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A Study on Mobile Phone Cleaning Practices and Knowledge of Microbial Contaminants

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Abstract

In today's fast-moving and globalised world, it is almost impossible to imagine everyday life without mobile-phones. However, it is also one of the filthiest things one can come in contact with on a daily basis. This study is aimed to assess the knowledge of microbial contaminants of mobile phone among undergraduate students and students' habits of phone use along with practices of phone cleaning. A cross sectional study was conducted from May 2020 to June 2020 in Melaka Manipal Medical College. A population size of 1100 was selected. The questionnaire consisting of five parts, including sociodemographic data, habits of phone use, mobile phone cleaning practices, knowledge of microbial contamination of mobile phones and the spread of COVID 19 through mobile phone was taken from previous studies and was then distributed online via google form. Data analysis consists of frequency tables, percentages and mean with standard deviation. Statistical tests (Chi-square test) was done using Epi Info Software (version 7.2.2.6). Level of significance was set at $p<0.05$ and odds ratios were calculated. Among the 214 participants in the study, the total mean score of the knowledge of microbial contamination of mobile phones of the participants was 42.27% where 10.75% of the students have good knowledge, 19.16% have moderate knowledge and 70.09% have poor knowledge. A total of 167 (78.04%) students cleaned their mobile phones and 210 (93.34%) students were aware that regular cleaning of phones was necessary. In our study, it was found that there were no significant associations between gender, ethnicity and knowledge levels in regards to cleaning practices. However, a noticeable difference was that students with high level of knowledge and moderate level of knowledge were 2.15 and 1.09 times more likely to clean their phones compared to those with low level of knowledge.

Keywords

Mobile Phone Contamination, Knowledge, Cleaning, Undergraduate Students

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1. Introduction

In this modern era, the healthcare system has been benefited greatly by technology through the development of more advanced methods in diagnosing and treating patients and this has decreased morbidity and mortality of the population. The rapid advancement in technology has also led to improvement of communication devices such as computers, mobile phones, tablets and more. [1-3] In Europe, the global system for mobile telecommunication was established in 1983 whereas in Malaysia the first wireless telephone system was introduced by Jabatan Telekom Malaysia and now up to 85% of Malaysians are reported to owning their own mobile phones. [4, 5] All across the world, mobile phones have become the dominant mode of communication. Mobile phones have now become a necessity and are owned by most adults and children. [6] Mobile phones are taken everywhere, in bed, in the washroom, at the gym, in restaurants, in hospitals, even to funerals. They are even passed one person to another, coming in contact with ears, mouths and hands and are passed back. People visit the most infectious places

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with phones and yet most of them do not disinfect their phones.

Roughly 25,000 germs inhabit each square inch of a mobile phone, making it one of the filthiest things one can come in contact with on a daily basis. Studies have shown that phones have more pathogenic bacteria than even toilet seats due to regular disinfection of toilet seats. [7, 8] They are indeed carriers of microorganisms and might be involved in transmitting the majority of infectious diseases without anyone being aware. Common illnesses like flu, diarrhea and infections of the eye can be transmitted by mobile phones. Extremely resistant and dangerous bacteria like MRSA (Methicillin Resistant Staphylococcus Aureus) and viruses like influenza virus have been found on phones by some studies. [9, 10] In the recent coronavirus pandemic, fomites such as tables, doorknobs and handrails can transmit infection through contact so its plausible that mobile phones too can play a role in its transmission.

In hospital settings, mobile phone sharing is a common practice amongst health care professionals. Health care professionals then shuffle between patients, often without prior sanitizing. While mobile phones allow the timely communication between caregivers, sharing mobile devices if not properly disinfected can also lead to the spread of Healthcare-Associated Infections (HAIs) to patients and they can fall even more ill by the hands of their own saviours. [11] Health care workers may also acquire these infections themselves. Previous studies of bacterial contamination of mobile phones showed 91% of phones in a teaching hospital in Turkey and one fifth of phones in New York were found to harbour pathogenic microorganisms. [13, 14] In a study done on 32 Health Care Workers (HCW), the rate of bacterial contamination of HCWs' hands increased to 93.7% after the use of a mobile phone. The bacteria isolated from HCW's hands were Klebsiella pneumonia, coagulase negative Staphylococcus and Bacillus anthropoid. A few isolates of Staphylococcus were methicillin resistant and some of the gram-negative bacteria were even found to be multi drug resistant. [11] In another study, antimicrobial susceptibility results indicated that most of the coagulase-negative isolates were resistant to benzylpenicillin, erythromycin and fusidic acid, with intermediate resistance to rifampicin. Resistance to oxacillin was observed in S. epidermidis (30%), S. hominis (22.2%), S. warneri (100%), and S. lentus (100%) proving that mobile phones can even transmit multidrug resistant bacteria. [12]

