Journal of ENVIRONMENTAL Treatment Techniques

J. Environ. Treat. Tech.
ISSN: 2309-1185

Journal web link: https://dormaj.org/index.php/jett
https://doi.org/10.47277/JETT/10(2)177

Isolation and Identification of Bacteria on Mobile Phones among Mechanics, Civil Servants, and Food Handlers in Imo State, Nigeria

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Received: 22/05/2022 Accepted: 04/06/2022 Published: 20/06/2022

Abstract

This study seeks to identify the counts and types of bacteria contaminating mobile phones used by randomly selected mechanics, civil servants, and food handlers within Owerri, Imo state. The investigation was on the antimicrobial resistance profiles of the isolates. Three hundred (300) questionnaires were distributed, of which 221 were returned in which swab samples were collected from their mobile phones using swabs moistened with sterile normal saline from an area of 3cm over mobile phone surfaces. Samples were cultured and processed by standard Microbiological procedures. Out of 221 mobile phones sampled, 147 were contaminated with bacteria. *Staphylococcus aureus* was the most predominant isolate followed by *Bacillus cereus*, *Streptococcus* sp., *Klebsiella* sp., and *Proteus vulgaris*. Mobile phones belonging to mechanics 81(55.10%) had the highest number of types of bacterial contamination followed by food handlers 41(27.89%) while the least was civil servants 25(17.01%). Antimicrobial susceptibility results showed that Gentamycin (22.44%) had the highest susceptibility pattern while Erythromycin (0%) had the least. This study, therefore, revealed that cell phones may have a notable role in the transmission of pathogens as well as multidrug-resistant pathogens.

Keywords: Mobile phones, Users, Pathogens, Drug-resistant, Nigeria

1 Introduction

A mobile or cellular telephone is a long-range, portable electronic device for personal telecommunications over long distances. Until the late 1980s most mobile phones were sufficiently large in that they were permanently installed in vehicles as car phones [1]. Mobile phones have become widely spread accessories in today's life. In 2013, more than 1.6 billion smartphones were in use worldwide, and it is estimated that this number will approximately double within the next 4 years [2]. In addition to the standard voice function of a telephone, mobile phones can support many additional services such as SMS for text messaging, email, packet switching for access to the Internet, and MMS for sending and receiving photos and video. With all the achievements and benefits of the mobile phone, it is easy to overlook the health hazard it might pose to its many users [3]. Mobile phones might act as fomites as they are carried with their owner to places such as toilets, hospitals, and kitchens, which are loaded with microorganisms [4]. Unlike fixed phones, mobile phones serve as a perfect habitat for the microbes to breed– providing the higher temperature and humid conditions [5]. Mobile phone usage has increased dramatically. In such environments where the percentage presence of bacteria is likely high, such as in hospitals, abattoirs, market places, and toilets, this could enhance pathogen transmission and intensify the difficulty of containing disease spread [6]. Sources of infection may be exogenous such as air, medical equipment, hands of surgeons and other staff, or endogenous such as the skin flora in the operative site, or rarely from blood [7]. The human skin is constantly in contact with microorganisms and becomes readily colonized by certain microbial species. The adult human is covered with approximately $2m^2$ of skin, with a surface area supporting about 1012 bacterial cells/person. During a phone call, the mobile phone comes into close contact with contaminated human body areas from hands to hands, and hands to other areas like the mouth, nose, and ears [8]. Moreover, physicians and paramedical staff, while attending patients, sometimes hold mobile phones close to their faces, which facilitates the transmission of bacteria from mobile surfaces to hands, thus leading to the nosocomial spread of the bacteria [9-10].

