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# Evaluation of Microbial Contamination of Mobile Phones of Persons Working in a Microbiology Laboratory

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ABSTRACT Mobile phones are portable electronic devices which are used worldwide for communication by men of all works of life, including laboratory workers. Over time, it has become an indispensable accessory for everyday life even during working hours. Phones are also carried into places were high microbial loads are anticipated. This study was conducted to evaluate the relative abundance and diversity of bacteria and fungi found on mobile phones of students working in the Microbiology laboratory of Rivers State University, Port Harcourt, Nigeria. Using standard microbiological procedures, twenty (20) mobile phones of students working in the laboratory (SWL), five (5) Lab staff (LS) and five (5) phones of non-Laboratory students(NLS) (control) were swabbed and cultured using spread plate method. The total heterotrophic bacterial counts of students working in the lab ranged from $2.7 \times 10^4$ to $8.5 \times 10^5$ cfu/ml, Lab workers $2.2 \times 10^4$ to $6.6 \text{ X } 10^4$ cfu/ml and the non-lab students $3.0 \times 10^3$ to $7.3 \times 10^3$ cfu/ml. While the fungal counts ranged from; $2.2 \times 10^2$ to $8.0 \text{ X } 10^3$ cfu/ml, $3.0 \times 10^2$ to $6.2 \times 10^2$ cfu/ml and $1.0 \times 10^2$ to $3.0 \times 10^2$ cfu/ml for students working in the lab, lab staff and non-lab students respectively. Microbial contamination of mobile phones was in the order of students working in lab > Lab staff > non Lab students. The highest microbial load recorded by the Lab students is attributed to the fact that students working in the lab answer phone calls while handling samples and specimen from various sources and drop their phones on the working surfaces without proper hygiene. The genera of bacteria and fungi isolated and characterized from the mobile phones include; *Staphylococcus*, *Escherichia*, *Salmonella*, *Pseudomonas*, *klebsiella*, *Enterobacter*, *Bacillus*, *Serratia*, *Micrococcus*, *Streptococcus*, *Proteus*; *Aspergillus*, *Penicillium*, *Candida*, *Mucor* and *Rhizopus*. Some of these organisms identified are microorganisms of public health importance, though some are normal flora of the hand and skin, they could be opportunistic pathogens which may result in infection. Therefore, there is need for proper enlightenment of lab personnel on the use of mobile phones during working hours in the laboratory and the danger this may pose in the transmission of pathogenic microorganisms within the communities. Proper hand hygiene and possible sanitization of mobile phones is advocated for all lab personnel.

*Keywords:* mobile phones, hand hygiene, contamination, bacteria, fungi, opportunistic pathogens.

## Introduction

Mobile phones have over time become indispensable tools of communication (El-Kady, 2017). Due to their portable size, it can easily fit into one's pocket, and are carried about even to places where there are high populations of microorganisms such as hospitals, toilets, laboratories etc (Tagoa *et al*., 2011; Akinyemi *et al*., 2009). Laboratory and Health-care workers touch and use these devices during working hours (El-Kady, 2017; Gita *et al.,* 2016), even when carrying out some activities involving sample collection, sample processing, culturing of microorganisms (El-Kady, 2017). With these device, close to them while work is on, make or take calls as it comes and so on which leads to contamination of mobile phones by many microorganisms some of which may be pathogenic (Jaya *et al.,* 2015). These organisms on the phones can be transferred from the phone to the face, ear, lips, hair and the hands of other users (Goel, 2009). Warm and ideal temperatures on the phone is due to the regular contact with the body, warm environment in the pocket, small pouches, handbags, sweat and water on the palms and the heat generated by the mobile phone itself, encourages the growth and proliferation of these organisms on the phone (Jaya *et al.,* 2015; Tagoe *et al.,* 2011; Brady *et al*., 2006). Even with the regular use of these phones, they are rarely cleaned and disinfected and the problem is more and more increasing as most of the mobile phone users cannot even observe personal hygiene related to the use of mobile phones (Jaya *et al.,* 2015).