In contrast to bacterial contamination, evidence of viral contamination of mobile phones are limited. Epidemic viruses such as influenza viruses, rotavirus (RV) and norovirus (NV) have been shown to adhere and contaminate inert surfaces and medical devices close to the patients' environment. [15, 17] NV and RV were seen to be able to survive for weeks, even months, on surfaces and in the hospital environment. [16, 18-21] Contamination of hospital surfaces may therefore cause nosocomial epidemics. [16, 18] Respiratory viruses such as corona, coxsackie, influenza, SARS or rhino virus have been shown to persist on surfaces for a few days, with a potential role in nosocomial transmission, as emphasized during the severe acute respiratory syndrome epidemic of 2003. [19, 22, 23] The reports on fungal contamination of mobile phones and the hands of their owners are still sparsely available in medical literature. [24] Özkan and Sülün examined 50 mobile phones used by Health Services Vocational School students and a total of 24 different microfungal species belonging to Alternaria, Aspergillus, Cladosporium, Geotrichum, Penicillium, Phoma, Rhinocladiella, Scopulariopsis, Trichoderma, and Trichophyton genera were obtained. [25]

The World Health Organization (WHO) declared COVID-19 a pandemic on 11 March 2020. Population densities and intensity of social contacts are the main transmission cause of this novel respiratory virus SARS-CoV-2. [26] In response, the government enforced movement control order under the Prevention and Control of Infectious Disease Act 1988 and the Police Act 1967 as a mitigation strategy to prevent COVID-19 starting from 18 March. As of 24th of May, Malaysia has achieved the number of 7245 positive cases of COVID-19.

COVID-19 is primarily spread from person to person through small droplets from the nose or mouth, which are expelled when a person with COVID-19 coughs, sneezes, or speaks. These droplets can land on objects and surfaces around the person such as tables, doorknobs and handrails. [27] People can become infected by touching the infected objects or surfaces, then touching their eyes, nose or mouth. Current evidence suggests that SARS-CoV-2 may remain viable for hours to days on surfaces made from a variety of materials. [28] Droplets of SARS-CoV-2, which causes the disease COVID-19, can be spread and live in the air for up to 3 hours, and be disseminated to hard surface areas where they can live up to 3 to 4 days. [29] Mobile phones are one of the most highly touched surfaces according to the Centers for Disease Control and Prevention (CDC). [30] Since mobile phone surfaces are considered as a peculiar 'high-risk' surface, which means it can directly come in contact with the face or mouth, while talking over phone, even if hands are properly washed and clean. Mobile phones are neither disposable nor washable, so mobile phones can effectively negate hand hygiene. Two of the biggest and well-known mobile phone companies (Apple and Samsung) do not recommend any chemical or spray to clean the mobile phone screen prior to covid-19. [31, 32] However, in the ongoing pandemic of covid-19, both Apple and Samsung companies have revised their user support

guidelines, saying that 70% isopropyl alcohol or Clorox Disinfecting Wipes can be used to gently wipe and clean the exterior surface of phones in switched-off mode.

The researchers from Hospital Wuhan, China, found that although the intensive care units were good at containing the spread of the virus outside of the patients' rooms, a high concentration of the virus were found in the air samples taken from the patients' toilets. Acknowledging that many people take their mobile phones with them into the bathroom, it's safe to assume that due to the aerosolization effect that occurs in toilets, micro-droplets can be inhaled or may persist on surface areas like mobile phones. [33] Studies show growing evidence of mobile phones acting as a vector for pathogenic microorganisms and that medical students are at greater risk of contamination of mobile phones than other hospital staff. [34] Mobile phones are mostly made of aluminium for the body and glass for the screen whereas phone cases are usually made of polycarbonate, a type of plastic. The study shows that Severe Acute Respiratory Syndrome-coronavirus (Sars-Cov) persists at room temperature for 4 days. [35] The study also identified the best biocidal agent against coronavirus. Ethanol (62% and 71%) reduced coronavirus infectivity by 2.0–4.0 log10 while 0.1–0.5% sodium hypochlorite and 2% glutardialdehyde were also effective, reducing viral titre by > 3.0 log10. However, 0.04% benzalkonium chloride, 0.06% sodium hypochlorite and 0.55% ortho-phtalaldehyde had less effect. [35] A similar effect is expected of the novel coronavirus (SARS-CoV 2).

Previous literature explained the habits of phone use and cleaning, and the factors influenced these habits. One of the factors is age group. A survey carried out in Malaysia demonstrated that the highest mobile phone users are from the young age group as for social networking and gaming purposes mainly. In regard to gender, males usually keep their phones in their pant or shirt pockets whereas females usually carry their phones in their handbags. The contamination level in front bottom pocket is higher since we tend to place more things there, such as keys, sweet wrappers, handkerchiefs etc., and also handbags for the women, where the phone is kept with cosmetics, combs, creams and tissues. [36] Moreover the duration of time spent on one's mobile phone may also lead to increase levels of microbial contamination. A survey amongst students of University Putra Malaysia revealed that the average duration of mobile phone use in a day was 353.36 minutes or 5.89 hours. [37] Furthermore the use of mobile phones in the washroom or during dining may also contribute to the growth of microorganisms on mobile phone. A study conducted at UMKJC showed that over 20% of the respondents took their cell phones with them to the washroom. [38] Contamination of cell phones by faecal bacteria is common, especially in the washroom. [39] As for cell phone use during dining, 67% responded that they did use their cell phone while dining. This increase chances of microbial growth on cell phones as dining tables and menu cards are the main breeding areas for microbes. [38] Regarding the use of touchscreen or keypad mobile phones, a study in 2011 amongst healthcare professionals found that the median colony count for touchscreen phones and keypad devices was 0.09 colony forming units (cfu)/cm^2 (interquartile range (IQR) 0.05–0.14) and 0.77 cfu/cm^2 (IQR range 0.45–3.52) respectively. Colony counts were significantly higher on the keypad phones and could be due to contact surface which is irregular and uneven allowing harbouring of bacteria. [40] A study carried out at King Abdulaziz University, Jeddah, Saudi Arabia indicated that decontamination with 70% alcohol significantly decreased the rate of contamination from 100 to 47.6%. [41]

