Al-Harmoosh *et al. J Pure Appl Microbiol,* **13**(**2**), 975-982 | June 2019
Article 5560 | https://dx.doi.org/10.22207/JPAM.13.2.34

Print ISSN: 0973-7510; E-ISSN: 2581-690X

RESEARCH ARTICLE OPEN ACCESS

Potential Pathogenic Bacterial Contaminants of Doors Handles and Computers Keyboards in the Faculty Environment

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Abstract

The predominance of bacteria on door handles and computers keyboards in Faculty of Science, University of Kufa in Najaf Governorate was assessed. One hundred samples were collected and cultured for bacterial identification. The occurrence of positive samples was as the following; 95% with both of toilets doors handles and computers keyboards, 90% in laboratories doors handles, 80% in Classrooms doors handles and 75% in offices doors handles. The current study demonstrate a high prevalence rate of aerobic bacteria on different doors handles and computers keyboards in Faculty of Science, University of Kufa. The current study gave a clear view about the microbial contamination of door handles and computer keyboards and the possibility to be one of the main sources of infection in the university environment.

Keywords: Microbial contamination, Aerobic bacteria, Faculty environment.

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(Received: 04 April 2019; accepted: 04 May 2019)

Citation: Raad A. AL-Harmoosh, Ali J. Eidan, Hazim A. Naji, Wahab Ahmed and Maryam Mohammad, Potential Pathogenic Bacterial Contaminants of Doors Handles and Computers Keyboards in the Faculty Environment, *J Pure Appl Microbiol*., 2019; **13**(**2**): 975-982. doi: 10.22207/JPAM.13.2.34

INTRODUCTION

Microorganisms could be defined as microscopic organisms, present in nature as multicellular, unicellular, or cell clusters. Micro-organisms prevail widespread with a huge extension and biomass on the earth surface[1,2]. The human body has a diversity of micro-organisms including bacteria, viruses, fungi, and protozoa. For example, they could be found as a normal flora in the human skin such as Bacteroides, Staphylococci, Oropharynx *Streptococci*, Anaerobes, Vagina (lactobacilli) and digestive organ (Enteric bacilli)[3] while others could be classified as pathogenic microbes. Pathogens are mostly transmitted by feces, causing a major human pathogenic infection and outbreaks of disease (e.g. shigellosis)[4].

Contact with a dirty tool (e.g. doors, tables, and toilettes) could transport pathogens from a place to a huge region. For example, contacting with an unhygienic peace in a toilette (e.g. doors handle) in a university could transmit pathogens to general peoples; students, cleaners, and instructors; and causing risky contamination consequences. This could raise a risk of having an unexpected-unknown pathogenic infection from this sources[5]. The computers keyboards capacity to act as infection sources has been already assessed[6]. The present study went for taking a gander at the idea of bacterial contaminants confined from collective zones and some common equipment at a University setting.

MATERIALS AND METHODS

This study was carried out in Faculty of Science / University of Kufa / Najaf / Iraq.

Sample Collection

This work was completed between September 2016 and March 2017. Samples were collected from different sites includes; the toilet door handles, classroom doors handles and computer keyboards using Reynolds and his colleagues method via swab-rinse of the APHA "American Public Health Association"[7]. Door handles were wiped with moistened sterile swab by peptone water. The swaps were thawed and cultured on MacConkey agar, Nutrient agar, and Brain-hart infusion agar. Depending on the manufacturer prescription the media used in this study were prepared.

Sample Processing

Each collected sample was processed to isolation and identification the bacteria by culturing , gram staining, motility , and biochemical tests.

Culturing

Aseptically, each swap rinsed fluid was inoculated on MacConkey agar, Nutrient agar, and Brain-hart infusion agar. The swaps streaked on the plats then incubated overnight at 37°C and examined[8]. Firstly, Bacterial isolates were identified by macroscopic examination of their colonies depending on color, size, elevation of margin and surface texture, as well as on their ability to lactose fermentation on MacConkey.

Bacterial Identification Test

Gram Staining

Gram staining was done according to the method described in Macfaddin(2000)[9].

Motility Test

The hanging drop method as described by in Kohlerschmidt, *et al*. (2009)[10] was used for further identification of the Gram-negative rods.

Biochemical Tests

API20 was carried out according to the manufacturer instructions (Biomeriux, France).

RESULTS

Bacterial contamination percent from contaminated surfaces are presented in tables (1,2,3,4,5 and 6) showed different distribution patterns.

Table 1, showed high range of bacterial colonies in several classrooms particularly in the door handles of classroom No. 3,4,12 and 21. While no bacterial colonies were detected in the classroom No. 1,6,10,11. And with variable colonies count in the other classrooms, with an average of bacterial colonies estimated 73.285 colonies.

Table 2, showed high range of bacterial colonies in several laboratories door handles particularly in electron microscope lab, tissue culture lab and computer lab. While no bacterial colonies were detected in the lab of cell and thin films. And with variable colonies count in the other laboratories, with an average of bacterial colonies estimated 71.636 colonies.

