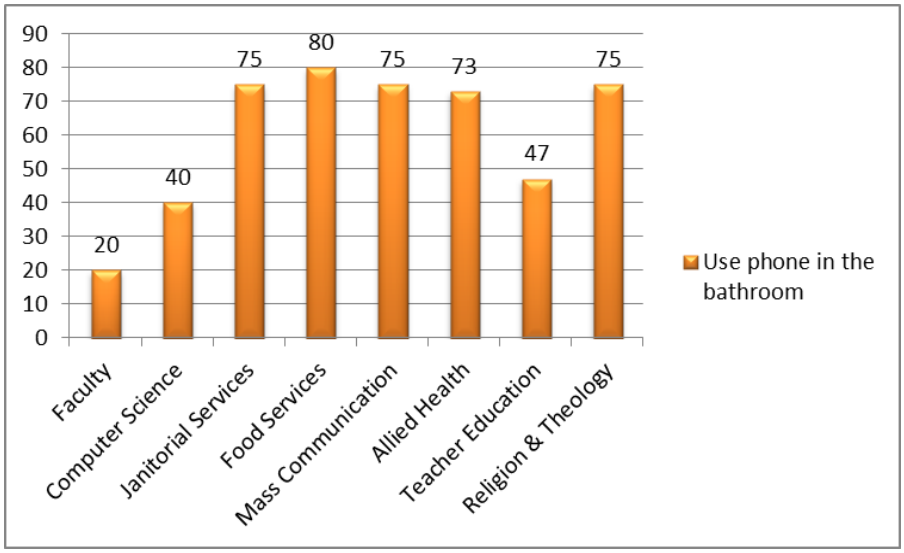

Fig. 6 Use of mobile phone in the bathroom (%)

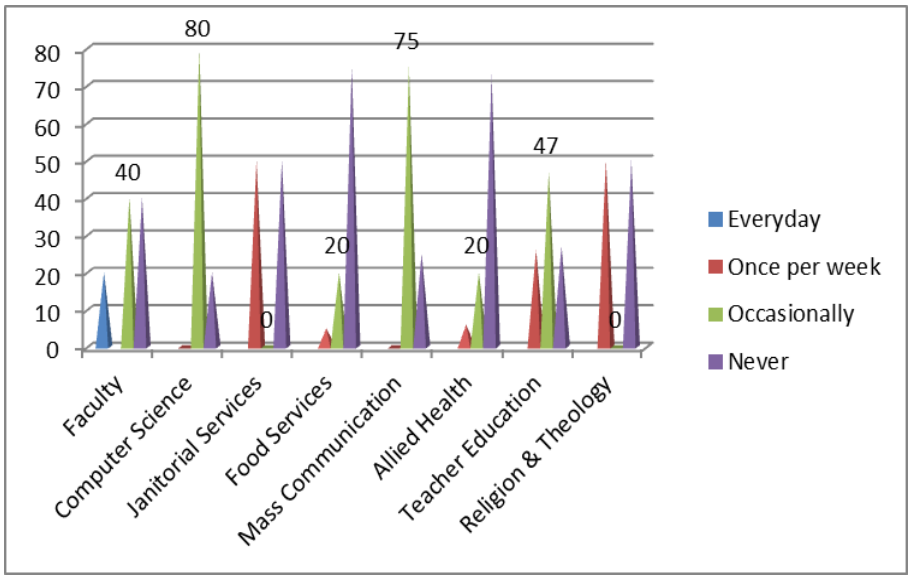

Fig. 7 Frequency of cleaning mobile phone (%)