In depth, the basic knowledge of the microbes and microbial contamination and its role in prevention are often overviewed. Many are not aware of the different types of germs and microbes. Less than 50% of participants know few commonly contaminated microbes through air, water and food such as E. coli, s. aureus, etc. About 56% of people answered that E. coli, S. aureus, Streptococcus and E. faecalis are expected on mobile phone when asked this question while 15% of people did not know which organisms are expected on mobile phone. [36] A study was conducted on the inpatients of surgical/urological wards of the Western General Hospital where 70.3% respondents were aware that phones could harbour harmful bacteria, but had not received advice from healthcare providers to mobile phone users on cleaning or decontamination of mobile phones, before, during or after admission to hospital. In addition, whilst a majority of patients are aware that mobile phones can harbour bacteria, a minority of patients actually attempt decontamination of their phones. [42] Another study conducted on 250 nursing staffs from different ICUs of MMIMSR, Mullana, Ambala showed that 95.2% of nursing staff are aware of mobile phones acting as fomites. [43] Amongst university staff and students, 45.74% were aware the risk of microbial transmission to others through the contaminated mobile phones but 30 participants admitted not knowing about the risk of transmission of contamination in a study conducted in 2017. Furthermore, 31.92% of participants were aware about the bacteria as one of the contaminants and followed by 27.66% who knew that fungi were also involved in the contamination in mobile phones. Few (4.26%) also knew about the possibility of virus contamination in mobile phones. [44]

Knowledge of microbial contaminants of mobile phone has been evaluated previously in undergraduate students in other countries but has yet to be done in Malaysia. [25, 44, 45]

The objectives of conducting this research study is to assess the knowledge of microbial contaminants of mobile phone among undergraduate students in Melaka Manipal Medical College's Muar and Melaka campus in Malaysia and students' habits of phone use along with practices of phone cleaning. The research hypothesis for this study are habits of phone use and cleaning is different among undergraduate students in MMMC in aspects of age, gender, ethnicity, programme, and knowledge on expected microbial contamination on mobile phones. Increased knowledge of microbial contamination of mobile phone encourages better and more frequent cleaning practices and habits of mobile phone use.

2. Methodology

2.1. Study Design, Setting, Time and Population

A cross sectional study was conducted from May 2020 to June 2020 in Melaka Manipal Medical College, Muar campuses, Johor and Melaka campus, Melaka in Malaysia. Melaka Manipal Medical College is a private medical college with two campuses; one based in Muar, Johor and the other in Bukit Baru, Melaka. In Manipal's Muar campus, Bachelor of medicine and surgery (MBBS) semester 6 and 7 are offered meanwhile Manipal' Melaka campus offers MBBS semester 8, 9 and 10, Bachelor of Dental Surgery (BDS) and Foundation in science (FIS).

2.2. Sample Size

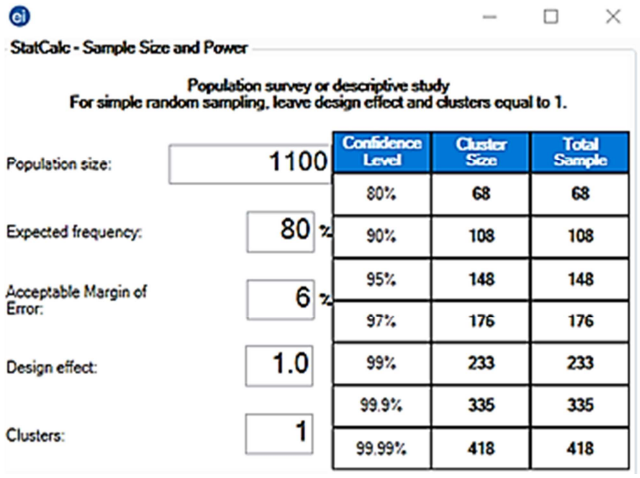

Figure 1. Sample Size Collection.

Based on a study done in Sarawak General Hospital, Sarawak, Malaysia among 50 healthcare workers from orthopaedic wards, it was found that 80% of health care workers clean their mobile phones while 20% do not. [47] Based on the application software 'Epi info' version 7.2.3.1 with our population size 1100, expected frequency 80% and precision error of 6.0%, and with a confidence level of 95% we conclude that our sample size is 148.

Upon calculating the sample size (n), we then chose to allow non-response of 30% and calculation is as below:

$$n_{final} = n_{calculated} / 1 - \text{non response}\%$$

$$= 148 / 1 - 0.3$$

$$= 211$$

Therefore, our final sample size is 211.

2.3. Sampling Method

Purposive sampling was used to select participants from MBBS, BDS and FIS students of MMMC. It is a non-probability sampling method. The inclusion criteria were undergraduate students in MMMC's Muar or Melaka campus, those who were willing to participate, owns a mobile phone, and completed questionnaires. The exclusion criteria included incomplete questionnaires, not providing informed consent or those unwilling to participate.

