International Journal of Current Trends in
Pharmacobiology and Medical Sciences
Volume 1 • Number 2 (July-2016) • ISSN: 2456-2432
Journal homepage: www.ijctpms.com

Original Research Article

Microbiological Safety of Mobile Phones Used among Food Handlers and Health Care Workers in Jimma Town, Southwest Ethiopia

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Abstract

Mobile phones have become one of the most indispensable accessories of professional and social life. However, several researchers have indicated that the potential colonization of surfaces of mobile phones and their ability to transmit diseases (fomites). This study was designed to investigate the microbiological safety of mobile phones used among food handlers and health care workers in Jimma town, southwest Ethiopia. A total of 188 samples of mobile phones, 119 from health care workers and 69 from food handlers were sampled and analyzed for microbiological safety of various microbial groups. Flora analysis was conducted following standard microbiological methods. All sampled mobile phones (100%) were found to be contaminated with various microbial groups. Over 98.84% the mobile phone samples had aerobic mesophilic bacteria counts ≥ 6 Log CFU/cm^2. The microbial counts of Enterobacteraceae, staphylococci, aerobic bacteria spores (ABS) were ≥ 4 Log CFU/cm^2, respectively. All food handlers and 87.4% of health care workers mobile phones had mean coliform counts were ≥ 3 Log CFU/cm^2. The counts of yeasts and moulds ranged between 1.8 to 4.1 Log CFU/cm^2 and 1.8 to 3.6 Log CFU/cm^2 for food handlers and health care workers, respectively. There was statistical significance variation (p<0.05) between the mean counts of all microbes isolated from the mobile phone. The aerobic mesophilic flora isolates were dominated by Staphylococcus spp 454(33.88%), *Bacillus* spp. 330 (24.63%), *Micrococcus* pp 188 (14.03%), Enterobacteraceae 164 (12.24%), *Pseudomonas aeruginosa* 145 (10.82%), *Acinetobacter* spp. 36 (2.69%) and *Streptococcus* spp. 23(1.72%). It was concluded that mobile phones of food handlers and health care workers can spread potential infectious agents unless used with greater care. Personal hygiene and sanitation measures such as cleaning of work environment, frequent hand washing practice and phone decontamination should be adopted by mobile phone users in order to minimize the risk of mobile phone as vector for pathogen transmission.

Article Info

Accepted: 26 June 2016
Available Online: 25 July 2016

Keywords

Food handlers
Health care workers
Jimma town
Microbial safety
Mobile phones

Introduction

Mobile phones are portable electronic devices for personal telecommunication over long distance (Ekrakene and Igeleke, 2007). They are ordinary in the world of today and are convenient accessories taken for granted by most people. As a result, the mobile phone technology is highly growing throughout the world

(Tambekar et al., 2006). In the world in many countries, mobile phones now outnumber landline telephones with most people have their own mobile phones regardless of their age (Ekrakene and Igeleke, 2007).

Global mobile phone penetration is increasing rapidly, and at a faster rate in China, India and Africa, around 3.3 billion users (Reuters and Ridley, 2007).

Africa has the largest growth rate of cellular subscribers in the world (Aker and Mbiti, 2010). Today in the region mobile phone becomes a key social tool, and people rely on their mobile phone address book to keep in touch with their family and friends (Jacob, 2011).

Beyond all these and an other several benefits to mankind, mobile phones have been described to spread potential infectious agents within the community unless the out most care is taken (Karabay et al., 2007; Akinyemi et al., 2009; Kohler et al., 2011).The reason is due to their ubiquity nature, mobile phones can be used in animal slaughter areas, in dining rooms , in hospitals and in toilets where the microbial presence is assumed to be high (Atun and Sittampalam, 2006). In addition, they are also handheld frequently and held close to the mouth, ear, eye and nose where high microbial colonization is assumed to be found. The constant handling with heat generated by the mobile phones creates a prime breeding ground for microbes that are normally found on our skin (James, 2009).

Although microbes have so far been isolated by health researchers are mostly normal flora of the source of contamination, they can cause opportunistic infections (Singh et al., 1998).

The most common microbes isolated from mobile phones include *Micrococcus* spp., *Bacillus* spp., *S. aureus, Streptococcus viridians*, *Escherichia coli* and *P. aeruginosa, Aspergillus* species, *Candida* species, *Rhizopus* species and *Mucor* species (Golblatt et al., 2007; Yusha'u et al., 2010).

