



## **Bacteria Associated with Students' Mobile Phones-Caritas University, Enugu State**

**C. C. Ezemba<sup>a\*</sup>, P. E. Oli<sup>b</sup>, S. O. Kehinde<sup>a</sup>, A. S. Ezemba<sup>c</sup>,  
C. C. Ezejiolor<sup>b</sup> and E. C. Amadi<sup>b</sup>**

<sup>a</sup> Department of Microbiology, Chukwuemeka Odumegwu Ojukwu University (COOU) / UIL, Anambra State, Nigeria.

<sup>b</sup> Department of Microbiology, Caritas University, Amorji-Nike Emene, Enugu State, Nigeria.

<sup>c</sup> Department of Microbiology and Brewing, Nnamdi Azikiwe University Awka, Anambra State, Nigeria.

### **Authors' contributions**

*This work was carried out in collaboration among all authors. Authors CCE, PEO and ECA designed the study. Authors CCE and PEO performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PEO and SOK managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.*

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## **ABSTRACT**

Microorganisms are ubiquitous, they are found everywhere. Mobile phones are not an exception. Mobile phones, also referred to as palmtops act as fomites, a source of infection because the palms used to handle mobile phones are often times in contact with surfaces which may have been pre-infected; nevertheless, their potential role in transmission of infections is of great concern. A cross-sectional study (male and female) was done from June to August 2018 at Caritas University, Amorji-Nike, Enugu State, in order to investigate the prevalence of bacterial contamination of mobile phones of students. Swab samples were collected from 50 mobile phones of Caritas University students. These were tested for bacterial contamination in the Microbiology laboratory. Quantification of bacteria was performed using standard streak plate technique. Isolated bacteria were identified using standard microbiological methods which include: cultural and morphological characterization and biochemical test. Antimicrobial susceptibility was also done. The microorganism isolated from students' mobile phones and their percentage frequency of occurrence were: *E. coli* (31.9%), *S. aureus* (40.4%), *P. aeruginosa* (8.5%), *K. pneumonia* (4.3%) and *Streptococcus sp.* (14.9%). The result showed that *Staphylococcus sp.* has the highest

\*Corresponding author: E-mail: CC.EZEMBA@COOU.EDU.NG;

percentage of occurrence. The antibiotic sensitivity test indicated the varied resistance of isolated bacteria to antibiotics used in this study, although most isolated bacteria were sensitive to erythromycin and chloramphenicol except the isolates of *E. coli* which were the most resistant to the antibiotics used. The high prevalence of bacterial agents isolated from students' mobile phones was attributed to poor hygiene and sanitary practices. It is recommended that students should wash their hands after using mobile phones, before eating or undertaking any venture requiring sepsis.

**Keywords:** Mobile phones; bacteria; antibiotic; students; hygiene and sanitary practices.

## 1. INTRODUCTION

A mobile phone is a hand-held, portable electronic telecommunication device. Aside the standard voice function of mobile phone, mobile phones can support many additional services such as SMS for text messaging, email, pocket switching for access to the internet and MMS for sending and receiving pictures and videos [1,2] they are widely used by students especially those in the university. The importance of mobile phones, especially smart phones cannot be overemphasized. They are used to store people's contact information, making it easier for one to communicate with family and friends, they are also used research, online schooling, online banking, online sales and purchase, online games, finding direction, learning new skills, taking photographs, chatting, to mention but a few. The indispensable use of mobile phones tend to increase day by day, but caution must be taken to avoid overuse owing to the fact that radiations from mobile phones can cause health problems and addiction may also develop. Most people spend most of their time surfing the internet and hardly interact with people physically present with them, putting at stake the typical way of social behavior. Mobile phone addiction, "the newest cigarette" in the world, has affected many people's life quality and the relationship with others and the addiction of children to mobile phones could threaten the very fabric of the society [3]. Addiction, neglect of bonding time with family and friends, cyber bullying, cyber blackmailing, emotional trauma, etc. which are socio-psychological risks associated with the use of mobile phones and the emerging health problems caused by radio waves emitted have posed a serious concern to human safety. Overexposure to electromagnetic waves and/or radiations from mobile phones might cause sleeping abnormalities, difficulty in reasoning, fatigue, headache, earache, disorientation, muscle and eye strain, dizziness, increase in resting blood pressure, reduction in the production of melatonin, brain tumors, infertility and has been implicated in DNA strand breaks

[4,5,6]. Mobile phones have become a part of daily lives of individuals, people go almost everywhere with mobile phones, including toilets and bathrooms which harbor high microbial presence. The heat and moist generated on mobile phones through constant handling have made it a favorable environment for microbial growth. The ability of the microbes to breed and multiply on the contact surfaces of the mobile phone makes an important fomites that may play a role in the spread of different microorganisms from one user to another. A study to determine the transfer efficiency of micro-organisms by fomites suggests that the Gram-positive bacteria are transmitted most readily followed by viruses and Gram-negative bacteria [7]. It has been shown that a significant number of germs could be transferred between the hands of the users of mobile phones, and vice versa [8].

