




Supplementary Materials: The Associations Between Knowledge and Behaviours Related to Touch Screens and Microbiological Threats Among IT Students'

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1. Medical Staff and Mobile Devices

There is a lot of research regarding mobile devices of medical staff and bacterial contamination and the survey is described in [1]. This work shows that recent studies found that between 9% and 15% of MCDs (Mobile Cellular Devices) carry pathogenic bacteria. Recommendations are to practice good hand hygiene, restrict MCDs in high-risk areas, and sanitize MCDs devices using 70% isopropyl alcohol to reduce contamination.

In study [2] revealed that one fifth of mobile phones harboured pathogenic microorganisms

Coagulase Negative Staphylococcus (CNS) was the most frequently isolated microorganism from cellphones belonging to doctors and paramedical staff in departments at government medical college and hospital, Amritsar [3]. Coagulase negative staphylococci are normal flora of the skin so inevitable contamination occurs. These can cause device related infections but are ubiquitous in the hospital environment. Hence, contamination is likely a reflection of use by the same person rather than hand hygiene. The results indicated that 40% of devices were contaminated and the decontamination with 70% isopropyl alcohol was 98% effective.

Mobile phones of health care workers also harboured microorganism according to [4]. In samples from mobile phones of resident doctors *Coagulase Negative Staphylococci* (71.87%) *Diphtheroids* (21.87%), *Aspergillus niger* (6.25%) were detected. That is why cellular phones are a potential source of microorganism causing nosocomial infections and the study indicates that proper hand hygiene and decontamination of devices should be carried out regularly.

A questionnaire was submitted to health care personnel and followed by the detection of bacterial growth in study [5]. There were questions about using headsets, disinfection of devices, hand hygiene, the location of using the devices. Fingers of both hands were examined for the presence of bacteria before and after phone call. It revealed that the bacterial growth was not present after hand rub, but after phone call the contamination increased to 93.7%.

Staphylococcus aureus was isolated from hands and mobile phones of health care workers according to [6]. *Methicillin Resistant Staphylococcus Aureus* (MRSA) was isolated from 53.3% mobile phones and it is unusual and reflects a high prevalence in the patient population of the hospital. Ethyl alcohol was effective as disinfecting agent.

The study [7] indicated that about 98% of cellular phones of health care workers were contaminated with bacteria, *ex Coagulase Negative Staphylococci*, *Staphylococcus aureus*, and *Escherichia coli*. The mobile phones were decontaminated with 70% alcohol, that decreased the rate of contamination from 98.3% to 55.2%.

In study [8] Of the mobile phones, 60% were contaminated, but drug resistant bacteria were not detected and 37% of individuals confirmed regular cleaning of devices.

A questionnaire asking about hygiene practice and the patterns of using of mobile phones was used in [9]. A cross-sectional study was performed in the study and 61.7% of mobile phones showed contamination. It revealed that mobile phones of health care workers were more likely contaminated with MRSA versus devices of non-health care workers and generally the cellular phones of health care workers were more contaminated with bacteria

There was a study about the contamination of mobile phones in healthcare workers of neonatal unit [10]. The disinfection and cleaning reduces contamination of mobile devices and not using disinfection agents and not cleaning them cause the isolation of bacteria.

The study of comparison of flora associated with cellular phones in healthcare workers versus non-healthcare workers was described in [11]. Predominant microorganisms isolated from mobiles of healthcare workers were: *Acinetobacter baumannii* (36.84%) and *MRSA* 46% of samples from mobiles of non-healthcare workers harboured microorganisms.

Comparisons of microbial contamination of keypads and touch screens of mobile cell phones between hospital and non-hospital staffs were described in [12]. It was revealed that the microbial contamination of phones was low in touch screen devices and the bacterial contamination was more frequent in hospital staff devices. It was also observed that women's mobile phones were less contaminated than men's devices. In hospital staff mobile cell phones the dominant microorganism were: *Enterobacteriaceae*, *Bacillus species*, especially Gram-positive bacteria sporulated and *Coagulase Negative Staphylococcus*.

In the [13] investigation of microbial contamination of mobile phones in a tertiary care hospital results indicated that the growth on bacteria was present in 87.3% of mobile phones of health care workers and 56.4% of the mobile phones of non-health care workers. *Coagulase Negative Staphylococcus* was predominant in the study group, aerobic spore bearers and micrococci were also frequent.

A cross sectional study was also performed in [14] 58% of health care workers' mobiles showed bacterial contamination with *Staphylococcus aureus* as a predominant bacterium (34%). Other detected bacteria were: *Micrococcus species*, *Coagulase Negative Staphylococcus* (CNS), *Pseudomonas aeruginosa* and *Escherichia coli*.