Despite the high possibility of being contaminated, mobile phones are seldom cleaned and are often touched during or after the examination of patients and handling of specimens without proper handwashing. These phones can harbor various potential pathogens and become exogenous sources of infection for the patients and are also a potential health hazard for self as well as family members [1];[11]. Further, sharing of cell phones among health care workers (HCWs) and non-HCWs may directly facilitate the spread of potentially pathogenic bacteria to the community (Chawla *et al.*, 2009). There is growing evidence that contaminated fomites or surfaces play a key role in the spread of bacterial infections with antimicrobial [12]. Nosocomial infections caused by multi-drug resistant Gram-positive organisms such as *S. aureus* and enterococcal species are growing problems in many health care institutions [13]. The main reservoir of *S. aureus*is the

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hand from where it is introduced into food during preparation [14]. The hand serves as a major vehicle for the transmission of various microbes, including the enteric species. Moreover, hand washing may not be performed often enough during a working day and the possibility that mobile phones may act as a potential source of microbial transmission is considerable [15]. With all the achievements and benefits of mobile phones, it is easy to overlook the health hazard they might pose to its many users. This is against the background that many users may not have regard for personal hygiene coupled with the location of the call center and the likely number of users per day. The constant handling of the phone by different users makes it open for arrays of microorganisms, making it a harbour and a breeding ground for microbes especially those associated with the skin, and, from this phone, different microorganisms are spread from user to user [16]. Research has shown that the mobile phone could constitute a major health hazard with tens of thousands of microbes living on each square inch, they harbour more bacteria than a man’s lavatory seat, the sole of a shoe, or the door handle [17]. Microbiologists say that the combination of constant handling and the heat generated by the phones creates a prime breeding ground for all sorts of microorganisms that are normally found on our skin. The human surface tissue (skin) is constantly in contact with environmental microorganisms and becomes readily colonized by certain microbial species [18]; [12]. The adult human is covered with approximately 2m^2 of skin, with a surface area supporting about 1012 bacteria [19].

The normal microbiota of the skin include among others; coagulase-negative Staphylococci, *Diptheroids, Staphylococcus aureus, Streptococci spp., Bacillus spp., Mallassesia furfur,* and *Candida spp*. Others include *Mycobacterium spp*(occasionally), *Pseudomonads*, and *Enterobacteriaceae*(occasionally). The normal microbiota is harmless and may be beneficial in their normal location in the host in the absence of coincident abnormities. They can produce disease conditions if introduced into foreign locations or compromised hosts. These problems triggered a need for this study to isolate and identify bacteria on mobile phones, among mechanics, civil servants, and food handlers in Owerri, Imo State, Nigeria.

2 Materials and Methods

2.1 Area of the Study

Owerri is the capital of Imo State in Nigeria, set in the heart of Igboland. It is also the state's largest city, followed by Orlu and Okigwe. Owerri consists of three Local Government Areas including Owerri Municipal, Owerri North, and Owerri West, it has an estimated population of about 1,401,873 as of 2016 and is approximately 100 square kilometers (40 sq m) in area. Owerri is bordered by the Otamiri River to the east and the Nworie River to the south. Owerri town, capital of Imo state, southern Nigeria, at the intersection of roads from Aba, Onitsha, Port Harcourt, and Umuahia.The town is home to the Federal University of Technology Owerri, Imo State University, Alvan Ikoku Federal College of Education, and several secondary schools. The town is located in one of the most densely populated areas of Nigeria and is inhabited by the predominantly Christian Igbo people. The mechanics, civil servants, and food handlers in Owerri form the setting for the study.

2.2 Description of Sample

A total of 300 Samples from mobile phones among mechanics, civil servants, and food handlers (100 for each group) in Owerri, Imo state were randomly collected and analyzed. The first group which is the “Mechanics” (M) is mainly males who repair or fix all kinds of machines within Owerri, Imo state. They come in contact with oils, dirt, and dust, exhaust smoke and also have access to their mobile phones. The second group named ‘’Civil servants’’ (CS) includes both male and female civil servants from different local government areas in Owerri, Imo state. These civil servants come from different L.G.A in Owerri, who work for the Government. This group includes those who work in offices, hospitals, laboratories, and schools and have access to their mobile phones. The third group which is the “Food handlers’’ (FH) are both male and female; they are involved in the preparation and distribution of foods within Owerri, Imo state. These foods are consumed by individuals that stay in Owerri and visitors. They come in contact with agricultural produce, industrial products, money, and mobile phone as well.