The health risks associated with the use of mobile phones have been overlooked due to the numerous beneficial exploits accomplished with mobile phones. The constant handling of mobile phones by university students makes it a reservoir for the spread of microorganisms, particularly those microorganisms residing on the surface of the skin especially our palms. Furthermore, the heat generated by mobile phones enables the colonization of bacteria on the device at alarming levels.

Apart from the studies on the bacterial contamination of mobile phones among health care workers and non-health care workers, many studies indicate bacterial contamination in mobile phones owned by university students. Studies on bacterial contamination of mobile phones and their antibiotic susceptibility pattern among students of University of Cape coast Ghana revealed that all sampled mobile phones had high contamination of variety of bacteria with high resistance to common antibiotics [9]. Another study done among the students of Faculty of Health Sciences, University of Ljubljana, Slovenia had shown that there was a statistically significant relationship between

gender and microbiological contamination of the mobile phones, such as mobile phones from female users were highly colonized with bacteria compared with those mobile phones from male students [10]. A study carried out in an Indian Dental school revealed that the mobile phones may act as an important source of nosocomial pathogens in the dental setting. The most common organisms isolated from the mobile phones from the above study were Coagulase-negative *Staphylococcus*, *Staphylococcus aureus*, *Bacillus spp.*, *Acinetobacter*, *Pseudomonas*, *Micrococci*, *Staphylococcus citreus*, and *Diphtheroids* [11].

The aims of this study were: to determine whether mobile phones play a vital role in the spread of bacterial pathogens, to determine the bacterial contamination of Caritas University students' cell phones, to isolate bacteria of medical importance from mobile phones of Caritas University students, to determine the nature of the isolates and to proffer possible control and preventive measures that could constitute to avoid this likely vehicle of infection.

## 2. MATERIALS AND METHODS

### 2.1 Study Area and Design

Across-sectional study was conducted on students' mobile phones from June to August 2018, at Caritas University, a private University located in Amorji-Nike, Emene, Enugu State, Eastern Nigeria, with a population of over 2500 students, with 4 faculties and 22 departments consisting of both male and female.

### 2.2 Sample Collection

A total of 50 samples were collected using sterile cotton swab from mobile phones of both male and female students in the university. Before taking a swab, both hands were cleaned using an alcohol-based instant hand sanitizer and powder-free disposable gloves were worn per sample throughout the work to prevent cross-contamination. From the 50 swab samples collected from mobile phone, two belonged to two different students in each department who volunteered. The swabs were first moistened with sterile saline solution and the target phones were wiped on the surface of both sides of the mobile; that is, over the keypad and back of the mobile phones. In cases of mobile phones with covers, swab was taken from the outer surfaces of the cover. Then, the mobile phone swab was

placed immediately into a sterile normal saline in a sterile container, properly labelled to avoid mistakes and transported to the Microbiology Laboratory within 30 minutes for microbiological analysis as described by Shooriabi et al. [12].

The collected samples were inoculated onto Blood Agar and MacConkey Agar by following the standard streak plate technique [13]. The inoculated plates were incubated aerobically at 37°C for 24 – 48h. Primary isolation of bacteria was made based on their colony characteristics and Gram stain reaction microscopically. Different biochemical tests like indole, citrate, oxidase, urease, catalase and coagulase tests were used for further identification.

### 2.3 Antimicrobial Susceptibility Test

Antimicrobial susceptibility test was done according to the Clinical Laboratory Standards Institute guidelines [14], using the Kirby-Bauer disc diffusion technique. The pure isolate (about four to five colonies) was added to a sterile tube containing 5ml of normal saline and mixed gently until it forms a homogenous suspension. The turbidity of bacterial suspension was standardized by using 0.5 McFarland standards. A sterile cotton swab was dipped into the suspension and inoculated over the entire surface of Mueller Hinton agar and left at room temperature to dry for 3 – 5 minutes. Antimicrobial discs were placed by using a disc dispenser on to the Mueller Hinton agar and incubated at 37°C for 18 – 24h. At the end of the incubation period, the diameter zone of inhibition was measured by using a digital caliper. The growth inhibition zone was interpreted as susceptible, intermediate or resistant after comparison with standard guidelines [14].

