

## Bacterial Contamination Associated with Mobile Cell Phones among Undergraduate Students of Federal University of Lafia, Nasarawa State, Nigeria

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### ABSTRACT

Mobile cell phones are extensively used globally. This study was aimed at determining bacterial contamination associated with mobile cell phones among undergraduate students of Federal University of Lafia, Nasarawa State, Nigeria. One hundred swab samples from mobile cell phones were randomly collected from the students' cell phones between August 2019 and December 2019. Demographic factors like age, gender, mobile phone type, storing of mobile cell phones, cleaning habits and use in toilets were collected using a semi-structured questionnaire. The samples were analysed using standard microbiological techniques. The data collected were analysed using percentile and SPSS version 20.0. The value ( $p < 0.01$ ) was statistically considered to have significant associations. Microbial analysis showed that 70 non-disinfected samples were contaminated by eight diverse types of bacteria, which included *Escherichia* sp., *Salmonella* sp., *Bacillus* sp., *Pseudomonas* sp., *Staphylococcus* sp., *Klebsiella* sp., *Micrococcus* sp and *Enterobacter* sp. The swabbed cell phones of females (56.3%) were more contaminated than those of males (43.7%) with bacterial load count of  $41.9 \times 10^3$  and  $28.8 \times 10^3$  CFU/mL among females and males, respectively. The mobile cell phones used in toilets (75.0%) were highly contaminated by bacteria. Users who did not cut their nails had higher contamination (69.4%) than those users who cut their nails (34.3;  $p = 0.01$ ). The age of mobile cell phones within 6 – 12 months had 55.5% for females and 23.5% for males. This study showed that mobile cell phones harbor bacteria liable for causing health threats to handlers. Therefore, awareness programs concerning hand hygiene and discouraging their use in toilets to avoid causing severe health consequences. The use of disinfectants to wipe mobile cell phones whenever contamination is encountered is advocated to safeguard public health.

**Keywords:** Mobile Cell Phone, Swabs, Microbes, Contamination

### INTRODUCTION

The use of mobile cell phones has expanded rapidly on a global scale and has brought numerous changes in the daily lifestyles of individuals. In Nigeria, it is estimated in 2017 that 71% of the population use mobile cell phones as the main platform for communication and accessing the Internet (Gillwald *et al.*, 2018). Pathogenic microbes can be widely spread through direct physical contact among individuals or through contaminated lifeless objects, and other surfaces especially at various user-crossing points in institutions or communities (Oluduro *et al.*, 2011). Studies proved that many pathogenic bacteria can be found on fomites and other

surfaces can survive for long periods depending on environmental factors such as temperature and relative air humidity (Grice *et al.*, 2009).

Mobile cell phones are essential tools of communication, both at home, in school and at the workplace. They are always picked, dropped or pocketed, thus the possibility of acquiring and harboring microorganisms from the handlers and the environment. Mobile cell phones as lifeless objects have been revealed to support microbial survival on their surfaces. Microbes such as bacteria, viruses such as influenza and corona can persevere for a few days while herpes virus can persevere for a week (Abad *et al.*, 1994; Kramer *et al.*, 2006). Several studies have shown

that cell phones contaminated with pathogenic bacteria play a big role in the spread of infectious disease (Brady *et al.*, 2006; Tagoe *et al.*, 2011). Many users do not generally know the microbial load on many regular objects within their living and workplaces (Al-Ghamdi *et al.*, 2011; Shalanimol, 2016). The unclean ways of handling such objects make them a cardinal reservoir of an assembly of pathogenic microorganisms (Zakai *et al.*, 2016; Adhikari *et al.*, 2018) thus mobile cell phones surfaces might serve as fomites in the transmission of these microbes (Bhoonderowa *et al.*, 2014).

Several studies carried out on mobile cell phones have exhibited the presence of some microbes such as *Bacillus* sp., *Staphylococcus aureus*, *Enterococcus* sp., *Escherichia coli*, *Streptococcus* sp., *Proteus* sp., *Pseudomonas aeruginosa*, *Klebsiella* sp., *Acinetobacter* and coliforms on medical personnel (Brady *et al.*, 2006; Ramesh *et al.*, 2008; Nwankwo *et al.*, 2014), students and patients (Tekerekoğlu *et al.*, 2011; Nwankwo *et al.*, 2014).