2.3 Sample Collection, Handling, and Transport

The mobile phones were first held with the aid of a sterile glove. Samples were then collected using sterile cotton swab sticks moistened with sterile normal saline and were used to swab the phones over the surface on both sides of the phone (this was done aseptically). The swab was placed in a 1 ml sterile normal saline tube to maintain the viability of microorganisms. All samples were collected and transported from the collection area within an hour to the Microbiology Laboratory, for processing.

2.4 Culture Media Preparation

The media used for this research study includes; MacConkey agar (MCA), Blood agar (BA), and Mueller Hinton Agar (MHA).

2.4.1 Description of Macconkey Agar

MacConkey agar is a selective and differential media used for the isolation of gram-negative enteric bacteria and differentiation of lactose non-fermenting gram-negative bacteria. Particularly members of the family Enterobacteriaceae and the genus *Pseudomonas*. Pancreatic digestion of gelatin and peptones (meat and casein) provides the essential nutrients, vitamins, and nitrogenous factors required for the growth of microorganisms.

2.4.2 Preparation of MacConkey agar:

This media was prepared according to the manufacturers' guide. This was done by suspending the measured amount of powder (see in the agar bottle and generally 50gram) in 1L of purified water and mixing thoroughly. The mix is then heated with frequent agitation and boiled for 1 minute to completely dissolve the powder. Autoclaving was done at 121^{o}C for 15 minutes.

2.4.3 Description of Blood Agar

Blood agar is an enriched, bacterial growth medium. Fastidious organisms, such as *Streptococci*, do not grow well on ordinary growth media. Blood agar is a type of growth medium (trypticase soy agar enriched with 5% blood) that encourages the growth of bacteria, such as *Streptococci*, that otherwise wouldn’t grow.

2.4.4 Preparation of Blood agar

The blood agar base was prepared as instructed by the manufacturer. This was done by sterilizing with autoclaving at 121^{o}C for 15 minutes, and the prepared blood agar base was transferred to a 15^{o}C water bath. When the agar-based cooled down to 50^{o}C, sterile blood was added aseptically and gently mixed well, avoiding the formation of air bubbles. 15ml amounts were dispensed to sterile Petri plates aseptically and labeled for inoculation.

2.4.5 Description of Mueller Hinton Agar

This is a microbiological growth medium that is commonly used for antibiotic susceptibility testing. Mueller-Hinton agar (MHA) is used in antimicrobial susceptibility testing by the disk diffusion method.

2.4.6 Preparation of nutrient agar

This media was prepared according to the manufacturer, this was done by dissolving 18 g of agar powder in 500ml of distilled water in a conical flask; the mixture was swirled and allowed to soak for 10mintes. The conical flask was corked with sterile cotton wool wrapped with aluminum foil to make it airtight and then sterilized in an autoclave at a temperature of 121 ^{o}C for 15 minutes at 15 psi. Thereafter, the media sterilized were dispensed into sterile Petri dishes aseptically to a depth of 4mm and then allowed to solidify [20].

2.5 Inoculation/Incubation of Collected Samples

The collected swab samples inserted into the swab container and labeled were aseptically and carefully removed and inoculated on MacConkey agar (MCA) and Blood agar (BDA) using the streak and spread method, it was incubated aerobically at 37^{o}C for 24-48 hours for both MCA and BDA, [20].

2.6 Characterization of Isolates

The microbes isolated from the mobile phone surfaces on MacConkey agar and Blood agar were appropriately characterized by observing their morphological colonies and performing a series of tests like Gram staining, Motility, Indole, Oxidase, Urease, Methyl red, Vogesproskeur, Catalase, Coagulase, and Sugar tests [21].