However, since the use of this device is on the increase, and carried everywhere dropped on surfaces without considering the microbial load of such environmental surfaces, the phone can act as an agent for the transmission of microorganisms (Akinyemi *et al*., 2009). Previous studies showed that about 90% of mobile phones of health care workers are contaminated with microorganisms that could cause nosocomial infections (Brady *et al*., 2006). Also, phone users, especially touch screen phones touches their phones several times a day, including laboratory workers even during working hours. They leave the office without sanitizing it, although there are no laid down guidelines for the cleaning and sanitization of phones used in hospitals and laboratory, before taking them outside, since these same phones are used outside the lab, making the phones a veritable agent in the transmission of pathogenic organisms (Parhizgari *et al.,* 2013). In a previous work by Akinyemi *et al.,* 2009, the following organisms were isolated; *S. aureus, P. aeruginosa* and *K. pneumoniae, E. coli, and Enterococcus faecalis.* Therefore, this research was carried out to evaluate the bacterial and fungal load and diversity on mobile phones of those working in the Microbiology Lab of Rivers State University.

## Materials and Methods

### *Sample collection*

In this research, a total of 30 phones were randomly sampled, twenty out of thirty-two phones, belonging to students carrying out their research work in the laboratory at that time; five belong to laboratory staff, and the other five belonging to students not working in the laboratory (students from Department of Management Sciences, which served as control). This control was used since these students do not work in

the laboratory. Twenty-six mobile phones out of thirty phones were touch screen phones, only four mobile phones were keypad phones. Same phones were sampled twice in an interval of four weeks, May to June 2017.

### *Sampling*

Using sterile swab sticks moistened in sterile peptone water, samples were aseptically taken by rubbing the swab stick over the surface of the phone, screen, earpiece, mouthpiece and the keypad in phones which are not touch screen (El-Kardy, 2017). Two milliliters of sterile peptone water were added to each swab and refrigerated at $4^0$C until required for use. Samples were collected from the same phones at an interval of one month. From each swab stick, 1ml was aseptically transferred into 9ml of peptone water and serially diluted to $10^{-4}$. Various differential media were used for the isolation and identification of the microbes associated with the phones, the media includes: nutrient agar, Sabouraud dextrose agar, MacConkey agar, Mannitol salt agar, Salmonella-Shigella agar, and Eosin methylene blue agar. An aliquot of 0.1ml from each dilution was transferred and dropped on the surface of these media and spread evenly using sterile hockey stick. All plates except the SDA plates were incubated at $37^0$C for 24 to 48hours. Also, in the SDA media 0.5g/l of chloramphenicol were added to inhibit bacterial growth. Inoculated plates were incubated at $28^0$C for 5 to 10days. Thereafter, counts were taken to calculate the colony forming unit and colonies that developed were further purified using the respective agar media. Pure isolates were stored at $4^0$C on nutrient agar slants until required for further analysis (Douglas and Amuzie, 2017).

### *Biochemical and Microscopic characterization of isolates*

The isolates were tentatively identified based on morphological characteristics like; size, shape and Gram's reaction. Other biochemical tests which includes; motility, indole, urease, catalase, Citrate, Coagulase, Oxidase, Vogues Proskauer and methyl red test according to Cheesbrough 2006. Bacterial isolates were finally identified using Bergey's Manual of Determinative Bacteriology (Holt *et al*., 1997, Cheesbrough, 2000). Characterization and identification of the fungal isolates were done both macroscopically and microscopically (Barnett and Hunter, 1972; Cheesbrough, 2000).

## Results

The results obtained from the two-sampling regime were very similar, since both samples were taken from the same phones. The total heterotrophic bacterial counts of students working in the lab ranged from $2.7 \times 10^4$ to $8.5 \times 10^5$ cfu/ml, Lab workers $2.2 \times 10^4$ to $6.6 \times 10^4$ cfu/ml and the non-lab students $3.0 \times 10^3$ to $7.3 \times 10^3$ cfu/ml. While the fungal counts ranged from; $2.2 \times 10^2$ to $8.0 \times 10^3$ cfu/ml, $3.0 \times 10^2$ to $6.2 \times 10^2$ cfu/ml and $1.0 \times 10^2$ to $3.0 \times 10^2$ cfu/ml for students working in the lab, lab staff and non-lab students respectively (Fig 1). A total of eleven bacterial genera and five of fungal genera were identified. These

