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Effectiveness of Commercial Alcohol Swabs in the Reduction of Microbial Load on Smartphone Screens

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Abstract

Smartphones are a part of almost every person's life. They are brought everywhere along with their owners. They provide the perfect habitats for microorganisms where some of these may be potentially pathogenic and harmful. Therefore, it is imperative to clean the screens of smartphones. As such, this study sets out to investigate the microbial load on the screens of smartphones and the effectiveness of commercially available alcohol swabs in the reduction of microbial load on these screens as well as to assess the perception, awareness, cleaning habits of smartphones and the opinion of its significance among the members of Melaka-Manipal Medical College (MMMC), Manipal campus. A quasi-experimental study was conducted among the faculty members, non-teaching staff and undergraduate students of the college. An online questionnaire was distributed and the participants' smartphones were swabbed for culture. A total of 112 responses were gathered. Data was analysed using Graphpad: Quickcalcs. Paired t-test was used. Findings showed that the median number of colonies cultured from the screens of smartphones was 24.5. Besides, a significant reduction of microbial load after the use of alcohol swabs was determined ($P<0.001$) with a 96.47% reduction. 69.8% of participants clean their smartphones, 26.4% cleans once a week, 90.6% are aware of microbes residing on their phones, 77.4% think that cleaning affects the microbial load significantly and 95% think that it is a hygienic practice to do so. In short, a high microbial load on smartphone screens were found which can be readily and almost completely removed by using alcohol swabs. The perception and frequency of cleaning smartphone screens were less than satisfactory. An effort should be made to increase awareness on this subject.

Keywords

Alcohol, Microbial Load, Smartphones, Screens, Quasi-experimental Study

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1. Introduction

Smartphones, once a luxury, are now a part of almost every person's life. They are brought everywhere and anywhere, along with their owners. Since 2011, the amount of the population that owns smartphones have increased drastically. [1] On top of that, the perception that smartphones are electronic devices which generally do not mix well with water has led most people into not cleaning their smartphones. However, as smartphones are carried everywhere, they provide the perfect habitats for wandering microorganisms. Some of these may be potentially pathogenic and harmful. Previous studies

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shown that most phone screens have microorganisms on them. [2, 3] As for their pathogenicity, it has been shown that more than half of these organisms are potentially pathogenic, or are opportunistically pathogenic to human beings. [4, 5] It is clear, based on insurmountable evidence that not only most screens of smartphones are contaminated with microorganisms, but also a significant percentage of these organisms are pathogenic and potentially harmful to humans. Therefore, it is imperative to clean the screens of smartphones to avoid contamination and transmission of diseases, especially in members of the medical industry.

To combat this problem, it is important that we clean the screens of smartphones to get rid of the presiding microorganisms. It has been found that just by cleaning it with simple disinfectants, the microbial load on the screens of smartphones are drastically reduced. [4, 6] Using microfiber cloths or alcohol impregnated lens also show similarly significant reduction. [5] While it is important for the general populace to maintain the sterility of their smartphone screens, it is doubly important for medical practitioners to do so. A previous survey has found that almost 94% of doctors own and use a smartphone. [7] Even among medical students, almost 90% admit to using smartphones. [8] On top of that, a 2017 study shows that the contamination rate of smartphone screens is higher in those of the healthcare profession than those outside of it [9]. The significance of bacterial load on the screens of healthcare personnel, especially doctors, lies in the danger of cross contamination. [10]

There could be many reasons as to why there is such a high microbial load on smartphone screens. However, it can be surmised that the most likely cause would be the number of times we touch our phones on a daily basis. Even when on the road, it has been found that young drivers touch their phone screens about 1.6 times per minute. [11] As it is impractical if not impossible to decrease the general population's usage of their smartphone, the next best solution would be to clean the screens such that there is little risk of infection by them.

In Malaysia, almost 85% of the population own smartphones and there is a significant amount of time spent on using them. [12] It has also been found that the younger population are starting to use smartphones beginning at an earlier age. [13] On the medical note, studies have shown that nosocomial infections, particularly involving organisms commonly found on smartphone screens, are on the rise. [14-16] Therefore, all the concerns mentioned above are of dire importance to us in Malaysia.