2.6.1 Macroscopic Characterization

This was done by the identification of isolates in each plate of MacConkey agar and Blood agar after 24hours, for colour, size (mm), shape, elevation, margin, and surface appearance using the method of [22].

2.6.2 Colonial Morphology

This involves the size of colony, texture, translucence, transparency, opaque, types of pigments, adherence to the agar, and undulating/round/dentate edge.

2.6.3 Microscopic Characterization

Microscopy is a category of characterization techniques that probe and map the surface and subsurface structure of a material. These techniques can use photons, electrons, ions, or physical cantilever probes to gather data about the structure of a sample on a range of length scales. Microscopic characterization is done by microscopy; it involves the use of a microscope to view objects and areas of objects too small to be seen with naked eyes.

2.6.4 Motility Test

The test distinguishes bacteria that are motile from non-motile ones. It tests the ability of a bacterium to swim or move. A clean grease-free cavity slide was placed carefully on a bench with the cavity uppermost. Holding a coverslip, a drop of Vaseline was placed on each edge of the coverslip. A test bacterial suspension was smeared on the coverslip where the Vaseline was applied and quickly inverted over the cavity slide. The observation was carried out for any bacterial movement using high-power objective lenses of 10x and 40x (microscope).

2.6.5 Gram Staining

The staining reagents used were crystal violet, Lugol iodine, and safranine dye. A thin film of the pure colony of bacterium isolated from the mobile phones was smeared on clean grease-free glass slides, air-dried, and heat-fixed before flooding with crystal violet for 1minute. The excess stain was washed off on a slow-running tap and flooded with Lugol's iodine for another 1minute. The excess iodine was washed off with distilled water decolorized and rinsed before counterstaining with safranine dye for thirty seconds. The slide was washed off and air-dried before examining under the microscope with oil immersion. A deep blue or purple colour shows gram-positive bacteria and pink or red colour indicates gram-negative bacteria.

2.7 Biochemical Tests

2.7.1 Catalase Test

A drop of 30% hydrogen peroxide was placed on a clean, dry glass side. A small amount of bacterial colony was transferred into the drop of the hydrogen peroxide using a sterile wire loop. Observation of the evolution of oxygen bubbles was then carried out [21]. Bubble production or effervescence sound indicates catalase positive. No bubble production shows catalase-negative.

2.7.2 The Coagulase Test

A drop of physiological saline was placed on either end of a clean glass slide, a bacterial colony was then emulsified on the drops to make a thick suspension. A drop or two drops of plasma was added to the suspension and mixed gently. Observations were carried out within 10 seconds [20]. Coagulase positive; clumping within 10 seconds. Coagulase-negative; No clumping within 10 seconds. Colonies from MCA were not used as bile salts contained in MCA may give false-positive results.

2.7.3 Indole Test

The peptone water was inoculated with a small amount of the bacterial colony and incubated at 37^{o}C for 48hours, 0.5ml of Kovac's reagent was added and the test tube was shaken gently. Observation carried out. Indole was positive; the appearance of red colour. Indolenegatve; the nonappearance of red colour.

2.7.4 The Oxidase Test

Two drops of freshly prepared oxidase reagent were placed on clear filer paper. A small amount of the bacterial colony was smeared on the filter paper. Observation after 10seconds; Oxidase position; blue-purple colour within 10sconds. Oxidase negative; absence of blue-purple colour within 10 seconds [23].

2.7.5 The VogesProskauer (V-P) Test

The bacterial culture was inoculated in a 2ml sterile glucose phosphate peptone water in a test tube and inoculated at 37^{o}C for 48 hours. 1ml of 40% KOH and 3ml of 5% alcoholic alpha-naphthol were added to the tube and gently shaken. Observations were carried out for 2-5 minutes. VogesProskauer positive: a pink colour within 2-5 minutes. VogesProskauer negative: No colour change within 2-5 minutes**.**

2.7.6 Urease Test

The surface of a urea agar slant was streaked with a portion of a well-isolated colony with 2drops from an overnight brain-heart infusion broth culture. The cap on was left loosely and the tube was incubated at 35^{o}C in ambient air for 48hours observing for the development of a pink colour. Urease positive; development of an intense magenta to bright pink colour. Urease negative; no colour change.