organisms from the mobile phones include; *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Salmonella* sp., *klebsiella sp., Enterobacter sp., Bacillus sp., Serratia sp., Micrococcus sp., Streptococcus sp., and Proteus sp., and Aspergillus niger, Aspergillus flavus, Penicillium sp., Candida sp, Mucor sp.* and *Rhizopus sp.* respectively. Table 1 shows the distribution of the various bacteria identified. From the phones of the Lab staff (LS), nine genera were isolated which includes: *Staph aureus, E. coli, Serratia* sp, *Micrococcus* sp, *Streptococcus* sp, *Pseudomonas aeruginosa*, *Enterobacter* sp and *Bacillus* sp, while from the phones of non-lab students (NLS) five genera were isolated which includes: *Staph aureus, E. coli*, *Micrococcus* sp, *Enterobacter* sp and *Bacillus* sp. Table 2, also showed the distribution of the fungi isolated. Four genera were isolated from the LS, they include; *Aspergillus niger, Penicillium* sp, *Candida* sp, and *Rhizopus* sp. while two were isolated from the phones of NSL, which includes *Aspergillus niger*, and *Candida* sp. Figure 2, shows the frequency of occurrence of the bacterial species isolated from the phones, *Staphylococcus aureus*, with 15.05% had the highest frequency of occurrence while *Proteus* sp with 2% had the least frequency of occurrence. *Staphylococcus aureus* was also isolated from all categories, and had the highest occurrence this may be due to its ability to resist drying, they can grow and survive in the warm environment for a long time (El-kady, 2017). *Aspergillus niger* (25.93%) had the highest frequency of fungal occurrence, while *Rhizopus* sp (5.56%) had the least frequency of occurrence for fungi (Figure 3). The organisms identified, are both Gram positive and Gram negative.

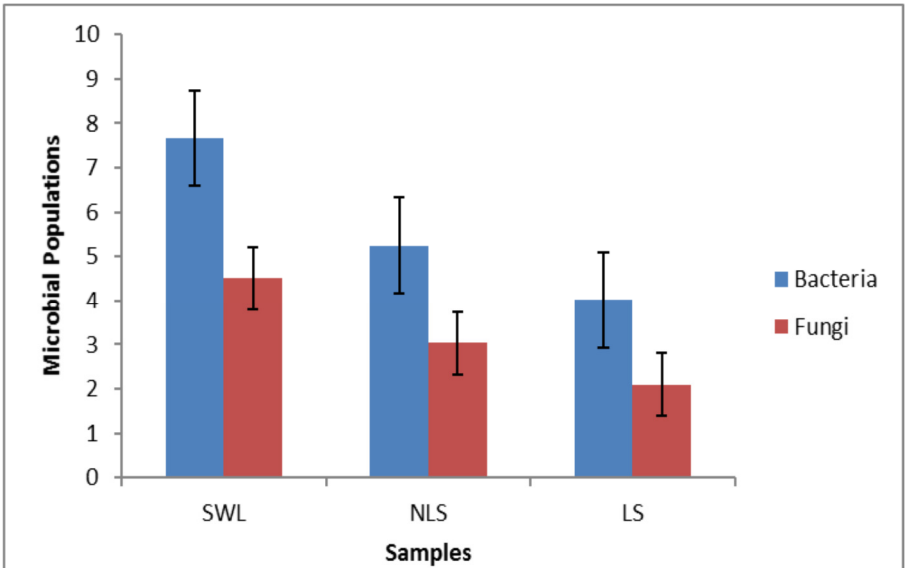


Fig. 1: Microbial Load of mobile phones of the various group of persons

**Table 1: Bacterial Isolates from the various categories**

| Isolates | SWL | NLS | LS |
|---|---|---|---|
| *Staph aureus* | + | + | + |
| *E. coli* | + | + | + |
| *Salmonella* sp | + | - | - |
| *Proteus* sp | + | - | - |
| *Serratia* sp | + | - | + |
| *Micrococcus* sp | + | + | + |
| *Streptococcus* sp | + | - | + |
| *Pseudomonas aeruginosa* | + | - | + |
| *Klebsiella* sp | + | - | - |
| *Enterobacter* sp | + | + | + |
| *Bacillus sp* | + | + | + |

Key: students working in the lab(SWL), non-lab students(NLS), lab staff(LS), + i.e. isolated, - i.e. not isolated

**Table 2: Fungal Isolates Identified from the various categories**

| Isolates | SWL | NLS | LS |
|---|---|---|---|
| *Aspergillus niger* | + | + | + |
| *Aspergillus flavus* | + | - | - |
| *Penicillium* sp | + | - | + |
| *Candida* sp | + | + | + |
| *Mucor* sp | + | - | - |
| *Rhizopus* sp | + | - | + |

Key: students working in the lab (SWL), non-lab students (NLS), lab staff(LS), + i.e. isolated, - i.e. not isolated