All in all, previous literature has proven that not only is the majority of the population using smartphones but also that a good majority, if not all, smartphone screens are contaminated with bacterial organisms. While some of these are commensal, there have also been pathogens detected among them. This posts as a significant concern, as there is an increasing trend of nosocomial infections in Malaysia. Even though there are no definite links between these nosocomial infections and those organisms found on smartphone screens, because doctors are also found to have a large number of organisms on their phones, it could pose a risk of hospital acquired infections.

Alcohol has long been a staple in the healthcare industry as a disinfectant. [17] As such, this study sets out to investigate the microbial load on the screens of smartphones and the effectiveness of commercially available alcohol swabs in the reduction of microbial load on these screens as well as to assess the perception, awareness, cleaning habits of smartphones and the opinion of its significance among the members of Melaka-Manipal Medical College (MMMC), Manipal campus.

2. Methods

2.1. Study Design, Time, Setting, Study Population

The study was a quasi-experimental study conducted from November 2019 till February 2020 among faculty members, non-teaching staff and the undergraduate students of Melaka Manipal Medical College (MMMC), Manipal Campus. The college has two more campuses in Malaysia, one in Melaka and another in Muar, Johor. This college offers three courses, Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Dentistry (BDS), and Foundation in Science (FIS). The pre-clinical phase for the MBBS and BDS programme is done in the Manipal campus in India whereas the second half or the clinical phase is done in the Malaysia campus.

2.2. Sample Size

Based on a previous study, 99.2% of all participants' smartphones are contaminated with microorganisms that are potentially harmful. [4] With the formula application software "Epi Info" version 7.2.4.0, the sample size (n) was calculated as below: -

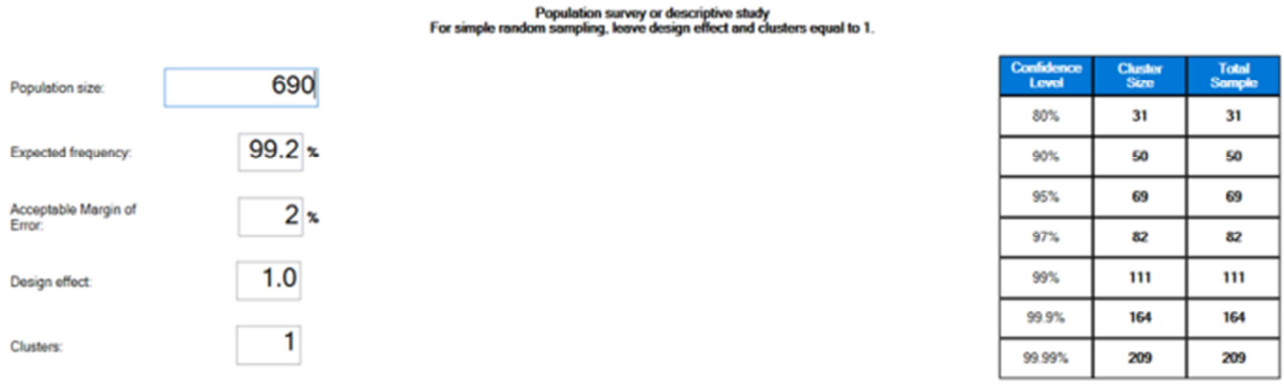

Figure 1. Sample size calculation.

The minimum sample size required with the confidence level of 95% is 69.

Taking non-response percentage of 30% into consideration, the final sample size was calculated as follows:

$$n(final) = \frac{n(calculated)}{1-(non-response)} = \frac{69}{1-0.3} = 98.57$$

Therefore, the final sample size for this study is 99.

2.3. Sampling

The sampling method used was purposive sampling. This method was selected in line with the characteristics of the sample population and the objectives of this study. Faculty members, non-teaching staff and students in the Manipal campus were selected to participate in this study. The inclusion criteria were faculties, non-teaching staff and students who understand English, owns a smartphone and those who willingly consented to participate in this study as well as completed all the required parts of the questionnaire given. The exclusion criteria were individuals without smartphones, those who did not consent to participate in the study and those who failed to complete the required parts of the questionnaire. Biological materials required were blood agar media and materials needed for biochemical identification.