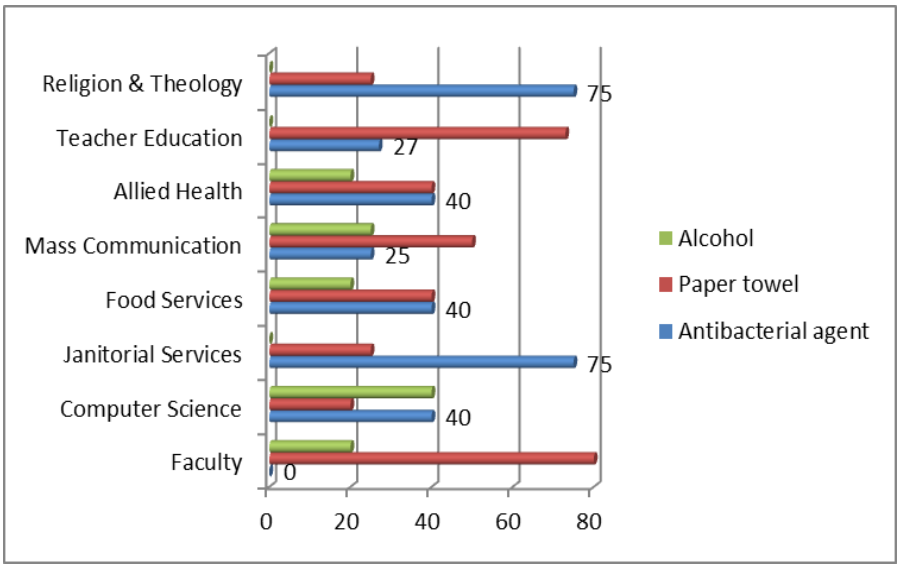

Fig. 8 Agent used to clean mobile phone (%)

IV. DISCUSSION

Microorganisms are found everywhere around us including on mobile phones. This could be due to the fact that these types of microbes, predominantly bacteria, are comfortable in the room to body temperatures of phones, get enough nutrition from oils and moisture from the skin and other surfaces, and are easily transferred to various surfaces because of user habits.

The predominant bacteria recovered in this study, *Staphylococcus epidermidis* and *Streptococcus pyogenes,* are normal flora of the skin. Since mobile phones are taken everywhere, being in close contact with users' mouths, hands, faces, and other surfaces, they easily become contaminated with different types of bacteria. It is not surprising then that microbes were recovered from the vast majority of phones. Of note is the 20% of phones from the Computer Science Department which showed no growth. It is plausible to reason that due to the nature of their studies, these participants do not handle many microbes and as shown in figures 6, 7 and 8, they were the group with the second lowest frequency of using the phone in the bathroom where microbes abound, mostly clean their phones occasionally, but with antibacterial cleaning agents and alcohol when doing so.

An alarming finding is that 80% of participants from Food Services reported that they used their phones in the bathroom. While 73% or higher from 5 departments reported this practice, food handlers should be more sensitive to infection prevention and control measures because of the nature of their work and the possible risks posed to patrons.

In regard to transmission of microbes from phones to other items, the fact that 75% of participants from both Janitorial Services and Religion and Theology sleep with their mobile phones under their pillows is telling. Microbes can easily transfer from phones to bedding to other body surfaces and companions when they are kept on the bed without cleaning. Thus, the risk of infection is significant.

In considering the question whether phone owner knowledge of infection prevention and control practices made any difference in the occurrence of microbes on mobile phones, it must be acknowledged that the three groups having the highest levels of knowledge and sensitization to these practices were participants from Allied Health, Janitorial Services and Food Services. Microbe recovery results showed a mixture of outcomes. The phones from Allied Health participants showed the lowest levels of recovery of GPC and GNB, but were tied with Religion and Theology participants' phones for the second highest levels of fungus growth. The phones owned by Food Services participants showed the second lowest levels of GNB growth, next to Allied Health. Therefore, while Allied Health and Food Services phone owners were the two groups who reported the highest lowest levels of cleaning their phones (20%), perhaps their frequent hand washing practices, due to the nature of their work and studies, had some positive effect on the levels and types of microbes recovered. Another interesting finding is that the phones of participants from Janitorial Services showed consistently moderate levels of growth at 33% for Gram positive cocci (GPC), Gram negative bacilli (GNB), and fungus. These levels were half that of Teacher Education participants' phones, 67% of which showed GPC growth. It is apparent that they utilize good infection control measures as indicated by the 75% who reported using antibacterial agents to clean their phones.

Implications of findings:

Microbes recovered included Gram positive cocci, Gram negative bacilli, Gram negative diplococci, and fungi.