2.7.7 Methyl Red (M-R) Test

Before inoculation, the medium was allowed to equilibrate to room temperature, organisms were lightly inoculated from a pure culture to the medium and were incubated aerobically at 37^{o}C for 24hours. After 24hours of incubation, 1ml of the broth was introduced to a sterile test tube and 2drops of methyl red indicator were added to the test tube and observed for colour change. Positive reaction; a distinct red colour. Negative reaction; a yellow colour.

2.7.8 Triple Sugar Iron Agar (TSIA) Test

TSI agar was prepared in slants; the medium was inoculated by stabling the butt and streaking the slant with a loopful of the appropriate isolate, and then incubated at 37^{o}C for 48hours. The production of gas is marked by cracks in the agar as well as the air gap at the bottom of the test tube while HS production is indicated by the presence of black precipitates which indicates the reduction of sodium thiosulphate to hydrogen sulphide. After an incubation period of 37^{o}C for 48 hours, the following results can be interpreted:

Butt colour	Slant colour	Results
Yellow	Red	glucose only fermented
Yellow	Yellow	glucose, lactose or sucrose
Red	Red	no action on sugar

2.7.8 Antibiotics Sensitivity

This was done to determine the sensitivity or resistance of the isolates to different antibiotics. Mueller-Hinton agar medium was prepared, sterilized, dispensed into sterile Petri dishes, and allowed to cool and solidify. Aliquots (0.1ml) of the freshly prepared 24hours nutrient broth culture of the test organism were spread on the surface of the nutrient agar media using a sterile glass rod. An antibiotic multidisk (Abtek biological Ltd, USA) for Gram-negative organisms was carefully placed on the surface of the incubated media using a pair of sterile forceps. The media was incubated at 37^{o}C for 24hours and the diameter of the zone of inhibition of the different antibiotics was measured and recorded.

Plate 1: Experimental set-up

2.8 Questionnaire Survey

The questionnaire consists of several questions which were geared toward obtaining relevant information and data for the research. The questionnaire consisted of three sections. Section A consists of the personal information of the respondents (age, gender, location, marital status, occupation) while Section B evaluates the use of mobile phones, then Section C addresses the health implications of the use of mobile phones. The questionnaires were given to the mechanics, civil servants, and food handlers from whom samples were taken.

2.9 Questionnaire Administration

The questionnaires were shared amongst the Mechanics, Civil servants, and Food handlers. A total number of 300 questionnaires were shared amongst 300 people who represent the sample size, and 100 for each group. The outcome of this process was presented in the results of this research work.

2.10 Data Analysis

Data were analyzed using descriptive statistics in frequency distribution and subjected to chi-square test analysis at $P \leq 0.05$ significant levels. A percentage descriptive statistical tool was also used.

3 Results

3.1 Basic Socio-demographic characteristics of respondents

The table below reveals that 220 of the respondents representing 73.33% were male while 80 representing 26.67% were female. It also shows without any ambiguity that most of the respondents within the age range of 31 - 40 years (46.67%) were high, followed by the age bracket of 20 – 30 years (33.33%), 41 – 50 years (13.33%) and the least was 50 years above (6.67%) Table1. The results also show that 120 of the respondents representing 40% were single while 180 representing 60% were married. It vividly describes that 35.75% of the respondent were mechanics, 32.58% were civil servants and 31.67% were food handlers (Table 1).