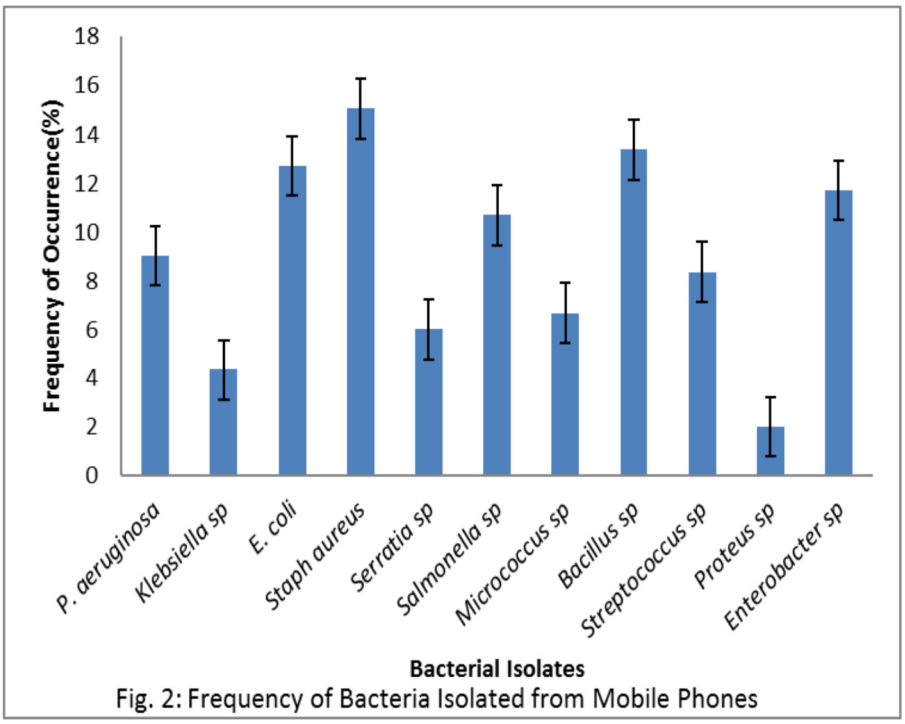


Fig. 2: Frequency of Bacteria Isolated from Mobile Phones

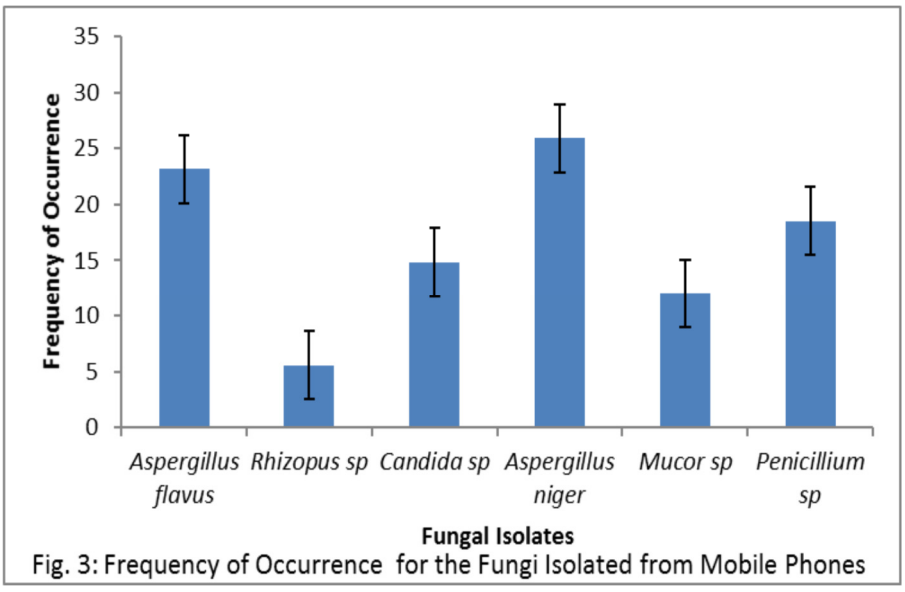


Fig. 3: Frequency of Occurrence for the Fungi Isolated from Mobile Phones

## Discussion

With improved technological advancement, mobile phones have become increasingly important communication and social tool. Due to the immense benefits derived from its use and size, it is carried everywhere even to the laboratories, hospitals and even into toilets where high microbial loads are possible (Akinyemi *et al*., 2009). This pose great danger as it will serve as an agent for the transmission of microorganisms including pathogens. As laboratory personnel can transfer these organisms from their samples to their hands, to the phone, to their face or ear to their hair and so on (El-Kady, 2017). They may not remember to observe proper hand hygiene and particularly sanitize the phones after work, before leaving the laboratory each day. From the results of this study, a total of eleven bacterial and five fungal genera were isolated from the thirty mobile phones. These organisms from the mobile phones include; *Staphylococcus aureus, Escherichia coli, Salmonella* sp, *Pseudomonas aeruginosa, klebsiella sp, Enterobacter sp Bacillus sp, Serratia sp, Micrococcus sp, Streptococcus sp and Proteus sp,and Aspergillus niger, Aspergillus flavus, Penicillium sp, Candida sp, Mucor and Rhizopus sp* respectively. The results showed that mobile phones of students working in the laboratory had higher microbial load and diversity, when compared with that of the laboratory attendants, and students not working in the laboratory. This may be due to the fact that the students working in the lab are working with samples from various sources and take calls with their phones while processing and culturing samples without proper hand hygiene. This will introduce the organisms and increase the microbial load on the phones. This result indicates that 83.34% of the phones studied were contaminated as compared to 90% contamination recorded by El-kady, 2017. Also, some of the organisms identified from this study has also been identified by previous researchers like; Akinyemi *et al*, 2009, Gita *et al*, 2016; El-kady, 2017. They also in their various studies, isolated; *Klebsiella* spp, *E. coli*, *Micrococcus* sp, *Pseudomonas* sp, *Bacillus* sp and *Staphylococcus aureus*. Although, some of the organisms identified are normal commensal flora of the skin, which may result in opportunistic infection in children, the elderly or immunocompromised patients. While the other organisms identified including; *Salmonella* sp, *Escherichia coli, Klebsiella* sp are potential human pathogens and indicators of feacal contamination (Douglas and Braide, 2015), which may be due to the unhygienic nature of the mobile phone owners. These organisms have been implicated in several infections especially gastrointestinal tract infections, and can be transferred from the phones to the mouth through the hands. Research