2.4. Data Collection

Firstly, the participants who fit the inclusion criteria were welcomed and introduced to the study and its purposes and briefed about the concept of informed consent. Informed consent was taken from them. Consenting participants are given an online questionnaire to answer. This questionnaire consisted of 5 questions assessing the participants' awareness of microorganisms on their phones, their phone cleaning habits and their perceptions towards the practice.

Then, the sample was collected from the smartphone screen to determine the microbial load on the screens by using a sterile swab. It is then inoculated on one half of a blood agar plate. This side of the plate was marked as 'Before', indicating pre-intervention. Then intervention was given in the form of using commercially available alcohol swabs containing 70% isopropyl alcohol to thoroughly clean the smartphone screen. Care was taken to ensure that the swab did not overlap the same area more than once to prevent retrograde contamination. Immediately after cleaning with alcohol swabs, a sample of the microbial population present on the screens of the phone was taken once more with a sterile swab which is then inoculated onto the other half of the same blood agar petri dish. This side of the plate was marked as 'After', indicating post intervention. The medium was then incubated at 37°C overnight. The next day, the number of colonies grown on each side of the plate was calculated to assess the percentage of reduction of the microbial load between the 'Before' and 'After' inoculates.

2.5. Data Processing and Data Analysis

Data from the online questionnaire distributed to the participants and the observations made from the culture media were recorded and entered into Microsoft Excel. The compiled data was then analysed using Graphpad: Quickcalcs.

For this study, quantitative data like the number of colonies on the blood agar before and after cleaning the screen of the smartphone with alcohol were summarized and calculated. The association between use of alcohol swab and the reduction of microbial load was also calculated. The statistical test used was paired t-test. Level of significance was set at $p = 0.05$ with a 95% confidence level.

2.6. Ethical Consideration

An informed consent form detailing all the important and relevant particulars of the study was provided to the participants. The participants were given full freedom of choice to participate in this study. No incentives were given to encourage participation, nor were the participants coerced or forced into taking part in this study. Whatever information that was provided by the participants in this study were kept confidential and strictly served the purpose of this study only.

The anonymity and privacy of the participants was ensured. This research was approved by the Kasturba Medical College and Kasturba Hospital Institutional Ethics Committee (IEC: 808/2019).

3. Results

Total responses that were collected for the test was 112 out of the 99 that was required. This gave us a response rate of 113%.

Table 1. Descriptive statistics for microbial load on smartphone screens.

	Mean (SD)	Standard Error of Mean	95% Confidence Interval	Median
Microbial Load (Pre-test colony count)	63.17 (97.28)	9.19	44.96-81.38	24.5

Table 1 shows the descriptive statistics for microbial load on smartphone screens. Participants' smartphone screens had a mean of 63.17 colony counts. However, the standard deviation is large at 97.28. As there are outliers on both ends of the data, the median, 24.5, is a more accurate representation.

Table 2. Pre-test colony count vs. post-test colony count.

Independent variable	Mean (SD)	Mean Difference (95% CI)	Standard error	P value
Pre-test colony count	63.17 (97.28)	60.94 (42.92-78.96)	9.10	<0.001
Post-test colony count	2.23 (5.39)			

*Paired T-test was used.

Out of the 112 respondents that went for the phone cleaning test, only 106 successfully completed the questionnaire. Data from the questionnaire was acquired from Google Forms and graphically presented in the form of bar graphs.

Based on Table 2, it was found that the mean colony count before alcohol was used to clean the screen of the smartphone was 63.17 (SD=97.28) colonies whereas the mean colony count after alcohol was used was 2.23 (SD=5.39) colonies. The mean difference is 60.94 colonies with a 95% confidence interval of 42.92-78.96. P-value was found to be lower than 0.05. This shows that this is statistically significant. Hence, there is a significant reduction of microbial load on the screens of smartphones after the use of alcohol swabs.