In Ethiopia, as in several areas of the world, mobile phone service has been increased dramatically (Adam, 2010). Several mobile phone borne outbreaks caused by pathogenic microorganisms have been reported from different regions of the world. Africa including Ethiopia might not be free from such a problem. However, reports from African are few Ekrakene and Igeleke (2007) with no report at all from Ethiopia. This may be due to lack of awareness on the role of mobile phones in spreading diseases. Hence, this study was designed to investigate the microbiological safety of mobile phones used among food handlers and health care workers in Jimma town, southwest Ethiopia.

Materials and methods

The study site and period

The study was conducted in Jimma town which is located at 353 km southwest of Addis Ababa, Ethiopia. The Geographical locations of the town are $7^{o}41'$N latitude, $36^{o}50'$E longitude. The town is generally characterized by warm weather condition with mean annual maximum and minimum temperatures of 30°C and 14°C, respectively (Alemu et al., 2011). The study was conducted from January 2014 to October 2015.

Study design and population

A cross sectional study design was used in this study. A total of 188 mobile phone samples, 119 from health care workers in Jimma town different health care centers and 69 from food handler in Jimma town selected hotels were taken as the study population. The selection of study population participants was based on using purposive sampling technique.

Sample collection

A total of 188 mobile phone cotton swab samples were collected from food handlers and health care workers in Jimma town, Southwest Ethiopia between January 2014 and October 2015. The sampled mobile phones were aseptically swabbed using sterile cotton moistened with normal saline solution by rolling it over exposed outer surface of the mobile phones. The cotton swabs were socked into10 ml sterile normal saline and kept in ice box and transported to Research and Postgraduate Laboratory, Department of Biology, College of Natural Sciences, Jimma University for microbiological analysis. The microbiological analysis was done after two-three hours of sample collection following standard microbiological methods.

Inoculation and enumeration

One ml of each mobile phone swab samples was transferred aseptically into 9 ml of buffered peptone water (BPW), and vortex mixed thoroughly for five

minutes. The homogenates were serially diluted from 10^{-1} to 10^{-6} and a volume of 0.1 ml aliquot of appropriate dilution was spread-plated on pre-solidified plates of Plat count agar (PCA), Mannitol salt agar (MSA), Violet red bile agar (VRBA), MacConkey agar (MaCA) and Potato dextrose agar (PDA). All the inoculated plates were incubated at 37^{o}C for 24-48 hours for aerobic mesophilic bacterial count and incubated at 25^{o}C for 3-5 days for fungal count. From countable plates, 30-300 colonies were counted and expressed in colony forming units per square centimeter (CFU cm^{-2}). The colony counts were converted to $_{10}$logCFU cm^{-2}.

Isolation of microbes

The microbial colonies were isolated from countable plates after their growth based on their morphological differences and purified by repeated plating on respective media and incubated at the appropriate temperature and time and preserved for further identification.

Identification of microbes

The isolated bacteria were identified morphologically and biochemically using John (2012) bacteriological classification manual. The fungi isolates were identified based on appearance, mycelia, spores and colour according to Carpenters Microbiology.

Statistical analysis

The Percentage of Coefficient of variation (% CV) was calculated to determine if there is significant variation in counts within microbes isolated and analyzed from mobile phone samples. Data entry and analysis were done by using SPSS for windows version 16.0 (SPSS Inc, Chicago, IL, USA). Accordingly, mean microbial values of mobile phone samples from two sampled population groups were compared using one way ANOVA and students T-test. In all cases the significance level was considered at $p<0.05$ (95% confidence interval).

Ethical consideration

Ethical permission was obtained from Research Review and Ethical Committee of College of Natural Sciences, Jimma University. Respondents and concerned officials were informed about the purpose of the study. The consent was obtained from mobile phone users prior to sample collection.

Results

Analysis of participants questionnaire response has shown that, 92 (92%) of food handlers have no idea on how mobile phones could contaminate foods whereas, only 8 (8%) had reported that, mobile phones could contaminate foods through human hands contact. Over 87.0 % of food handlers were stated that, they have responding phone calls while handling ready to eat foods. On other hand, 104(86.7%) of health care worker mobile phone users had stated that, they have no practice of washing hands after using mobile phones, whereas 101 (84.16%) was found using mobile phones in the health care centers and 103(85.8%) have no the habit of cleaning mobile phones.

Table 1. Mean microbial counts (log CFU/cm^2) of mobile phone samples of food handlers and health care workers, Jimma town, Southwest Ethiopia.