Table 1: Basic socio-demographic characteristics of respondents

Socio-demographic characteristics	Frequency	Percentage (%)
Gender		
Male	220	**73.33**
Female	80	**26.67**
Total	**300**	100.00
Age bracket of respondents		
20 – 30 years	100	**33.33**
31 – 40 years	140	**46.67**
41 - 50 years	40	**13.33**
50 and above	20	**6.67**
Total	**300**	100
Occupation/number of Respondents		
Mechanics	79	**35.75**
Civil servants	72	**32.58**
Food handlers	70	**31.67**
Total	221	100

3.2 Information of respondents on possession and use of mobile phone

Figure 2 showed that 65.61% (145) of the respondents use their mobile phones regularly, and 34.89% (76) of respondents use theirs irregularly while doing their business. 114 (51.58%) of respondents who own a mobile phone use their mobile phones in the toilet while 107 (48.42%) of the respondents do not use theirs in the toilet and 186 (81.16%) out of the respondents who own mobile phones wash their hands after using the toilet before handling their mobile phones while 35 (15.84%) of the respondents do not. The knowledge of respondents on bacteria on mobile phones revealed that 28 (12.67%) knew that their mobile phones were capable of carrying infectious agents like bacteria while 193 (87.33%) of the respondents had no idea of bacteria on mobile phones. 179 (81%) of the respondents place their mobile phones in their mouths whether consciously or unconsciously while 42 (19%) do not place their phones in their mouths. The results also revealed that 149 (67.42%) of the respondents know that bacteria could be harmful to one’s health while 72 (32.58%) of the respondents do not know that bacteria could be harmful to one's health (Table 2).

3.3 Identification of Bacteria Isolates

Out of 221 samples of mobile phones investigated for bacteria isolates, 147 yielded bacteria growth after incubation for 24hours at 37^{o}C. These isolates formed pink, small, round, creamy, mucous, shiny, small, round colonies on both agar (MacConkey and Blood agar). Mechanic (M) mobile phone users 81(55.10%) harbored more bacteria followed by food handlers (FH) mobile phone users 41 (27.89%) and least were civil servants (CS) mobile phone users 25 (17.01%). Five species of bacteria were identified from the mobile phone samples: *Staphylococcus aureus*, *Bacillus cereus*, *Streptococcus* sp., *Klebsiella* sp., and *Proteus vulgaris* (Table 3).

3.4 Biochemical Analysis

The result of the biochemical analysis shows the sensitivity and the resistivity of the bacteria species isolated. The result of the gram staining and motility test in Table 4 shows that the motility test indicated that all isolates were non-motile except for mechanic samples which were motile. Gram staining results showed there were both Gram-positive and Gram-negative bacteria isolates for all sample groups; Gram-positive cocci (GPC), Gram-positive bacilli (GPB), and Gram-negative bacilli (GNB) as shown in Table 4. Table 5 shows the results on the percentage occurrence of the antibiotic sensitivity isolates from mobile phones. Gentamycin, Ciproxolacin, and Peflozacin have the highest susceptibility pattern to the isolates having the percentage occurrence of 22.44%, 13.61%, and 13.61% respectively while Amoxicillin and Erythromycin revealed the least susceptibility pattern having a percentage occurrence of 4.76% and 0% respectively. Table 6 shows the overall sensitivity test.

Table 2: Information on respondents' level of exposure to mobile phone

Exposure to mobile phone			
Variables	Frequency (%)	Chi-square	P-value
Regular businesses with mobile phone			
Regular	145(65.61)	0.661	0.136*
Irregular	76 (34.89)		
Use mobile phone in the toilets			
Yes	114(51.58)	0.387	0.274*
No	107 (48.42)		
Washing of hands after daily businesses			
Yes	186 (81.16)	1.027	0.104*
No	35 (15.84)		
Knowledge of bacteria on mobile phone			
Yes	28 (12.67)	0.968	0.235*
No	193 (87.33)		
Placing of mobile phones in the mouth			
Yes	179 (81.00)	1.043	0.111*
No	42 (19.00)		
Bacteria being harmful to human			
Yes	149 (67.42)	0.417	0.118*
No	72 (32.58)		