According to [15] 85% of the participants never cleaned their devices. Predominant bacterial isolates were *Staphylococcus aureus* and *Coagulase Negative Staphylococcus*, it was noted that 40% of *Staphylococcus aureus* isolates were resistant to methicillin. Gram negative bacteria are likely to represent poor hand hygiene.

The study [16] indicated that 81.8% of mobile phones and 80% of swab samples showed the growth of bacteria, where *Coagulase Negative Staphylococcus*, *Staphylococcus aureus*, *Acinetobacter species*, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas species* and *Enterococcus species* were the most frequently isolated. That is why mobile phones may be a source of nosocomial pathogens.

2. Materials and Methods

The questions from the subset of the full survey considered in this paper are presented in the Table 1.

Table S 1: Questions considered in this paper.

Question	Range
(Q6) Smartphone market price	(300) · · · (>2100) PLN
(Q77) Did you lend your smartphone to another person?	never \iff it happened often
(Q82) Do you ever use someone else's smartphone?	never \iff it's not a problem
(Q83) Would you use someone else's smartphone that is dirty?	never \iff it's not a problem
(Q84) Would you use someone else's smartphone that is wet with sweat?	never \iff it's not a problem
(Q78) Would you lend your smartphone to a person who is visibly sweaty sweating?	never \iff it happened often
(Q79) Would you lend your smartphone to a visibly dirty person?	never \iff it happened often
(Q80) Would you lend your smartphone to a person coughing or with a runny nose?	never \iff it happened often
(Q81) Would you lend your smartphone to a person with visible skin changes?	never \iff it happened often
(Q104 top) Do you think there are bacteria on touch screens?	none \iff a lot of them
(Q104 middle) Do you think there are viruses on touch screens?	none \iff a lot of them
(Q104 bottom) Do you think there are fungi on touch screens?	none \iff a lot of them

Figure S1. Fragment of the questionnaire with the questions considered in the article (questionnaire in Polish).

3. Results

3.1. K-means and K-median Clustering of Social Behaviors Related to Giving Own Smartphone to Other Persons

Table S 2: Centroid locations for k-means.

Number of clusters: k=3		Number of clusters: k=4	
centroid no.	value	centroid no.	value
k-centroid type: k-means			
Would you lend your smartphone to a person who is visibly sweating ? never (-1.0) \iff it happened often (1.0)			
suggested minus signs in all tables are ok [2]	-0.200	[1]	-0.418
		[2]	0.127
[3]	-0.725	[3]	-0.790
[1]	0.800	[4]	0.817
Would you lend your smartphone to a visibly dirty person ? never (-1.0) \iff it's not a problem (1.0)			
[2]	-0.482	[1]	-0.554
		[2]	-0.400
[3]	-0.832	[3]	-0.852
[1]	0.554	[4]	0.570
Would you lend your smartphone to a person coughing or with a runny nose ? never (-1.0) \iff it's not a problem (1.0)			
[2]	0.345	[1]	0.563
		[2]	-0.078
[3]	-0.668	[3]	-0.685
[1]	0.880	[4]	0.876
Would you lend your smartphone to a person with visible skin changes ? never (-1.0) \iff it's not a problem (1.0)			
[2]	-0.225	[1]	-0.009
		[2]	-0.618
[3]	-0.823	[3]	-0.819
[1]	0.760	[4]	0.776

Table S 3: Centroid locations for k-medians.

Number of clusters: k=3		Number of clusters: k=4	
centroid no.	value	centroid no.	value
k-centroid type: k-medians			
Would you lend your smartphone to a person who is visibly sweating ? never (-1.0) \iff it happened often (1.0)			
[2]	-0.2	[1]	-0.4
		[2]	0.0
[3]	-0.8	[3]	-0.8
[1]	1.0	[4]	1.0
Would you lend your smartphone to a visibly dirty person ? never (-1.0) \iff it's not a problem (1.0)			
[2]	-0.6	[1]	-0.4
		[2]	-0.6
[3]	-1.0	[3]	-1.0
[1]	0.8	[4]	1.0
Would you lend your smartphone to a person coughing or with a runny nose ? never (-1.0) \iff it's not a problem (1.0)			
[2]	0.4	[1]	0.6
		[2]	-0.2
[3]	-0.8	[3]	-0.8
[1]	1.0	[4]	1.0
Would you lend your smartphone to a person with visible skin changes ? never (-1.0) \iff it's not a problem (1.0)			
[2]	-0.4	[1]	0.0
		[2]	-0.8
[3]	-0.8	[3]	-1.0
[1]	1.0	[4]	1.0

89 3.2. Subjective Associations Between Expected Microbiological Threats and Behaviors using
90 Linear Model