Gram negative bacilli:

Klebsiella pneumoniae was the most significant gram negative bacteria found in this research. It was found on samples obtained from mobile phones owned by participants from Food Services. *Klebsiella pneumoniae*, causes pneumonia, urinary tract (UTI) and abdominal infections in humans. This pathogen is the second leading cause of UTI, next to *Escherichia coli.* It normally affects persons with weakened immune systems such as hospitalized patients, diabetics, persons with chronic lung disease such as chronic obstructive pulmonary disease, alcoholics. Persons on glucocorticoid therapy and those with renal failure also may contract *K. pneumoniae* infections. Thus, the infections are either nosocomial or community-acquired. In healthcare settings, Klebsiella bacteria can be spread through person-to-person contact (for example, from patient to patient via the contaminated hands of healthcare personnel, or other persons) or, less commonly, by contamination of the environment. The bacteria are not spread through the air. This has implications for

participants from the Allied Health group who are being trained to be healthcare professionals and must exercise greater caution in using mobile phones and handling patients, especially those who are immunocompromised.

Gram positive cocci:

There are two major groups of Gram-positive cocci that are of medical importance: the staphylococci and the streptococci. *Staphylococcus epidermidis* and *Streptococcus pyogenes* were identified in some of the samples of this research. *Staphylococcus epidermidis* is a gram-positive, coagulase-negative cocci that is a part of human normal flora. It is considered to be a true opportunistic pathogen, but requires a major breach in the host's innate defense. It is one of the leading pathogens of nosocomial infections, particularly associated with foreign body infections. Some of the diseases associated with this organism include: UTIs, septicemia, and endocarditis. As *S. epidermidis* is part of the human normal flora, it has developed resistance to several common antibiotics such as methicillin, novobiocin, clindamycin, and benzyl penicillin. As a result, vancomycin or rifampin is used to treat an infection.

Streptococcus pyogenes is the most significant cause of group A streptococcal infections. *S. pyogenes* is the cause of many important human diseases, ranging from mild superficial skin infections to life-threatening systemic diseases. Infections typically begin in the throat or skin. Examples of mild *S. pyogenes* infections include pharyngitis and impetigo.

Infections due to certain strains of *S. pyogenes* can be associated with the release of bacterial toxins causing streptococcal toxic shock syndrome. *Streptococcus pyogenes* is most often spread through contact with mucus or wounds of infected individuals. Due to this, thorough hand washing is a good way to reduce the risk of becoming infected.

Fungi:

Fungi were recovered from the mobile phones from every group of participants except Computer Science. Fungus can be any of a wide variety of organisms that reproduce by spores, including the molds, yeasts. The most common fungal pathogens associated with invasive disease in humans are opportunistic yeasts (e.g., *Candida albicans*) or filamentous fungi (e.g., *Aspergillus* spp.). Fungi previously thought to be nonpathogenic for humans or only sporadically associated with human disease, such as *Candida* (except *albicans*), *Fusarium*, *Trichosporon*, and *Malassezia* spp., are emerging as important nosocomial fungal pathogens. These pathogens are associated with increasing morbidity and mortality. The emergence of these organisms and antifungal-resistant fungi, especially those that are azole-resistant, poses an important challenge to the clinician.

Gram negative diplococci:

These are found as human flora prevalent in the gut, skin, and vagina. There are several infectious Gram negative diplococci including *Moraxella catarrhalis*, *Neisseria gonorrhoeae* and *Neisseria meningitidis.* The possibility of indirect transmission of these organisms via mobile phones, whose owners practice using them in bathrooms and clean them infrequently, should not be discounted.

V. CONCLUSION

This research was conducted to determine whether microbes colonize mobile phones and the difference, if any, that exists between persons with high knowledge and sensitivity of infection control and prevention and others. The recovery of several types of Gram positive and Gram negative bacteria and fungi from the mobile phones highlights the potential of these communication devices to transmit infectious agents. There was no clear cut answer to the question of whether there is a difference in recovery of microbes from the mobile phones of owners who have high levels of knowledge of infection prevention and control. This is due to the fact that varying levels of different types of microbes were recovered from each group. However, the risk for infection cannot be overlooked when one considers the finding that up to eighty percent (80%) of participants from two groups who are trained in infection prevention and control never clean their mobile phones. In addition, the study found that participants who came from 8 areas in a university reported a mixture of usage habits ranging from using their mobile phones in the bathrooms to sleeping with them under their pillows. Thus, the researchers recommend that since pathogens lurk on mobile phones, users should be sensitive to this reality and practice routine cleaning with appropriate agents to reduce their risk of infection.

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