The mean percentage reduction after the application of alcohol swab was calculated using the formula $100 - (\frac{Post\ Test\ Colony\ Count}{Pre-test\ Colony\ Count} \times 100)$. Thus, the mean percentage reduction is $100 - (\frac{2.23}{63.17} \times 100)$, resulting in a mean percentage reduction of 96.47%.

Figure 2 shows the data of whether participants clean the screen of their smartphones. Out of all 106 participants, it was found that 74 (69.8%) of them clean their smartphones, whereas 32 (30.2%) of them has not.

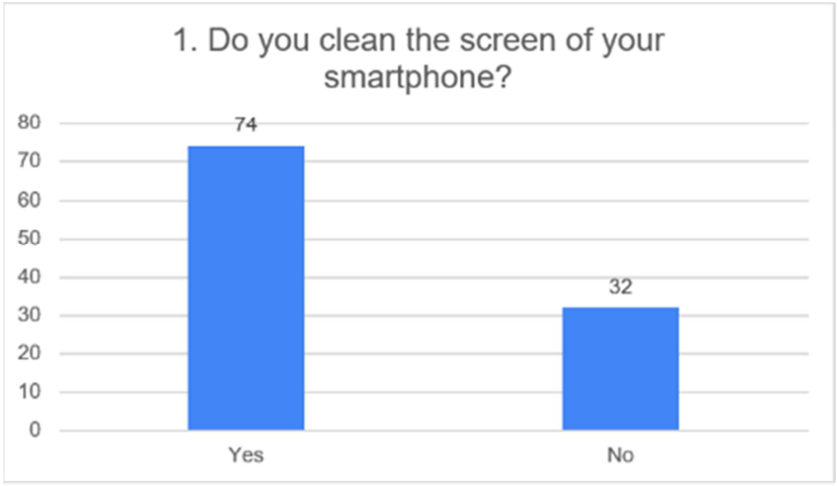

Figure 2. Number of participants who clean the screen of their smartphone.

According to figure 3, out of the 74 participants who answered Yes to cleaning their smartphones, it was found that most of them cleans their smartphones once a week, with 23 people, consisting 26.4%. The next largest group cleans their smartphones once daily with 21 people (24.1%). 18 participants (20.7%) clean their phones once a month and less than once a month each. Finally, 7 people, which makes up 7.7% of the participants, have cleaning habits that do not fit into the above categories. These include responses such as those who only clean their phones when there are visible oil or fingerprints on the surface of the screens or those who cleans only occasionally when they feel like it.

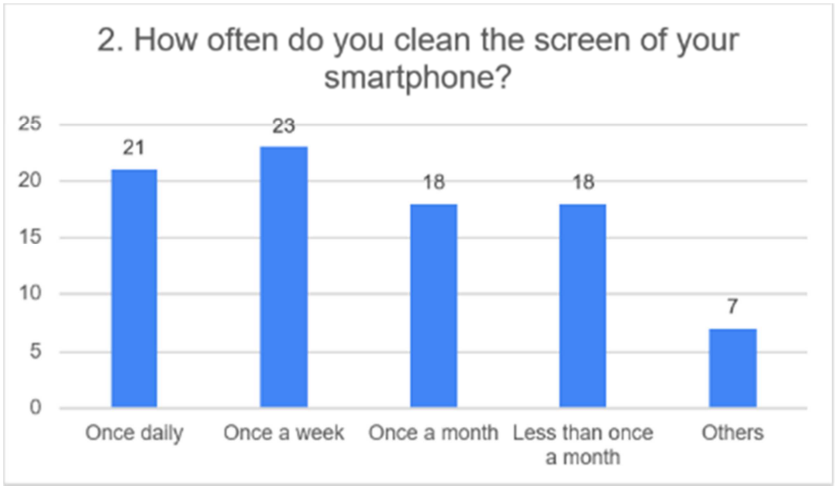

Figure 3. Frequency of participants cleaning the screen of their smartphone.