2.4. Data Collection

The questionnaire was taken from previous studies. [36, 38, 46] It was then distributed online via google forms to MBBS, BDS and FIS students of MMMC's Muar and Melaka campus. The questionnaire consists of five parts. The first part includes sociodemographic data where participants had to fill up their age, gender, ethnicity and programme. The second part was habits of phone use; the type of phone they use, area where phone is kept, habits of using phones in bathroom, when dining and when in bed. The third part consists of mobile phone cleaning practices including close ended questions if participants cleaned their phones and phone covers as well as multiple choice question to assess frequency and method of cleaning. The next part was knowledge of microbial contamination of mobile phones where participants were given a list of microorganisms and had to answer true, false or unsure of its ability to contaminate mobile phones, a multiple choice question on the most common source of contamination and a closed ended questions about participants opinion regarding microbial contamination of mobile phones and hospital acquired infections. The last part was the spread of COVID 19 through mobile phone where participants were asked if coronavirus could be transmitted through mobile phones, its life span and participants sneezing and coughing habits when using mobile phones. In this study, the independent variables include gender, ethnicity, programme and knowledge of microbial contamination expected on phone whilst the dependent variables are cleaning of mobile phones (method and frequency) and phone cover, areas used to keep mobile phones, use of mobile phones in washroom, use of mobile

phones when dining, habit of keeping mobile phone at bed and use of phone cover.

2.5. Data Processing and Data Analysis

The data collected from the distributed questionnaires were processed with Microsoft Excel 2016. Level of knowledge of microbial contamination of mobile phones was categorized into high, moderate and low. For the questions related to knowledge, each correct answer was given a score of 1 and incorrect answers or 'unsure' response was given a score of 0. The score was converted into percentage. Knowledge score of more than 80% which corresponds to raw score of 12 was categorized as high. Scores in between 60 to 80% corresponding to raw score of 9 to 12 were considered as moderate level of knowledge. Scores of less than 60% corresponding to raw score of 9 were categorized as low. All the processed data were analyzed by using Epi Info version 7.2.3.1 from the Centers for Disease Control and Prevention website (CDC). Frequency and percentage of qualitative variables (gender, ethnicity, programme, cleaning of mobile phones, frequency of phone cleaning, method of phone cleaning, areas used to keep mobile phones, use of mobile phones in washroom, use of mobile phones when dining, habit of keeping mobile phone at bed and use of phone cover) were calculated. For quantitative data (age and knowledge), the range, mean along with standard deviation was calculated.

Following statistical test was used in our study:

Table 1. Independent and dependent variables with statistical tests.

Independent variable	Dependent variable	Statistical test
Gender	Phone cover cleaning Phone screen and back cleaning	Chi square test
Ethnicity	Phone cover cleaning Phone screen and back cleaning	Chi square test
Programme	Phone cover cleaning Phone screen and back cleaning	Chi square test
Knowledge	Phone cover cleaning Phone screen and back cleaning	Chi square test

Odds ratio was used to determine the association between independent and dependent variables. We set the level of significant at 5% which is 0.05.

2.6. Ethical Consideration

Participants of our study was strictly voluntary. They were able to withdraw at any time without any reason. All information obtained was anonymous and confidentiality was maintained by omitting participants roll number in the publication. Besides, the research was conducted ethically by obtaining approval from the Research Ethics Committee, Faculty of Medicine of Melaka Manipal Medical College, Malaysia.

3. Results

Table 2. Sociodemographic characteristics of undergraduate students (n=214).

Variables	Frequency (%)
Age	
<22	60 (28.04)
22-25	152 (71.03)
>25	2 (0.93)
Mean (SD)	22 (2.1)
Min-Max	16-26
Gender	
Male	63 (29.44)
Female	151 (70.56)
Ethnicity	
Malay	25 (11.68)
Chinese	85 (39.72)
Indian	80 (37.38)
Others	24 (11.21)
Programme	
MBBS	114 (53.27)
BDS	57 (26.64)
FIS	43 (20.09)

Table 2 illustrates the sociodemographic characteristics of undergraduate students in MMMC. A majority of the students are between 22-25 years of age (71.03%), while the mean age of participants is 22.0 years. Most of the respondents were female (70.56%) leaving only 63 (29.44%) male respondents. In terms of ethnicity, the predominant ethnic group are Chinese (39.72%) followed by Indians (37.38%), Malays (11.68%) and others (11.21%). In terms of the programmes taken by the participants, 114 (53.27%) are MBBS students, 57 (26.64%) are BDS students and 43 (20.09%) are FIS students.

Table 3. Habits of phone use among undergraduate students of MMMC (n=214).

Variables	Frequency (%)
Type of phone used	
Touchscreen	213 (99.53)
Keypad	1 (0.47)
Location of keeping phone	
Front bottom pocket	85 (58.41)
Handbag	70 (32.71)
Back pocket	40 (18.69)
Upper pocket	17 (7.94)
Handphone sack	2 (0.93)
Habit of using phone in washroom	
Yes	135 (63.08)
No	79 (36.92)
Reasons of using phone in washroom	
Browsing	100 (46.74)
Texting	89 (41.59)
Playing games	68 (31.78)
Listening to music	64 (29.91)
Answering calls	39 (18.22)
Taking picture	15 (7.01)
All of above	6 (2.80)
Not applicable	16 (7.48)
Habit of using phone when dinning	
Yes	126 (58.88)
No	88 (41.12)