Table S 4: Absolute frequency for 2D linear model of associations (changed to *italic* $N=172$) (part 1/3)

y: Do you think there are bacteria/viruses/fungi on touch screens?			
		Mean (SD)	$Pr(> t)$
x: Smartphone market price PLN			
bacteria	Intercept:	-2.472638 (1.848149)	0.187
	x:	-0.000348 (0.000873)	0.692
	y:	8.951989 (1.948162)	3.26e-05 ***
viruses	Intercept:	1.073403 (0.566339)	0.0621 .
	x:	0.000298 (0.000335)	0.3770
	y:	1.657018 (0.594299)	0.0068 **
fungi	Intercept:	2.287e+00 (5.079e-01)	2.57e-05 ***
	x:	8.776e-05 (3.167e-04)	0.783
	y:	-1.523e-01 (5.490e-01)	0.782
x: Did you lend your smartphone to another person ? (never \iff it happened often)			
bacteria	Intercept:	-2.6421 (1.4627)	0.076774 .
	x:	1.6776 (0.7729)	0.034638 *
	y:	7.9599 (1.9375)	0.000145 ***
viruses	Intercept:	1.2649 (0.3245)	0.000202 ***
	x:	0.9856 (0.2799)	0.000717 ***
	y:	1.3994 (0.5195)	0.008619 **
fungi	Intercept:	2.0778 (0.2034)	< 2e-16 ***
	x:	0.7921 (0.1941)	0.000101 ***
	y:	-0.4274 (0.3575)	0.235210
x: Would you lend your smartphone to a person who is visibly sweating ? (never \iff it's not a problem)			
bacteria	Intercept:	-2.6437 (1.4397)	0.07203 .
	x:	-0.8927 (0.6741)	0.19120
	y:	7.6367 (1.8246)	0.00011 ***
viruses	Intercept:	2.0181 (0.4214)	9.06e-06 ***
	x:	-0.3315 (0.3078)	0.285
	y:	0.5000 (0.6368)	0.435
fungi	Intercept:	2.4472 (0.2894)	1.48e-12 ***
	x:	-0.5195 (0.2432)	0.0359 *
	y:	-0.6521 (0.4892)	0.1865

added: $Pr(> |t|)$ gives the p -value for that t-test (the proportion of the t distribution at that df which is greater than the absolute value of t statistic)

Signif. codes: '***' *changed to italic* $p \leq 0.001$, '**' $p \leq 0.01$, '*' $p \leq 0.05$, '.' $p \leq 0.1$, ' ' $p > 0.1$

PLN - Polish zloty (currency)

Table S 5: Absolute frequency for 2D linear model of associations (**changed to italic** *N=172*) (part 2/3).

y: Do you think there are bacteria/viruses/fungi on touch screens?			
		Mean (SD)	$Pr(> t)$
x: Would you lend your smartphone to a visibly dirty person ? (never \iff it's not a problem)			
bacteria	Intercept:	-3.9010 (1.9875)	0.05574 .
	x:	-2.3988 (0.9425)	0.01434 *
	y:	9.3391 (2.4976)	0.00051 ***
viruses	Intercept:	1.8567 (0.4465)	9.59e-05 ***
	x:	-0.9953 (0.3171)	0.00255 **
	y:	0.7462 (0.6748)	0.27292
fungi	Intercept:	2.5334 (0.3047)	3.97e-12 ***
	x:	-1.1753 (0.2581)	2.09e-05 ***
	y:	-0.9758 (0.5132)	0.0612 .
x: Would you lend your smartphone to a person coughing or with a runny nose ? (never \iff it's not a problem)			
bacteria	Intercept:	-2.5770 (1.4285)	0.076918 .
	x:	0.5885 (0.6831)	0.392861
	y:	7.9498 (1.9107)	0.000117 ***
viruses	Intercept:	1.4788 (0.3831)	0.000234 ***
	x:	0.2728 (0.2822)	0.336717
	y:	1.2200 (0.6126)	0.049956 *
fungi	Intercept:	2.3450 (0.2935)	8.45e-12 ***
	x:	0.3909 (0.2494)	0.121
	y:	-0.5530 (0.5133)	0.285
x: Would you lend your smartphone to a person with visible skin changes ? (never \iff it's not a problem)			
bacteria	Intercept:	-2.088 (1.448)	0.155272
	x:	-1.248 (0.650)	0.060178 .
	y:	7.001 (1.902)	0.000546 ***
viruses	Intercept:	1.3987 (0.3230)	4.34e-05 ***
	x:	-0.5588 (0.2502)	0.0284 *
	y:	1.1397 (0.5120)	0.0289 *
fungi	Intercept:	2.4107 (0.2716)	2.85e-13 ***
	x:	-0.8387 (0.2256)	0.000388 ***
	y:	-0.5339 (0.4790)	0.268606
x: Do you ever use someone else's smartphone ? (never \iff it's not a problem)			
bacteria	Intercept:	-2.3287 (1.0734)	0.0344 *
	x:	0.3559 (0.5154)	0.4927
	y:	7.4149 (1.4168)	2.68e-06 ***
viruses	Intercept:	1.5779 (0.2846)	3.87e-07 ***
	x:	0.3062 (0.2412)	0.2081
	y:	1.0620 (0.4482)	0.0203 *
fungi	Intercept:	2.08703 (0.20186)	<2e-16 ***
	x:	0.00136 (0.18260)	0.994
	y:	-0.37245 (0.35547)	0.298

added: $Pr(> |t|)$ gives the p -value for that t-test (the proportion of the t distribution at that df which is greater than the absolute value of t statistic)