*= Significant at $P \leq 0.05$ confidence interval

Table 3: Bacterial Isolates from Mobile Phones used by Mechanics, Civil Servants and Food Handlers in Owerri, Imo State

MOBILE PHONE USERS	No isolated (%)	ORGANISMS ISOLATED
MECHANICS (M)	26 (17.69)	*Staphylococcus aureus*
	20 (13.61)	*Bacillus cereus*
	15 (10.20)	*Streptococcus* sp.
	9 (6.12)	*Proteus vulgaris*
	11 (7.48)	*Klebsiella* sp.
Subtotal	81 (55.10)	
CIVIL SERVANTS (CS)	12 (8.16)	*Staphylococcus aureus*
	7 (4.76)	*Bacillus cereus*
	4 (2.72)	*Streptococcus* sp.
	2 (1.36)	*Klebsiella*sp.
Subtotal	25 (17.01)	
FOOD HANDLERS (FH)	14 (9.52)	*Staphylococcus aureus*
	12 (8.16)	*Bacillus cereus*
	9 (5.12)	*Streptococcus* sp.
	6 (4.08)	*Klebsiella* sp.
Subtotal	41(27.89)	
TOTAL	147(100)	

Table 4: Microbiological and Biochemical Characteristics of the Isolates from Mobile Phones of Selected Mechanics, Civil Servants, and Food Handlers

ISOLATE CODE	GRAM STAIN	MOTILITY	INDOLE	OXIDASE	UREASE	M-R	V-P	CATALASE	COAGULASE	T	S	I	A	MOST PROBABLE ORGANISM
										H_2S	Slope	Butt	Ga	
MECHANICS (M)	**GPC**	-						+	+					***Staphylococcus aureus***
	GPB	-	-	-	-	-	-	+		-	**R**	**R**	-	***Bacillus cereus***
	GPC	-						-	-					***Streptococcus* sp.**
	GNB	+	-	-	+	-	+	-		+	**R**	**Y**	+	***Proteus vulgaris***
	GNB	-	-	-	+	-	+	-		-	**Y**	**Y**	+	***Klebsiella* sp.**
CIVIL SERVANTS (CS)	**GPC**	-						+	+					***Staphylococcus aureus***
	GPB	-	-	-	-	-	-	+		-	**R**	**R**	-	***Bacillus cereus***
	GPC	-						-	-					***Streptococcus* sp.**
	GNB	-	-	-	+	-	+	-		-	**Y**	**Y**	+	***Klebsiella* sp.**
FOOD HANDLERS (FH)	**GPC**	-						+	+					***Staphylococcus aureus***
	GPB	-	-	-	-	-	-	+		-	**R**	**R**	-	***Bacillus cereus***
	GPC	-						-	-					***Streptococcus* sp.**
	GNB	-	-	-	+	-	+	-		-	**Y**	**Y**	+	***Klebsiella* sp.**

Table 5: Percentage Occurrence of the Antibiotic Sensitivity Pattern for Isolates Obtained

ANTIBIOTICS	SENSITIVITY PATTERN	PERCENTAGE OCCURRENCE (%)
GN	33	22.44
APX	9	6.12
Z	19	12.93
AM	7	4.76
RO	11	7.48
CPX	20	13.61
ST	11	7.48
SXT	17	11.56
ERY	0	0
PEF	20	13.61

KEY: GN = GENTAMICIN, CPX = CIPROXOLACIN, APX = AMPICLOX, ST = STREPTOMYCIN, Z = ZINNA\CEFUROXIME, SXT = SEPTRIN, AM = AMOXICILLIN, ERY = ERYTHROMYCIN, RO = ROCEPHIN, and PEF = PEFLOXACIN

Table 6: Overall Sensitivity Test

RESULT	MECHANIC	CIVIL SERVANT	FOODHANDLER
S	37	14	25
I	18	3	6
R	26	8	10

KEYWORDS: S = SENSITIVE (Drug killed the Bacteria), **I= INTERMEDIATE** (More concentration will kill the Bacteria), and **R= RESISTANT** (Did not kill the Bacteria)