Use and handling of mobile cell phones is common among students in tertiary institutions in Nigeria (Ozdalga *et al.*, 2012; Robinson *et al.*, 2013) and this increases the chances for cross-contamination amongst individuals (Ulger *et al.*, 2015). At present, there are no guidelines for disinfection of mobile cell phones as an emphasis on disease control practices. This study was designed to determine the extent of bacterial contamination of mobile cell phone surfaces among undergraduate students of Federal University of Lafia, Nasarawa State, Nigeria.

## MATERIALS AND METHODS

### Study Design and Area

The study was carried out in the Faculty of Science, Federal University of Lafia (FUL), Nasarawa State, Nigeria from August 2019 to December 2019. Approval for the study was given by the Health Research and Ethics Committees (HREC) of Nasarawa State, Ministry of Health, Lafia in accordance with the code of ethics for biomedical research involving human subjects (NHREC/18/09/2019). Consent to

participate was sought from volunteer students and were informed about the confidentiality of information that they provide in the questionnaire and rights to participate or refuse to participate in the study. Socio-demographic data such as age, gender and status of each student were extracted by a semi-structured questionnaire. Information regarding the type of mobile phones used, a span of use by the users, the practice of handling the mobile phones such as disinfection, place of storing (if not in use) and their use in toilets, kitchen or laboratory were also collected.

### Sample Collection and Processing

A total of 70 mobile cell phones were swabbed out of which 34 belonged to male students. The hearing (speaker) and the back regions of the mobile cell phones were swabbed using sterile swab sticks. The swab samples were immediately placed in sterile airtight containers and transported to the laboratory. Another set of 30 mobile phones, 15 each from male and female volunteer students were cleaned with 70 % ethanol to disinfect prior to swabbing and served as the control for the study. Microbiological examination of all samples collected was conducted. Briefly, swab sticks were dipped in 0.5 mL saline water and inoculated on the following culture media: Nutrient agar, MacConkey agar, Mannitol Salt Agar, Eosin Methylene Blue agar, Selenite Cysteine agar and *Salmonella - Shigella* agar. The culture plates were then incubated at 37°C for 48 hrs (Forbes *et al.*, 2007).

### Bacterial Count and Identification of Isolates

Immediately, after incubation, the plates were checked for bacterial growth and counted using a colony counter and expressed as colony-forming units per millilitres (CFU/mL). Isolates were identified by colony morphology, arrangement, size and color as described by Barry (2012). The isolates were further subjected to Gram staining reaction. The Gram-positive bacteria were further tested for oxidase, catalase, coagulase, oxidative/ fermentative tests, methyl red and Voges-Proskauer tests. Gram-negative bacteria

were identified using colony morphology and the following biochemical tests: indole, methyl red, Voges Proskauer, citrate, triple sugar Iron, catalase, oxidase, urease, oxidative/fermentative tests (Forbes *et al.*, 2007).

### Statistical Analyses

Descriptive statistics were used to present the socio-demographic information and bacterial count analysis. The results were presented in tabular form and analysed using percentile and SPSS version 20.0.

### RESULTS

Table 1 presents the demographic characteristic of participating students concerning cell phone bacterial contamination. The results suggest 72.2 % bacterial contamination amongst female students while 75.0% of phones used in toilets were observed to be contaminated. Mobile phones of users who do not cut their nails regularly were more contaminated with bacteria (69.4 %). Phones recently purchased by male students (6 -12 months) were less contaminated (23.5 %) when compared with female students

within the same period (55.5 %). No cell growth was demonstrated for cell phones disinfected before swabbing.

Results presented in Table 2 identify eight bacterial isolates present as contaminants on cell phones of students selected for this study. The bacterial isolates were identified as *Escherichia* sp., *Salmonella* sp., *Bacillus* sp., *Pseudomonas* sp., *Staphylococcus* sp., *Klebsiella* sp., *Micrococcus* sp and *Enterobacter* sp.

The non-disinfected 70 mobile cell phones (34 from males and 36 from females) had revealed growth, out of which the highest proportion of mobile cell phones from females (55.6%) than males (47.1%). As presented in Table 3, 55.6 % of cell phones belonging to female students were contaminated with *Staphylococcus* sp., *Escherichia* sp. (41.7%), *Klebsiella* sp. (38.9%), *Enterobacter* sp. (36.1%), *Pseudomonas* sp. (25.0%), *Bacillus* sp. (22.2%), *Salmonella* sp. (19.4%) and *Micrococcus* sp (11.1%). Mobile cell phones belonging to male students were more contaminated with *Staphylococcus* sp., (47.1%) and *Escherichia* sp. (38.2%).