## 3. RESULTS

The rate of bacterial contamination on students' mobile phones was very high, out of 50 samples collected; only 3 samples had no microbial growth. A total number of five potential clinically relevant microorganisms were isolated, most isolates gave positive reaction to catalase test hence, belong to *Enterobacteriaceae*. The bacteria isolated from students' mobile phones include; *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia* and *Streptococcus sp.* Their percentage frequency of occurrence was; *E. coli*, 15 (31.9%); *S. aureus*, 19 (40.4%); *P. aeruginosa*, 4 (8.5%); *K. pneumonia* 2 (4.3%) and *Streptococcus sp.* 7 (14.9%).

#### 4. DISCUSSION

In this study of isolating bacteria from students' mobile phones in Caritas University, it was noted that most of the students' mobile phones were contaminated with bacteria, due to the fact that most students are addicted to their phones and most of the times use them in the toilet or rest room which create an avenue for fecal contamination or other sorts of contaminations. This is quite unhealthy. Amadi et al. [15] had similar result with mobile phones of health workers (i.e. Doctors, nurses, technologists, etc).

The world we are living in is a world which is full of microbes, it is not possible to make this world microbe free but microbiological standards and hygiene practices should be adapted by the society for a healthy life. This investigation aimed to isolate and identify bacteria of medical importance on mobile phones and create awareness that mobile phones could also serve as vectors for transfer of diseases from one individual to another. Therefore, personal hygiene and mobile phones' decontamination are much related. The presence of *E. coli*, a member of the coliforms, indicates the possibility of the presence of fecal contamination on the mobile phones, because *E. coli* signifies fecal contamination of hands through poor personal hygiene. This as well stresses the need for better sanitary measures amongst persons. *E. coli* and *P. aeruginosa* have been indicated as the most predominant Gram negative bacteria involved in nosocomial infections [16].

Five potential pathogens were isolated, which are: *E. coli*, *S. aureus*, *Streptococcus spp*, *K. pneumonia* and *P. aeruginosa*. Table 1 shows the result of the colonial morphology, gram staining and biochemical tests conducted to identify the isolated bacteria. Table 2 shows the percentage of the bacteria isolated from students' mobile phones which were: *E. coli*, (31.9%); *S. aureus*, (40.4%); *P. aeruginosa*, (8.5%); *K. pneumonia* (4.3%) and *Streptococcus sp.* (14.9%).

The antimicrobial susceptibility test result showed that the isolated bacteria showed variable sensitivity patterns to different antibiotics tested. The results showed that the isolates of *E.coli* were sensitive to Erythromycin but resistant to other antibiotics that were used. The isolates of *S.aureus* were sensitive to Chloramphenicol, Ceftriaxone, Ciprofloxacin and Erythromycin but resistant to Ampicillin and Gentamicin. *P.aeruginosa* isolates were sensitive to Chloramphenicol and Ceftriaxone, however, were resistant to Ampicillin, Ciprofloxacin, Erythromycin and Gentamicin. The isolates of *K.pneumonia* and *Streptococcus sp* were sensitive to all the antibiotics used in this study.

In another study, researchers found that 95% of phones harbored some kind of bacteria, many of which were resistant to multiple antibiotics. The researchers also revealed that bacteria were transmitted from the hands of the users to their phones and from their phones to their hands after testing the users' hands. It has been established that about 30% of the bacteria on phones ended upon the owner's hands [17]. In a