Variables	Frequency (%)
Reasons of using phone when dinning	
Browsing	75 (35.05)
Texting	68 (31.78)
Taking picture	51 (23.83)
Answering calls	46 (21.50)
Listening to music	22 (10.28)
Playing games	17 (7.945)
All of above	6 (2.80)
Not applicable	93 (43.46)
Habit of sleeping with mobile phone	
Yes	186 (86.92)
No	28 (13.08)

Table 3 sums up the mobile phone use habits of the undergraduate students of MMMC. Almost all of the students use touchscreen smartphones (99.53%). Mobile phones are kept in a variety of places while the students are on the move, either in a bag or on their person. 85 (58.41%) students keep their phones in the bottom front pant/trouser/jeans pocket, 70 (32.71%) students store it in their handbag, 40 (18.69%) keep their mobile phone in back pocket of their pant/trouser/jeans, 17 (7.94%) students keep their phone in the upper shirt/blouse/coat pocket and 2 (0.93%) store their phone in a handphone sack. The data on usage habits indicates that a majority of the students use their mobile phones in the washroom (63.08%) while 126 (58.88%) use the phone when dinning with 186 (88.92%) students admitting to sleeping with their mobile phone right next to them. In the washroom, majority of the students (46.73%) used their phone for browsing followed by 89 students (41.59%) for texting, 68 (31.78%) students for playing mobile phone games, 64 (29.91%) students for listening to music, 39 (18.22%) students for answering calls and 15 (7.01%) students for taking pictures in the washroom. Similarly when dining, most of the students use their phone for browsing (35.05%), 68 (31.78%) students for texting, 51 (23.83%) students for taking picture, 46 (21.50%) students for answering calls, 22 (10.28%) students for listening to music and 17 (7.94%) for playing games on mobile phone.

Table 4. Mobile phone cleaning practices among undergraduate students of MMMC (n=214).

Variables	Frequency (%)
Use of Phone cover	
Yes (Closed cover)	116 (54.21)
Yes (Perforated cover)	80 (37.38)
No	18 (8.41)
Clean Phone Cover	
Yes	167 (78.04)
No	47 (21.96)
Regularity of cleaning phone cover	
Occasionally	136 (63.55)
Once a week	33 (15.42)
Once a day	11 (5.14)
More than once a day	24 (11.21)
Never	10 (4.67)
Method of cleaning phone cover	
By rubbing with the cloth	20 (9.35)
Not applicable	23 (10.75)
Using a sterile alcohol swab	50 (23.36)
Using a wet tissue	87 (40.65)
Using handkerchief or tissue paper	34 (15.89)
Clean Phone (Screen and Back)	
Yes	197 (92.06)
No	17 (7.94)
Regularity of cleaning phone (Screen and Back)	
Occasionally	130 (60.75)
Once a week	37 (17.29)
Once a day	26 (12.15)
More than once a day	14 (6.54)
Never	7 (3.27)
Method of cleaning phone (Screen and Back)	
By rubbing with the cloth	33 (15.42)
Not applicable	8 (3.74)
Using a sterile alcohol swab	54 (25.23)
Using a wet tissue	79 (36.92)
Using handkerchief or tissue paper	40 (18.69)
Proper method of cleaning phone	
Antimicrobial spray	110 (51.40)
Sterile solution	75 (35.05)
Taking to the shop	22 (10.28)
Detergent	7 (3.27)
Do u think regularly disinfecting your phone is necessary?	

Variables	Frequency (%)
Yes	201 (93.93)
No	7 (3.27)
Unsure	6 (2.80)

Table 4 shows detailed data on mobile phone and phone cover cleaning practices amongst undergraduate students. Data on the use of phone covers shows that, 116 (54.21%) participants used closed phone cover, 80 (37.38%) students used perforated phone cover and the remaining 18 (8.41%) students do not use a phone cover. With respect to the habit of cleaning mobile phone cover, most students do this (78.04%) but in terms of cleaning frequency, only 10 (4.67%) students cleaned their phone cover more than once a day while 130 (60.75%) students cleaned their phone cover occasionally. A variety of cleaning practices were used by students ranging from use of wet tissue to sterile alcohol swabs. The predominant method was using a wet tissue (40.65%), followed by use of sterile alcohol swab (23.36%), handkerchief or tissue paper (15.89%) and rubbing with a clean cloth (9.35%). As to cleaning the mobile phone itself, 197 (92.06%) students cleaned their phones (screen and back) with most cleaning their phones occasionally (60.75%). Cleaning practices used were similar to that adopted for cleaning the phone cover. These included the use of a clean cloth (15.42%), sterile alcohol swab (25.23%), wet tissue (36.92%) and handkerchief or tissue paper (18.69). When participants were asked on the proper method of cleaning mobile phones, 110 (51.40%) responded that a microbial spray should be used, 75 (35.05%) participants chose sterile solution, 22 (10.28%) respondents answered that they would take the phone to a shop (10.28%) and the remaining selected detergent (3.27%). The majority of the students, however, were aware and held the view that regularly disinfecting mobile phones was necessary (93.93%).