Microbes	Sample source								Total mean	*p*- value
	Food handlers				Health care workers					
	Mean ± SD	%CV	Min	Max	Mean ± SD	%CV	Min	Max		
AMB	7.06 ± 0.41	5.75	6.10	7.50	6.67 ± 0.52	7.85	5.40	7.30	6.87	0.000
Coliform	3.92 ± 0.19	4.79	3.50	4.20	3.79 ± 0.23	6.06	3.00	4.00	3.86	0.000
Entero	4.64 ± 0.38	8.23	4.00	5.30	4.29 ± 0.38	8.89	3.80	4.70	4.47	0.000
ABS	4.56 ± 0.11	2. 41	5.40	5.80	4.28 ± 0.18	4.21	4.80	5.60	4.42	0.000
Staph	4.45 ± 0.42	9.44	4.20	6.00	5.13 ± 0.16	3.12	5.80	6.40	4.79	0.000
Yeasts	3.77 ± 0.25	6.51	3.30	4.10	2.99 ± 0.38	12.61	1.80	3.80	3.38	0.000
Moulds	2.86 ± 0.26	9.17	2.10	3.20	2.69 ± 0.33	12.36	1.80	3.30	2.78	0.001

Where: AMB= Aerobic Mesophilic Bacteria; Entero= Enterobacteriaceae; ABS= Aerobic Bacteria Spore; SD= Standard Deviation; Min= Minimum; Max= Maximum

Microbial counts of mobile phones

All the sampled mobile phones (100%) were found to be contaminated with various microbial groups. Over 98.84% of the mobile phone samples had aerobic mesophilic bacteria counts ≥6 log CFU/cm^2. The microbial mean counts of Enterobacteriaceae, staphylococci, aerobic bacteria spores (ABS) were ≥4 log CFU/cm^2, respectively. All food handlers and 87.4% of health care workers mobile phones had mean coliform counts were ≥3 log CFU/cm^2. The counts of yeasts and moulds ranged between 1.8 to 4.1 Log CFU/cm^2 and 1.8 to 3.6 log CFU/cm^2 for food handlers and health care workers, respectively (Table 1). There was statistical significance variation (p<0.05) between the mean counts of all microbes isolated from the mobile phone samples. Generally, 1340 aerobic mesophilic bacteria were isolated from the sampled mobile phones besides the fungal isolates. The isolates were dominated by *Staphylococcus* spp. 454 (33.88%), *Bacillus* spp. 330 (24.63%), *Micrococcus* spp. 188 (14.03%), *Enterobacteraceae* 164 (12.24%), *Pseudomonas aeruginosa* 145 (10.82%), *Acinetobacter* spp. 36 (2.69) and *Streptococcus* spp. 23 (1.72%).

Discussion

Analysis of questionnaire of health care workers has shown that, 104 (86.7%) had no practice of washing hands after using mobile phones, while 101 (84.16%) were found using the device in the health care centers with 103 (85.8%) having no habit of cleaning mobile phones. This is in line with the earlier study by Jagadeesan et al. (2013) from India where 85% of mobile phone users sampled had no the habit of cleaning their mobile phones. Therefore, the device may serve as substrate for multiplication of various microorganisms. One study by Jayalakshmi et al. (2008) reported that the use of 70% isopropyl alcohol to be effective as a disinfectant.

On other hand, 92(92%) of food handlers had no idea on how mobile phones could contaminate foods while about 8(8%) were stated that, they have been responding phone calls while handling foods. According to Ohiokpehai (2003) and Mensah et al. (2002), some food handlers may introduce biological hazards by cross contamination after handling raw materials when they suffer from specific diseases and physical hazards by careless food handling practices. Thus, food handlers play an important role in ensuring food safety throughout the chain of food production, processing, storage and preparation (WHO, 1989).

Similarly, Akinyemi et al. (2009) in Nigeria isolated various pathogenic microorganisms from food handlers' mobile phones. Therefore, food handlers should have the necessary knowledge and skills to handle foods hygienically with great care (FAO, 1998).

The high microbial counts in this study in food handlers mobile phones is in agreement with the earlier study by Ilusanya et al. (2012) made in Nigeria where high level of microbial contamination in food venders and marketers mobile phones encountered. This may be accounted to the low education level, hygienic problem and lack of awareness to the contamination of mobile phones among the users.