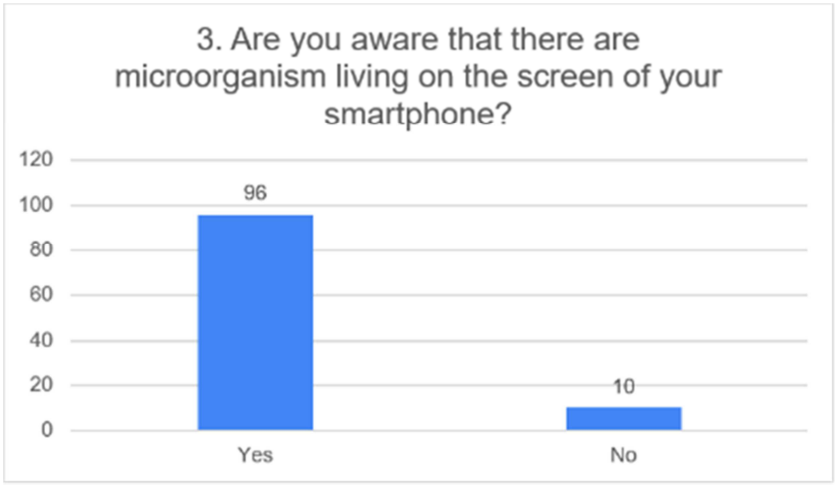

Figure 4. Number of participants who are aware of microorganisms residing on the screen of their smartphone.

In the next section as presented in figure 4, participants were assessed on whether they were aware that there are microorganisms living on the screens of their smartphones, of which the vast majority, at 96 participants (90.6%) were aware while the remaining 10 participants (9.4%), were unaware.

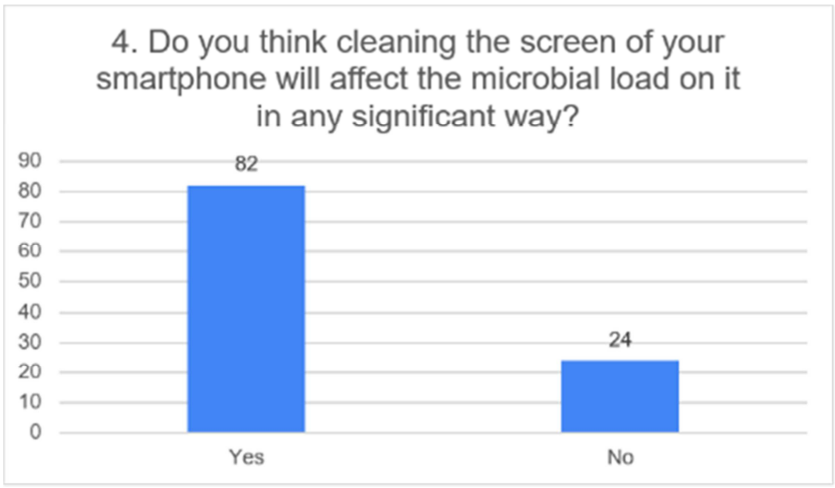

Figure 5. Perception of participants towards cleaning their smartphone screen with regards to significant reduction of microbial load.

Figure 5 shows that a majority of participants at 77.4%, which consists of 82 participants think that cleaning the

screens of smartphones will affect the microbial load significantly while the remaining 22.6%, consisting of 24 participants do not think that cleaning the screens of smartphones will affect the microbial load significantly.

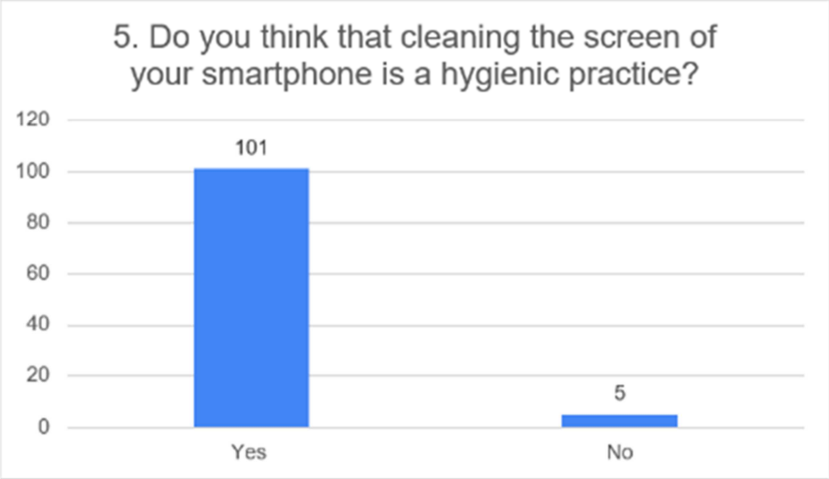

Figure 6. Perception of participants towards cleaning their smartphone screen as a hygienic practice.