**Table 1:** Demographic characteristics of selected students in Federal University of Lafia associated with cell phone bacterial contamination

CHARACTERS (USERS)	DISTRIBUTION OF CONTAMINATED MOBILE CELL SAMPLES			
		Male (%) (n = 34)	Female (%) (n = 36)	Total (%) (n = 70)
<b>Gender</b>	Male			34 (48.6)
	Female			36 (51.4)
<b>Mobile phone type</b>	Screen touch	10 (29.4)	10 (27.8)	20 (57.2)
	Keypad	24 (70.6)	26 (72.2)	48 (68.5)
<b>Use of mobile phones in the toilet</b>	Non users	10 (29.4)	9 (25.0)	19 (27.1)
	Users	24 (70.6)	27 (75.0)	51 (72.9)
<b>Mobile phone storing place</b>	Pockets	22 (67.7)	8 (22.2)	30 (42.9)
	Bags	12 (35.3)	28 (77.8)	40 (57.1)
<b>Users cutting nails</b>	Nail cutters	13 (38.2)	11 (30.6)	24 (34.3)
	Non nail cutters	21 (61.8)	25 (69.4)	46 (65.7)
<b>Time since Possession and use of mobile cell phone</b>	Less than 6month	4 (11.8)	16 (44.4)	20 (56.2)
	6 – 12month	8 (23.5)	20 (55.5)	28 (79.0)
	More than 12month	22 (64.7)	-	22 (64.7)

Key: n = number, % = percentage

Cumulative aerobic bacteria plate count showed  $41.9 \times 10^3$  CFU/mL observed for mobile cell phones of female students while  $28.8 \times 10^3$  CFU/mL was recorded for mobile cell phones of male students (Table 4).

### DISCUSSION

Hand contamination of various surfaces with pathogenic and non-pathogenic microbes has been documented (ICT, 2006). The isolation of enteropathogenic bacteria including *Staphylococcus* sp., *Escherichia* sp., *Klebsiella* sp., *Enterobacter* sp., *Pseudomonas* sp., *Bacillus* sp., *Salmonella* sp. and *Micrococcus* sp. from surfaces of the handheld mobile phones as demonstrated in this study is an indication of unhygienic practices, poor handling and sharing among multiple users (Yusha'u *et al.*, 2010; Shahaby *et al.*, 2012; Auhim, 2013; Bhoonderowa *et al.*, 2014) and may predispose to opportunistic infections (Cerdá *et al.*, 2006). Karabay *et al.* (2007) reported the isolation of *S. aureus* (8.1%), Coagulase Negative Staphylococci (CONS) (68.4%), *E. coli* (26.0%),

*Enterobacter faecalis* (1.8%) and *Klebsiella* sp. (0.9%) from mobile phones swab samples. The aerobic bacterial plate count variation of  $41.9 \times 10^3$  CFU/mL recorded for female volunteer students supports strongly that mobile cell phones used by female students were contaminated by different species of bacteria (Table 3). Although not measured in this study, the likelihood to share mobile phones among peers could be more among female students. This and other social behaviours could be attributable to the cocktail of bacterial cells isolated from mobile cell phones of female students.

A report by the Infectious Disease Society of America (IDSA) in San Francisco disclosed that natural and artificial nails longer than 3 millimeters beyond the fingertip harbor more bacteria and yeast cells (Puleo, 2017). As shown in this study, surfaces of the mobile phone of users who kept long nails were highly contaminated (69.4%) when compared with users who cut their nails (30.6%)

**Table 2:** Cultural, morphological and biochemical characterization of bacterial contaminants on cell phones of selected students in Federal University of Lafia

CHARACTERISTICS	IS1	IS 2	IS3	IS4	IS5	IS6	IS7	IS8
<b>Cultural</b>								
<b>Shape</b>	Circular	Circular	Irregular	Circular	Circular	Circular	Circular	Circular
<b>Elevation</b>	convex	Convex	Flat	Low convex	convex	Convex	Convex	Convex
<b>Margin</b>	Entire	Entire	Undulate	Entire	Entire	Entire	Entire	Entire
<b>Wetness/Dryness</b>	Wet	Wet	Dry	Wet	Wet	Wet	Wet	Wet
<b>Transparency</b>	Opaque	Opaque	Opaque	Opaque	Opaque	Opaque	Opaque	Opaque
<b>Colour</b>	Cream	Yellow	Cream	Cream	Yellow	Cream	Yellow	Yellow
<b>Size</b>	Small	Small	Large	Medium	Medium	Medium	Medium	Small
<b>Morphological</b>								
<b>Gram Staining</b>	-	+	+	-	-	-	+	-
<b>Cell Type</b>	Rod	Cocci	Rod	Rod	Rod	Rod	Cocci	Rod
<b>Cell Arrangement</b>	Single	Cluster	Chain	Single	Single	Single	Single	Chain
<b>Biochemical</b>								
<b>Catalase</b>	+	+	+	+	-	+	+	+
<b>Coagulase</b>	-	-	-	-	-	-	-	-
<b>Oxidase</b>	-	-	-	-	-	-	-	+