A total of 1340 aerobic mesophilic flora were isolated in the presents study. The isolates were dominated by *Staphylococcus* spp 454(33.88%), *Bacillus* spp 330 (24.63%), *Micrococcus* pp 188 (14.03%), *Enterobacteraceae* 164 (12.24%), *Pseudomonas auerginosa* 145(10.82%), *Acinetobacter* spp. 36(2.69) and *Streptococcus* spp 23(1.72%). This result is higher than the reports from India (Tambe and Pai, 2012; Jagadeesan et al., 2013) and (Al-Abadalall, 2010) Saudi Arabia. However, the profile of microbes isolated in this study was similar to the reports elsewhere (Sepehri et al., 2009; Singh et al., 2010). Thus, mobile phones are ideal breeding sites for microbes as they are kept warm in the pockets and handbags (Braddy et al., 2006; Jeske et al., 2007).

Staphylococcus spp. is the predominant isolate in the present study, which made up 33.88% of the entire isolates. This high occurrence of *Staphylococcus* spp. in the mobile phones may be due to its resistance to drying which favours its transmission and its presence as part of the normal flora of the nose, mouth and skin of human being. The organism is constantly disseminated from these body sites during talking, breathing and even exercising (Gandara et al., 2006). Its transmission from these sites causes both endemic and epidemic diseases (Cruickshank et al., 1973).

Thus, staphylococcal infection can be transmitted through handling of mobile phones contaminated with staphylococcal (Ekrakene and Igeleke, 2007). The organism causes illnesses ranging from pimples and boils to pneumonia and meningitis. *Bacillus* spp. which

is known to be free-living in the soil, atmosphere and water (Huys et al., 2005). About 24.63% of the entire mobile phone samples in the present study were positive for the presence of *Bacillus* spp. The high isolation of *Bacillus* spp. from mobile phones confirms the ubiquitous nature of the *Bacillus* spp. giving it greater colonization ability as well as the ability of its spores to resist environmental changes, withstand dry heat and certain chemical disinfectants for moderate periods (Brooks et al., 2007). *Bacillus subtilis* has been identified as an important organism in food spoilage, whereas *Bacillus cereus* can cause food poisoning and opportunistic infections in immuno compromised persons (Jay, 2000).

Streptococcus spp. was one of the isolates among gram positives in the present study which is commonly found in the oral and nasal passages of the human being. Infections that are caused by this organism include pneumonia, meningitis, endocarditis, otitis, bronchitis, bacteraemia and sinusitis (Salle, 1985).

Micrococcus spp. is the bacterium that causes micrococcal infections associated with that of *Staphylococcus* spp. About 14.03% of the mobile phone samples assessed in the present study were contaminated with *Micrococcus* spp. This result is in line with the earlier report Ilusanya et al. (2012) evaluated in Nigeria.

Pseudomonas auerginosa was one of the predominant gram-negative bacteria in the present study. About 10.80% of the mobile phone samples were positive for *Pseudomonas auerginosa*. The current prevalence of *Pseudomona* species in mobile phones is in agreement with the result reported from Saudi Arabia (Al-Abdalall, 2010). *Acinetobacter* spp. was commonest isolate among Gram-negatives in this study. In agreement with this Borer et al. (2005) from Israel has reported *Acinetobacter* spp. to be the predominant isolate recovered from mobile phones. This is because the bacterium has resistant to drying and can survive for weeks and multiply rapidly in warm environment (Smith et al., 1996). About 2.68% of the mobile phone samples in this study were found contaminated with *Acinetobacter* spp. The reason for the persistence of this pathogen in mobile phones is, due to its ability to form biofilm on inanimate surfaces (Beggs et al., 2006; Christin and Luis, 2011). Therefore, it requires strong controlling system of the personal hygiene and educating food handlers and health care workers regarding microbial contamination of mobile phones.

In conclusion, mobile phones can act as vehicles for spread of potential pathogens within the community. Regular hand washing prior to attending patients and handling foods, decontamination of mobile phones with alcohol disinfectant wipes should be done to prevent mobile phone related infections.

Conflict of interest statement

Authors declare that they have no conflict of interest.

Acknowledgement

The authors would like to acknowledge Jimma University for funding this research. Also heartfelt thanks go to mobile phone user health care workers and food handlers in Jimma town for their willing to participate in the study.

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How to cite this article:
Shamebo, T., Bacha, K., Ketema, T., 2016. Microbiological safety of mobile phones used among food handlers and health care workers in Jimma Town, Southwest Ethiopia. Int. J. Curr. Trend. Pharmacobiol. Med. Sci. 1(2), 13-18.