The last question as shown in figure 6 assessed whether participants think that cleaning their smartphone screens is a hygienic practice. For this question, 101 participants which makes up the majority at 95% thinks that it is a hygienic practice while the remaining 5 participants which makes up 4.7% thinks that it is not a hygienic practice.

4. Discussion

This study was a quasi-experimental study done to investigate the microbial load on the screens of smartphones and the effectiveness of commercially available alcohol swabs in the reduction of microbial load on these screens as well as to assess the perception, awareness, cleaning habits of smartphones and the opinion of its significance among the members of Melaka-Manipal Medical College (MMMC), Manipal campus.

Regarding the microbial load on the screens of smartphones, it was found that the mean colony counts on the smartphone screens of our participants was 63.17 (SD=97.28). However, in our data set, there were outliers on both ends of the data, and thus the median, 24.5, is a more accurate representation. A previous study on the cell phones of orthopaedic surgeons have shown that the mean result (and standard deviation) at initial testing was 3488 ± 2998 relative light units, which indicates a highly contaminated surface. [4]

As for the effectiveness of commercially available alcohol swabs in the reduction of microbial load on the screens of smartphones, our study shows that the mean percentage reduction of microbial load on smartphone screens to be 96.47% with the use of 70% isopropyl alcohol. There are multiple previous studies that show that alcohol can fully eliminate microbes. [18, 19, 20] In comparison, our finding of 96.47% reduction is in line with the 100% in previous literature.

Our study found that a majority of the participants have good perception regarding the need to clean smartphone screens, with 95% agreeing that it is a hygienic practice. Out of 106 participants, 69.8% clean their smartphones. Compared to a previous study done among medical students in Saudi Arabia, which reported only 32% of participants cleaning their smartphones, our study has more participants cleaning their smartphone screens. [2] Our study also shows that the most common frequency of cleaning smartphone screens is once per week.

We encountered a few limitations during the study. The most significant limitation would be the lack of access to more sophisticated methods of quantifying microbial load on smartphone screens. We could only manually count the colonies on each blood agar as a way to represent microorganism growth. This caused us to be unable to correlate our findings with previous literature, as most of them used advanced methods such as CFU/cm^2 and RLU as a method of quantifying microbial load. Another limitation would be that due to shortage of manpower, we could not simultaneously collect the samples for inoculation on the agars and ensure all participants completed the questionnaire. As a result, out of 112 participants who got the screen of their phones swabbed, only 106 answered the questionnaire. During our study, we also faced the problem of cross contamination, leading to a few samples having to be discarded. Another limitation of this study is that our findings cannot be generalized to other institutions or populations.

We recommend that future researches on this subject use a more standardised method of quantifying microbial load that is universally accepted so that it can be compared to previous

literature. We also recommend that future studies include a way to identify and classify potential pathogens from commensal organisms. There should also be a more systematic and careful approach to prevent cross contamination between the cultures.

5. Conclusion

In conclusion, it was found that the mean percentage reduction of microbial colonies on smartphone screens was 96.47%. As shown by the high number of colonies before intervention and the significantly low colonies after the use of alcohol swabs, we can draw a conclusion to the effectiveness of alcohol in reducing microbial load. Besides that, the perception and frequency of cleaning smartphone screens among students and faculty members were less than satisfactory. There should be an effort to increase awareness on this subject as healthcare workers, either future or present, should all be mindful of the possibility of spreading pathogenic strains of microorganisms towards others, especially high-risk individuals. As such, we should all take measures of infection control to ensure minimal risk of transmission of pathogenic organisms.

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