Signif. codes: '***' **changed to italic** $p \leq 0.001$, '**' $p \leq 0.01$, '*' $p \leq 0.05$, '.' $p \leq 0.1$, ' ' $p > 0.1$

Table S 6: Absolute frequency for 2D linear model of associations (changed to italic *N=172*) (part 3/3).

y: Do you think there are bacteria/viruses/fungi on touch screens?			
		Mean (SD)	$Pr(> t)$
x: Would you use someone else's smartphone that is dirty ? (never \iff it's not a problem)			
bacteria	Intercept:	-2.0815 (1.1102)	0.0663 .
	x:	0.1105 (0.5294)	0.8355
	y:	7.1536 (1.4578)	9.2e-06 ***
viruses	Intercept:	1.4251 (0.2742)	1.51e-06 ***
	x:	0.1981 (0.2177)	0.36566
	y:	1.2240 (0.4399)	0.00673 **
fungi	Intercept:	2.09286 (0.20382)	2.91e-16 ***
	x:	0.34832 (0.18051)	0.0572 .
	y:	0.01384 (0.37325)	0.9705
x: Would you use someone else's smartphone that is wet with sweat ? (never \iff it's not a problem)			
bacteria	Intercept:	-4.1361 (1.3420)	0.003312 **
	x:	-2.2725 (0.6409)	0.000849 ***
	y:	9.6104 (1.7407)	1.14e-06 ***
viruses	Intercept:	1.5417 (0.3921)	0.000196 ***
	x:	-0.9295 (0.3001)	0.002810 **
	y:	1.0380 (0.6041)	0.090133 .
fungi	Intercept:	2.2300 (0.2427)	5.24e-14 ***
	x:	-1.0951 (0.2241)	5.47e-06 ***
	y:	-0.6505 (0.4077)	0.115

added: $Pr(> |t|)$ gives the p -value for that t-test (the proportion of the t distribution at that df which is greater than the absolute value of t statistic)

Signif. codes: '***' *changed to italic* $p \leq 0.001$, '**' $p \leq 0.01$, '.' $p \leq 0.05$, ' ' $p \leq 0.1$, ' ' $p > 0.1$

91 3.3. Subjective Associations between Microbiological Threats for Personal Contact Situations
92 using Linear Model

Table S 7: Absolute frequency for 2D linear model of associations (changed to *italic* $N=172$).

x:	Did you lend your smartphone to another person ?	
	Mean (SD)	$Pr(> t)$
y: Would you lend your smartphone to a person who is visibly sweating ? (never \iff it's not a problem)		
Intercept:	2.4154 (0.2837)	3.57e-12 ***
x:	0.4029 (0.4455)	0.369
y:	-0.2379 (0.4070)	0.561
y: Would you lend your smartphone to a visibly dirty person ? (never \iff it's not a problem)		
Intercept:	2.4044 (0.2938)	3.4e-11 ***
x:	0.8876 (0.4437)	0.0502 .
y:	-1.1045 (0.4211)	0.0112 *
y: Would you lend your smartphone to a person coughing or with a runny nose ? (never \iff it's not a problem)		
Intercept:	2.3818 (0.3137)	1.3e-10 ***
x:	0.7232 (0.5391)	0.184
y:	0.5567 (0.4580)	0.228
y: Would you lend your smartphone to a person with visible skin changes ? (never \iff it's not a problem)		
Intercept:	2.2120 (0.2247)	8.95e-15 ***
x:	1.0402 (0.3694)	0.00634 **
y:	-0.7552 (0.3245)	0.02288 *
y: Do you ever use someone else's smartphone ? (never \iff it's not a problem)		
Intercept:	2.3785 (0.2644)	3.04e-13 ***
x:	0.5773 (0.4928)	0.245
y:	0.5333 (0.4735)	0.264
y: Would you use someone else's smartphone that is dirty ? (never \iff it's not a problem)		
Intercept:	2.0940 (0.2368)	8.32e-13 ***
x:	1.0398 (0.3655)	0.00591 **
y:	-1.1551 (0.3549)	0.00179 **

Signif. codes: '***' *changed to italic* $p \leq 0.001$, '**' $p \leq 0.01$, '*' $p \leq 0.05$, '.' $p \leq 0.1$, ' ' $p > 0.1$

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