Table 5. Knowledge of microbial contamination of mobile phone among undergraduate students of MMMC. (n=214)

Variables	Correct answer Frequency (%)
Organism	
Streptococcus (True)	141 (65.89)
Staphylococcus aureus (True)	134 (62.62)
Influenza (True)	114 (53.27)
Escherichia coli (True)	95 (44.39)
Respiratory syncytial virus (True)	88 (41.12)
Enterococcus faecalis (True)	83 (38.79)
Candida albicans (True)	70 (33.64)
Aspergillus spp. (True)	60 (28.04)
Adenovirus (True)	53 (24.77)
Rotavirus (True)	43 (20.09)
Norovirus (True)	37 (17.29)
What is the most common microbial contamination source?	
Human skin or hands*	142 (73.83)
Transmission from contaminated material	56 (26.17)
Environment	16 (7.48)
Dust	0 (0.00)
Do you think cross contamination and hospital acquired infection will decrease with regularly disinfecting mobile phones?	
Yes*	194 (90.65)
No	20 (9.35)
Do you think COVID 19 can be spread through mobile phones by direct contact?	
Yes*	184 (85.98)
No	30 (14.02)
How long do you think COVID 19 is present on mobile phones?	
Up to 24 hours	67 (31.31)
Up to 48 hours	88 (41.12)
Up to 72 hours*	42 (19.63)
Up to 1 week	17 (7.94)
Knowledge	
High (>80%)	23 (10.75)
Moderate (60%-80%)	41 (19.16)
Low (<60%)	150 (70.09)
Mean (SD)	42.17% (22.32)
Minimum-Maximum	6.67%- 100%

*Correct answer.

Table 5 highlights the knowledge part of our questionnaire. Responses were received for all 25 questions which included including 11 questions for on the expected organism expected to exist on mobile phones. Out of 214 participants, 10.75% of participants had a high level of knowledge whereas while 19.16% and 70.09% of the participants, respectively displayed moderate and low levels of knowledge respectively. The mean score of knowledge was 42.17% with a standard deviation of 22.32. For organisms expected on mobile phones, the highest correct response rate was for Streptococcus with 65.89% and the lowest correct response rate was 17.29% for norovirus. Other correct response rates were 44.39% for Escherichia coli, 62.62% for Staphylococcus aureus, 38.79% for Enterococcus faecalis, 53.27% for Influenza, 41.12% for Respiratory Syncytial Virus (RSV), 24.77% for Adenovirus, 20.09% for Rotavirus, 33.64% for Candida albicans and 28.04% for Aspergillus spp. As for knowledge of most common microbial contamination source, the highest response rate was for human skin or hands (73.83%), followed by transmission from contaminated material (26.17%), environment (7.48%). There were no responses for dust. Most students believed that cross contamination and hospital acquired infection will decrease with regularly disinfection of mobile phones (90.65%) and that COVID 19 can be spread through use of mobile phones by direct contact (85.98%). With respect to life span of COVID 19 on mobile phones, only 42 (19.63%) participants responded with up to 72 hours as the answer. Other responses include 31.31% for up to 24 hours, 41.14% for up to 48 hours and 7.94% for up to one week.

Table 6. Sneezing or coughing habits among undergraduate students of MMMC. (n=214)

Variables	Frequency (%)
I randomly sneeze or cough onto my phone	27 (12.62)
I sneeze or cough onto my hands and wipe on shirts or pants then continue scrolling	66 (30.84)
I sneeze or cough onto my hands and wash my hands before continue scrolling	62 (28.97)
I always sneeze or cough onto a handkerchief	59 (27.57)

Table 6 elaborates sneezing or coughing habits among undergraduate students. Out of 214 participants, 27 (12,625) students sneezed or coughed onto their phone, 66 (30.84%) students sneezed or coughed onto their hands which they then wiped on their shirts or pants before continuing use of the mobile phone, 62 (28.97%) students sneezed or coughed onto their hands but washed their hands before continuing to use the mobile phone scrolling and 59 (27.57%) students always sneezed or coughed onto a handkerchief.

Table 7. Association between sociodemographic, knowledge and phone (screen and back) cleaning among undergraduate students of MMMC (n=214).

Independent variables	Phone cleaning (screen and back)		OR (95% CI)	Chi-square	P value
	Yes n (%)	No n (%)			
Gender					
Male	59 (93.7)	4 (6.4)	1.39 (0.44, 0.44)	0.311	0.577
Female	138 (91.4)	13 (8.6)	Reference		
Ethnicity					
Malay	22 (88.0)	3 (12.0)	Reference		
Chinese	79 (92.9)	6 (7.1)	1.80 (0.42, 7.76)	0.628	0.428
Indian	74 (92.5)	6 (7.5)	1.68 (0.39, 7.28)	0.492	0.483
Others	22 (91.7)	2 (8.3)	1.50 (0.23, 0.87)	0.180	0.672
Knowledge					
High	23 (95.8)	1 (4.2)	2.15 (0.27, 17.24)	0.545	0.461
Moderate	35 (92.11)	3 (7.89)	1.09 (0.29, 4.04)	0.017	0.896
Low	139 (91.5)	13 (8.6)	Reference		

Table 7 shows the association between sociodemographic profiles and knowledge of mobile phone microbial contamination towards the habit of phone cleaning (screen and back) among the undergraduate students of MMMC. According to our study, the odds of male having the habit of cleaning phone was 1.39 higher than female. However, the findings are not significant (95%CI 0.435-0.438, p value 0.577). In terms of ethnicity, the odds of cleaning phone were 1.80 times higher in Chinese compared to Malays but this association is not significant (95%CI 0.42-7.76, p value 0.428). whereas Indians were 1.68 times more likely to clean their phones compared to Malays with no significant association (95% CI 0.39-7.28, p value 0.483). Those with other ethnicities on the other hand were 1.50 times more likely to clean their phones compared to Malays but without significant association (95%CI 0.23-0.87, p value 0.672). With respect to knowledge of participants, the likelihood of students with high level of knowledge to clean their phones

compared to those with low level of knowledge was 2.15 times higher nevertheless the findings were not significant (95%CI 0.27-17.24, p value 0.461) meanwhile when comparing those with moderate and low levels of knowledge, students with moderate level of knowledge were 1.09 times more likely to clean their mobile phones yet this association was not significant (95% PI 0.2904.04, p value 0.896).