has shown that mobile phones harbour more organisms than the hands, door knobs, etc (Gita *et al*., 2016). The presence of *Serratia* and *Proteus* spp may be due to contamination from the cultures they were working on. This organism can thrive in many diverse environments, has been found in water, soil, animals and even some food items (Obire and Hakam, 2015). *Staphylococcus* sp was the most frequently isolated; it was observed in all samples. This organism is a normal flora of the skin. *Bacillus* sp was also observed in high numbers, this may be due to their high population in the environment and they are able to survive for a long period in the environment due to their spores. This organism may cause food poisoning when ingested due to the production of enterotoxin in food. *Pseudomonas aeruginosa* isolated has been

implicated in nosocomial infections where it results in gastroenteritis especially in immunocompromised patients (Akinyemi *et al*., 2009). Tagoe *et al*., 2011, suggested that environmental conditions may encourage these organisms to remain on surfaces for weeks after attachment, especially on keypad phones which would lead to the formation of bacterial biofilm. And that, the higher the microbial population on the phones, the longer its survival, which could even last for months. For the fungal population identified, *Aspergillus* genera had the highest frequency of occurrence (49.08%), and is an opportunistic pathogen, ubiquitous in the environment, producing toxins called aflatoxins (Okpako *et al*., 2009; Douglas, 2015). These fungi may also result in some health problems in man. *Aspergillus niger* may cause infections in man like fungal ball in lungs as the spores grow in the lungs, Otomycosis (an ear infection that block the ear and it is very painful causing ear problem or hearing loss), asthma and many allergic reactions (Allergic bronchopulmonary Aspergillosis, Acute invasive Aspergillosis etc). *Penicillium* sp are also known to cause allergy and respiratory problems in susceptible host. *Rhizopus* sp had the least frequency of occurrence, but is known to cause infection in immunocompromised host (Okpako *et al*., 2009; Douglas, 2015). The presence of these organisms on the mobile phones, could pose public health concerns which could result in community acquired infections, since the phones could serve as a vector for transmitting these pathogens.

## Conclusion

This research work has shown that mobile phones used by laboratory personnel in the Department of Microbiology were highly contaminated with various microorganisms. Some of these organisms isolated are of public health importance. Hence, these devices can act as a means for the transmission of disease causing microorganisms acquired from the laboratory to the community. The continuous enlightenment on the importance of hand washing and proper hand hygiene, regular cleaning and sanitization of mobile phones by laboratory personnel should be encouraged.

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