Urease	-	-	-	+	+	+	-	-
Indole	+	-	-	-	-	-	-	-
Citrate	-	+	+	+	-	+	-	+
Sugar								
Glucose	AG	A	A	A	A	AG	A	A
Lactose	+	+	-	-	-	+	-	+
Possible Isolates	<i>Esc heri- chia</i> sp.	<i>Staphyl- ococcus</i> sp.	<i>Bacillus</i> sp.	<i>Pseudomon -as</i> sp.	<i>salmonell a</i> sp.	<i>Klebisella</i> sp.	<i>Micrococcc- us</i> sp.	<i>Enterobac -ter</i> sp.

Key: + = Positive, - = Negative, A = Acid, AG = Acid and Gas, sp. = species, IS = Isolate Number 1, 2, 3, 4, 5, 6, 7, 8

**Table 3:** Frequency of bacterial sp isolated from mobile cell phones of selected students of Federal University of Lafia

ISOLATES	MALE STUDENTS' MOBILE CELL PHONE (n= 34)	FEMALE STUDENTS' MOBILE CELL PHONE (n= 36)
<i>Escherichia</i> sp.	13 (38.2)	15 (41.7)
<i>Staphylococcus</i> sp.	16 (47.1)	20 (55.6)
<i>Salmonella</i> sp.	5 (14.7)	7 (19.4)
<i>Enterobacter</i> sp.	11 (32.4)	13 (36.1)
<i>Klebisella</i> sp.	12 (35.3)	14 (38.9)
<i>Pseudomonas</i> sp.	6 (17.6)	9 (25.0)
<i>Bacillus</i> sp.	5 (17.7)	8 (22.2)
<i>Micrococcus</i> sp.	2 (5.9)	4 (11.1)
<b>Total (160)</b>	<b>70 (43.7)</b>	<b>90 (56.3)</b>

Values in parenthesis are in percentage (%)

**Table 4:** Bacterial cell count of isolates from swabbed mobile cell phones of students of Federal University of Lafia

BACTERIAL SPECIES	BACTERIAL COUNT MALES MOBILE CELL PHONE (X10 <sup>3</sup> CFU/ML)	BACTERIAL COUNT FEMALES MOBILE CELL PHONE (X10 <sup>3</sup> CFU/ML)
<b>Total viable count</b>	9.1	17.6
<i>Escherichia</i> sp.	5.3	6.5
<i>Staphylococcus</i> sp.	3.6	4.9
<i>Salmonella</i> sp.	2.3	2.7
<i>Enterobacter</i> sp.	3.9	4.4
<i>Klebisella</i> sp.	2.1	2.3
<i>Pseudomonas</i> sp.	1.1	1.6
<i>Bacillus</i> sp.	0.9	1.1
<i>Micrococcus</i> sp.	0.5	0.8
<b>Total</b>	<b>28.8</b>	<b>41.9</b>

Key: CFU = colony-forming unit

A similar study on college students conducted in Nepal indicated 56 % bacterial contamination of mobile phones which included multidrug-resistant *S. aureus* (MRSA) and the use of mobile phones in toilets predisposes to multiple bacterial cell

contamination of cell phone surfaces (Adhikari *et al.* 2018). Regular cleaning of mobile cell phones surfaces with disinfectant could prevent or reduce a load of microbial contamination of surfaces of mobile cell phones (Ramesh *et al.*, 2008).

## CONCLUSION

Surfaces of handheld mobile phones of selected male and female students of the Federal University of Lafia were observed to be contaminated with different species of bacteria including *Staphylococcus*, *Escherichia*, *Klebsiella*, *Enterobacter*, *Pseudomonas*, *Bacillus*, *Salmonella* and *Micrococcus species*. Mobile cell phone surface of female students was found to be more predisposed to contamination in relation to personal hygienic practices. Hand hygiene, consistent disinfection of mobile cell phones, discouraging mobile phone use in toilets are some practices that should be encouraged especially amongst the youth.

## ACKNOWLEDGEMENT

We are sincerely grateful to the management, lecturers and technologists of the Department of Microbiology, Federal University of Lafia.

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