4 Discussion

The study shows that Bacterial isolates detected on the mobile phone samples include; *Staphylococcus aureus*, *Bacillus cereus*, *Streptococcus* sp., *Klebsiella* sp., and *Proteus Vulgaris).* The research findings indicated that *Staphylococcus aureus*, *Bacillus cereus,* and *Streptococcus* sp. were the main bacterial isolates and most predominant microorganisms associated with mobile phone samples. These findings are in line with other similar reports [24-28] These organisms may probably have found their entry to their phone through the skin and hand-to-hand mechanism. This is because the isolates are a subset of the normal microbiota of the skin [29]. Mobile phones due to their personal nature and proximity to delicate parts of our bodies in usage such as faces, ears, lips, and hands of users, could become an important mode of transmission for pathogens that could result in infections [30-31]. Bacterial contamination was found on some mobile phones investigated in this study. In addition, it has been previously established that frequent contact with skin microbial flora and sustainable temperatures for bacterial growth attained on the device while in use provide a favorable environment for the growth of these microorganisms. Storage of Mobile phones in pockets, handbags and briefcases is likely to further encourage bacterial growth in warm and protected surroundings environment [32]. Frequent handling by many users of different hygiene profiles having regular skin contact with the phones may have resulted in the frequency and the degree of the population of the isolates. This has a lot of health implications.

Gram-positive cocci found on the mobile phone samples like *Staphylococcus aureus* and *Streptococcus* are opportunistic pathogens that are normal flora of the skin, glands, nose, nasopharynx, and gastrointestinal tract that can cause various infections in humans. *Staphylococcus aureus* is the most important Staphylococcal pathogen that causes boils, abscesses, wound infections, impetigo, toxic shock syndrome, Pneumonia, and meningitis which are not unlikely as corroborated by the high population of colonies even at low dilutions. *Proteus vulgaris* exist as members of the normal intestinal flora of humans, these organisms including *Alkaligenes feacalis* have been isolated from feces, and sewage. They can accidentally be transferred onto the skin through feacal contamination, inanimate or animate material for instances, due to improper hand washing after using the toilet. *Bacillus* sp. was commonly associated with Mobile phones in this study as the second most occurring isolate. This finding is explained by the ubiquitous nature of this organism in the environment, since it can survive harsh conditions being one of the few organisms that can sporulate and spread when met with sub-optimal conditions [33-35]. *Bacillus* spp. although generally considered to be of low virulence are known to be opportunist pathogens in patients predisposed to infections. Gentamycin and Peflozacin have the highest susceptibility respectively while Erythromycin and Amoxicillin revealed the least susceptibility pattern having percentage. This result concurs with findings of [36-39] showing that the variation in the susceptibility to commonly used antimicrobial was similar for mobile phones irrespective of their source. These results showed that, the presence of pathogenic microbes on mobile phones suggests that hands may be source of transmission and those mobile phones are gradually assuming the status of pathogenic agents.

5 Conclusion

The findings in this study have been able to show that personal items such as mobile phones are often colonized by microorganisms and serve as a potential source of infection. Users of mobile phones are found everywhere: in the market, the home, hospitals, and schools. This could help to spread infections in the community. Therefore, this indicated that isolates were associated with various strata of society. It is important to adopt handwashing practices and routine surface disinfection of personal items including mobile phones.

Ethical issue

Authors are aware of and comply with, best practices in publication ethics specifically about authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests, and compliance with policies on research ethics. Authors adhere to publication requirements that the submitted work is original and has not been published elsewhere in any language. Also, all procedures performed in studies involving human participants were following the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All procedures performed in this study involving animals were following the ethical standards of the institution or practice at which the studies were conducted.

Competing interests

The authors declare that no conflict of interest would prejudice the impartiality of this scientific work.

Authors' contribution

All authors of this study have a complete contribution to data collection, data analyses, and manuscript writing.

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