Table 8. Association between sociodemographic, knowledge and phone cover cleaning among undergraduate students of MMMC (n=214).

Independent variables	Phone cover cleaning		OR (95% CI)	Chi-square	P value
	Yes n (%)	No n (%)			
Gender					
Male	46 (73.0)	17 (27.0)	0.67 (0.34, 1.33)	1.314	0.2517
Female	121 (80.1)	30 (20.0)	Reference		
Ethnicity					
Malay	20 (80.0)	5 (20.0)	Reference		
Chinese	70 (82.4)	15 (17.7)	1.17 (0.38, 3.60)	0.072	0.789
Indian	57 (71.3)	23 (28.8)	0.62 (0.21, 1.85)	0.746	0.388
Others	20 (83.3)	4 (16.7)	1.25 (0.29, 5.35)	0.091	0.763
Knowledge					
High	17 (70.8)	7 (29.2)	0.62 (0.24, 1.63)	0.942	0.332
Moderate	29 (76.3)	9 (23.7)	0.83 (0.35, 1.92)	0.198	0.656
Low	121 (79.6)	31 (20.4)	Reference		

Table 8 shows the association between sociodemographic profiles and knowledge towards the habit of cleaning phone cover among the undergraduate students of MMMC. With respect to gender, the odds of cleaning phone cover were 0.67 times higher in male respondents than female respondents but it was not significant association (95% CI 0.34-1.33, p value 0.2517). Compared to Malays, those of other ethnicity and Chinese were 1.25 times and 1.17 more likely to clean their phone covers respectively whereas Indians were 0.62 times less likely to do so. However, these findings were not significant (p value 0.763; 0.789; 0.388). When testing the association of knowledge and phone cover cleaning, it was determined that those with high and moderate levels of knowledge were 0.62 and 0.83 times less likely to clean their phone covers compared to those with low levels of knowledge but this association was not significant (p value 0.942; 0.198).

4. Discussion

The study we conducted was a cross-sectional study with the objective is to assess the knowledge of microbial contaminants of mobile phone among undergraduate students in Melaka Manipal Medical College's Muar and Melaka campus in Malaysia and students' habits of phone use along with practices of phone cleaning.

Based on our study, it was found that majority of the students, that is, 70.09% had low level of knowledge on microbial contamination of mobile phones and only 10.75% of students had high level of knowledge on microbial contamination on mobile phones, while the remaining had moderate knowledge level category. Contrary to our findings, a previous cross-sectional study on willing participants on campus of University Malaysia Kelantan, Jeli Campus in Jeli, Kelantan, shows most respondents (72 people) were aware that microbes are able to grow on cell phones and 28 respondents were not aware of the microbial contamination on mobile phones. [38] Similarly, another cross-sectional surveillance study among inpatients of Edinburgh Western General Hospital, Edinburgh, UK, found that 102 (70.3%) respondents were aware that phones could carry harmful bacteria. [42] Although this is the case, most of the students in our study knew the most common source of microbial contamination where 73.83% correctly answered human skin. Based on a previous cross-sectional study of Medical Laboratory Department, Al-khoms Higher Institute of Science and Medical Technology, Al-khoms, Libya, 25 (26.60%) participants responded that the contamination of mobile phones by using the phones which are used by others (who are having disease/contaminated hand). [44] Besides that, almost all of our participants (90.65%) also recognized that cross contamination and hospital acquired infections will decrease with regular disinfection of mobile phones corresponding to a previous cross sectional study on willing participants on campus of University Malaysia Kelantan, Jeli Campus in Jeli, Kelantan, where 80% of participants had the same opinion. [38] Furthermore, 85.98% of MMMC students were aware Covid-19 could contaminate mobile phones through direct contact and propagate the spread of the disease. The knowledge gap stemmed from the lack of awareness of specific microorganisms that contaminate mobile phones. In our study, an average of 37.9% of participants were aware of bacterial contamination of mobile phones whereas 31.38% were aware of viral contamination and 30.84% were conscious of fungal involvement. These results were comparable to a previous cross-sectional study students and staffs at Higher

Institute of Science and Medical Technology, Al-khoms, Libya, 31.92% of participants were aware about the bacteria as one of the contaminants and followed by 27.66% were know that fungi also involved in the contamination in mobile phones. Few (4.26%) persons were known about the virus contamination in mobile phones. [44]