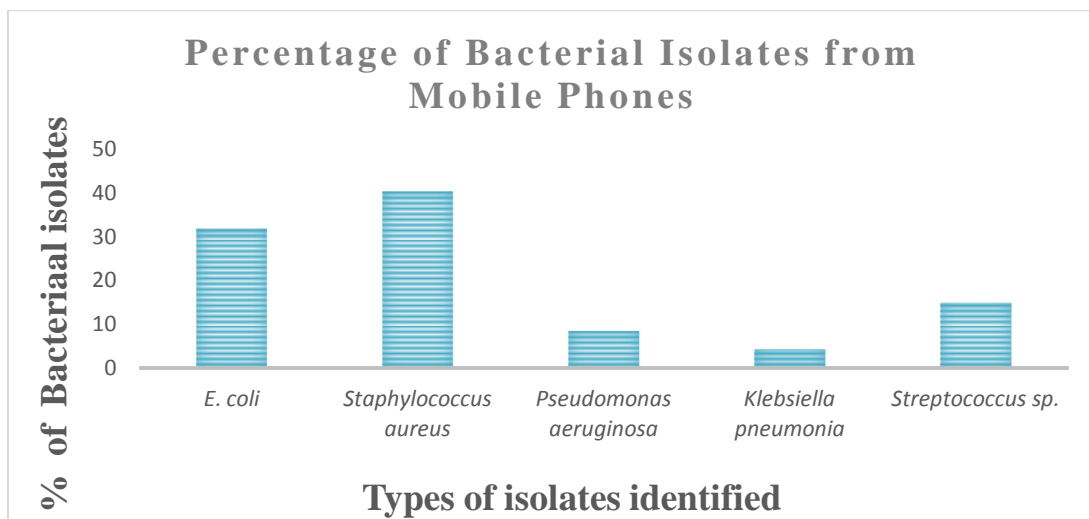


Fig. 1. Percentage of bacteria isolated from the students' mobile phones

**Table 1. Results of gram staining, biochemical test and colonial morphology of bacterial isolates**

<b>Colonial Morphology</b>	<b>Gram Staining</b>	<b>Catalase</b>	<b>Indole</b>	<b>Citrate</b>	<b>Urease</b>	<b>Oxidase</b>	<b>Coagulase</b>	<b>Possible Organism</b>
Regular cocci in clusters	+	+	-	-	-	+	+	<i>Staphylococcus aureus</i>
Straight rods in singles and two	-	+	+	-	-	-	-	<i>Escherichia coli</i>
Regular rods in pairs	-	+	-	+	-	+	-	<i>Pseudomonas aeruginosa</i>
Regular rods in chain	-	+	-	+	-	-	-	<i>Klebsiella pneumoniae</i>
Cocci	+	-	-	-	-	-	-	<i>Streptococcus sp.</i>

KEY: + = Positive; - = Negative

**Table 2. Percentage of bacteria isolated from student mobile phones in caritas university**

<b>S/N</b>	<b>Bacterial isolates</b>	<b>Number</b>	<b>Percentage (%)</b>
1	<i>Escherichia coli</i>	15	31.9
2	<i>Staphylococcus aureus</i>	19	40.4
3	<i>Pseudomonas aeruginosa</i>	4	8.5
4	<i>Klebsiella pneumoniae</i>	2	4.3
5	<i>Streptococcus sp.</i>	7	14.9
Total			100

study done by Meadow et al. [18], they characterized microbial communities on mobile phone touch screens to determine whether there was significant overlap with the skin microbiome sampled directly from their owners. They found that about 22% of the bacterial taxa on participants' fingers were also present on their own phones. Beckstrom et al. [19] in their study, of bacterial contamination of the parent's cell phone in the Neonatal Intensive Care Unit (NICU) and the effectiveness of an anti-microbial gel in reducing transmission to the hands found that all cell phones demonstrated bacterial contamination, 90% had the same bacteria on the cell phone and their cleaned hands and 22% had no growth on their hands after applying anti-microbial gel after they had the same bacteria on the cell phone and hands.

The susceptibility test is important because of the present increasing rate of microbial resistance to antibiotics, because if by chance infected with this organism through mobile phone the drug to inhibit the organism is known. On inanimate objects, Kramer et al. [20]; Kampf and Kramer [21] have shown that *Staphylococcus sp* is able to persist for 4 weeks to 7 months, *Pseudomonas* for 6 h to 16 months, *Klebsiella* for 2 h to 30 months, and *E. coli* for 5 to 16 months.

## 5. CONCLUSION

These results showed that mobile phones were contaminated with different types of bacteria. Due to their personal nature and proximity to sensitive parts of our bodies in usage, such as faces, ears, lips and hands of users could become veritable reservoirs of pathogens that could result in infections. Hence, personal hygiene and sanitation measures such as hand washing, cleaning of the environment and washing of hand before and after handling of food and phone decontamination should be adopted by people to prevent bacterial infections. These findings substantiate the need for future investigations in order to monitor the transfer of pathogenic bacteria mediated by mobile phones and to educate users on the potential health-risk that may be posed by contaminated fomites such as transmission of infections.

I therefore recommend that it is of utmost necessity to keep mobile phones far from reach of children to prevent transmission of microorganisms. People are also encouraged to put interest to strict personal hygiene and environmental sanitation in order to prevent disease outbreaks and transmission. Developing

active preventive strategies like decontamination of mobile phones with alcohol containing disinfectant might reduce cross-infection. Another way of reducing microbial contamination on mobile phones is by enlightening the public on the microbial colonization of mobile phones and the use of regular cleansing agents and rearranging of their environment.

Using the phone while in the toilet or bathroom and thereafter going to eat food could easily lead to the contamination of the food, despite washing hands after using the toilet hence mobile phones should not be taken to toilets, bathrooms or put on dirty surfaces. Students should avoid sharing their mobile phones to prevent occurrence of different types of bacteria on phone surfaces.

Basol et al. [22] recommended that using either 70% isopropyl alcohol wipes or ethyl alcohol wipes; both were deemed effective in eliminating bacteria on mobile communication devices. Two studies found that due to the uneven surface of a keypad, such devices were able to harbor more bacteria than the smooth surface of touch screen phones [23].

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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