In our study, it was found that more than half of the students (63.08%) have the habit of using mobile phones in the washroom. In comparison, a previous cross-sectional study done on 105 second and third year medical students from Department of Medical Microbiology and Parasitology, King Abdulaizm University in Saudi Arabia showed that about 59% of the participants use cell phones in the washroom. [41] As for mobile phone use when dining, we found that a little more than half (58.88%) of students used their mobile phones when dining in contrast to 44.44% of respondents using their mobile phones when dinning in a cross-sectional study on students and faculty of Independent University in Dhaka, Bangladesh. [47] When considering students' habit of sleeping with their phones, our study findings showed that the majority (86.92%) of the students do this through the night whereas in a cross sectional study previously done by Aimst University, Malaysia on public and college students around Penang, Perak and Kedah, Malaysia, about 72% of the participants have the habit of keeping phone at the bed during sleep. [36] When regarding the area for keeping mobile phones, we found that most of the students in MMMC kept their phones in the front bottom pockets (58.41%) and handbags (32.71%). Similarly, 69% and 16%of respondents in a previous cross-sectional study done in University Malaysia Kelantan, Jeli Campus faculty of science among random participants on campus also showed that most of the respondents kept their mobile phones in their pockets of trousers and handbags. [38]

We found that though 78.04% of students did clean their phone cover, 63.55% of them only cleaned their phone cover occasionally, which was insufficient to prevent phone contamination and only 5.14% and 15.42% of the students cleaned their phone cover once a day and once a week in contrast to a cross sectional study done among public and college students around Penang, Perak and Kedah states in Malaysia, where only 37% of them clean their phone cover or change their phone pouch regularly. [36] However, majority of the students in our study used wet tissues to clean their phone cover (40.65%), instead of using the appropriate method which is cleaning with a sterile alcohol swab (23.36%). In the aspect of phone cleaning itself, 92.06% of students cleaned their mobile phones and more than half of them only cleaned occasionally (60.75%). There were just a few students who cleaned their mobile phones once a day (12.15%) and once a week (17.29%). In comparison, a cross sectional surveillance study among 145 inpatients on surgical/urological wards of the Western General Hospital, Edinburgh, 50.9% of those presenting phones responded that they had never clean their phone outside hospital, 6.9% cleaned their phone yearly, (11.8%) monthly, (17.6%) weekly and (12.7%) daily. [42] Based on our study, most (36.92%) of the students used wet tissue to clean their mobile phone compared to a quarter of them (25.23%) cleaning with a sterile alcohol swab. In comparison, a cross sectional study that was conducted at University Malaysia Kelantan Jeli Campus showed that most respondents preferred to rub the phone with the clothes they were wearing or just using tissue paper and 5% of respondents use antibacterial wet tissues to clean their cell phones. [38] In addition, another cross-sectional study was conducted among the students and staffs at Higher Institute of Science and Medical Technology, Al-khoms, Libya, wet tissue was used by most people (35.11%) to clean their mobile phones and 20.21% of people use alcohol to clean their mobile phones. [44]

There are many factors that can affect cleaning practices of mobile phones and mobile phone covers. Based on our study findings, there were no significant associations between different genders, ethnicities, and knowledge level in cleaning practices of mobile phone and mobile phone cover. Even so, we could see a difference when relating level of knowledge with cleaning of mobile phones. Although not significant, there was a 2.15 increase in likelihood to clean mobile phones in students with high knowledge levels compared to those with low knowledge levels. On the other hand, those with moderate knowledge level were 1.09 times more likely to clean their mobile phones compared to those with low knowledge level.

There were few limitations in our study. We conducted this study in 6 weeks and our study was a cross-sectional study which only allowed us to observe participants at one-point in time. Therefore, we were unable to observe the effect of time on the changes in participants' knowledge and cleaning practices. Besides that, our study was only done in one private medical college; hence the findings cannot be generalized to other setting or population. Furthermore, we were unable to obtain results equally from all year students. There was less participation from final year students in comparison to their juniors. This might affect the results as final year students might have different knowledge and cleaning practices.

Owing to the fact that lack of knowledge among students has mostly due to the questions on specific microorganisms playing a role in contamination of mobile phones, we recommend that students be made aware of these organisms and the diseases that they could risk transmitting before being brought into the hospital setting as clinical phase of

their course. With regards to cleaning practices, students should be encouraged to clean their phones properly and frequently in view of the majority of the students using incorrect method, that is, using a wet tissue and only cleaning their mobile phones and phone covers occasionally whereas they should be cleaning more frequently and with a sterile alcohol swab. Moreover with 7.94% of students not cleaning phone and 21.96% not cleaning phone cover along with the ever-growing evidence of mobile phone acting as a vehicle for disease transmission, it is important to educate the students on this topic so they can implement changes in their cleaning practices. This will then decrease spread of nosocomial infections to other patients, the students themselves and their friends and family.

5. Conclusion

In conclusion, it was found that the percentage of high, moderate, low level of knowledge microbial contamination of mobile phone among undergraduate students of MMMC were 10.75%, 19.16% and 70.09% respectively whereas in regards to phone cleaning practices, 92.06% clean their phone and 7.94% does not clean their phone. Although there were no significant associations between them, it was found that students with high level of knowledge and moderate level of knowledge were 2.15 and 1.09 times more likely to clean their phones compared to those with low level of knowledge. Hence, students should be made aware of these organisms and the disease that they could risk transmitting before being brought into the hospital setting for their clinical phase. With regards for cleaning practices, education via media ads encouraging students to clean their phones properly and frequently would be an ideal method. Further studies should focus on analysing the knowledge regarding microbial contamination of mobile phones and habits of mobile phone cleaning.

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