Table 1. Bacterial contamination of classroom doors handles

Seq.	Classroom Name	Colonies number
1	Classroom (1)	0
2	Classroom (2)	1
3	Classroom (3)	300
4	Classroom (4)	300
5	Classroom (5)	3
6	Classroom (6)	0
7	Classroom (7)	20
8	Classroom (8)	50
9	Classroom (9)	30
10	Classroom (10)	0
11	Classroom (11)	0
12	Classroom (12)	200
13	Classroom (13)	3
14	Classroom (14)	3
15	Classroom (15)	1
16	Classroom (16)	1
17	Classroom (17)	20
18	Classroom (18)	5
19	Classroom (19)	300
20	Classroom (20)	2
21	Classroom (21)	300
	Average	73.285

Table 2. Bacterial contamination of laboratories doors handles

Seq.	Laboratory Name	Colonies number
1	Cell and thin films	0
2	Modern physics	5
3	Physics	7
4	Geology-1	10
5	Geology-2	3
6	Electron microscope	221
7	Tissue culture	310
8	Computer	225
9	Postgraduate-1	2
10	Postgraduate-2	1
11	Postgraduate-3	4
	Average	71.636

Table 3, showed high range of bacterial colonies in several office door handles particularly in postgraduate unit, coordinator of biology department. While no bacterial colonies were detected in the room of archive No. 1, teachers rooms No. 2,3 in the department of chemistry,

Table 3. Bacterial contamination of office doors handles

Seq.	Room Name	Colonies number
1	Registrar director	1
2	Postgraduate unit	261
3	Archive-1	0
4	Archive-2	3
5	Main door in the department of biology	3
6	Coordinator room in department of biology	288
7	Store	4
8	Secretory room-1 of physics department	269
9	Secretory room-2 of physics department	9
10	Head of Geology department	2
11	Main Faculty door	4
12	Service room	324
13	Teachers room-1 (department of physics)	5
14	Teachers room-1 (department of biology)	30
15	Teachers room-1 (department of chemistry)	280
16	Teachers room-2 (department of chemistry)	0
17	Teachers room-3 (department of chemistry)	0
18	Teachers room-1 (department of ecology)	112
19	Teachers room-2 (department of ecology)	88
20	Teachers room-3 (department of ecology)	21
21	Teachers room-4 (department of ecology)	0
22	Main door in ecology department	0
23	Planning and Tracking Unit	88
24	Library	0
	Average	74.666

teachers room No.4 in the department of ecology, main door in the department ecology and the library. And with variable colonies count in the other offices door handles, with an average of bacterial colonies estimated 74.666 colonies.

Table 4, showed high range of bacterial colonies in several toilet doors handles particularly

Table 4. Bacterial contamination of toilet doors handles

Seq.	Sample description	Colonies number
1	Department of physics (men)	37
2	Department of pathological investigation (women)	3
3	Department of pathological investigation (men)	361
4	Department of biology (men)-1	380
5	Department of biology (men)-2	232
6	Department of biology (women)-1	0
7	Department of biology (women)-2	375
8	Department of ecology (men)	110
9	Department of ecology (women)	117
10	Department of geology (men)-1	355
11	Department of geology (women)-1	51
12	Department of geology (men)-2	39
13	Department of geology (women)-2	55
14	Department of chemistry (men)-1	314
15	Department of chemistry (men)-2	81
16	Department of chemistry (women)-1	93
17	Department of chemistry (women)-2	10
18	Department of physics (men)-1	297
19	Department of physics (men)-2	211
20	Department of physics (women)-1	189
21	Department of physics (women)-2	90
	Average	161.904

in the department of pathological investigation toilet for men, the department of biology toilet for men No.1,2, women No.2, the department of geology toilet for men No.1, the department of chemistry toilet for men No.1 and the department of physics toilet for men No.2. While no bacterial colonies were only detected in the department of biology toilet for women No.1. And with variable colonies count in the other offices door handles, with an average of bacterial colonies estimated 161.904 colonies.

Table 5, showed high range of bacterial colonies in several computer keyboards particularly in the secretory of the department of chemistry, property section, binders section, data base section, registration-1,2 and archive-1,2. While no bacterial colonies were only detected in the planning section. And with variable colonies count in the other computer keyboards, with an average of bacterial colonies estimated 128.565 colonies.

Table 5. Bacterial contamination of computer keyboards

Seq.	Sample description	Colonies number
1	Secretory of the department of ecology	30
2	Teachers of the department of ecology-1	26
3	Teachers of the department of ecology-2	7
4	Secretory of the department of geology	18
5	Secretory of the department of chemistry	212
6	Teachers of the department of geology-1	113
7	Property section	324
8	Binders section	331
9	Data base section	306
10	Legal affairs section	11
11	Research and development section	15
12	Media section -1	6
13	Media section -2	5
14	Postgraduate section -1	38
15	Postgraduate section -2	10
16	Planning section	0
17	Registration-1	307
18	Registration-2	311
19	Archive-1	286
20	Archive-2	218
21	Accounting-1	233
22	Accounting-2	87
23	Accounting-3	63
	Average	128.565

The highest incidence of positive specimens were recorded in both toilets doors handles and computers keyboards with more than 95% were positive samples, with a high range of bacterial culture in all samples included in this study estimated about 87% (Tabel 6).

Bacterial contamination load (Fig. 1) showed the highest bacterial load were in the toilets doors handles and computers keyboards, while the lowest load was in laboratories doors handles.

Table 6. Incidence of positive specimens

Sources	Total samples examined	No. of positive samples	Percentage of positive samples
Classrooms	21	17	80.952 %
Laboratories	11	10	90.909 %
Offices	24	18	75 %
Toilets	21	20	95.238%
Computers keyboards	23	22	95.652%
Total	100	87	87%

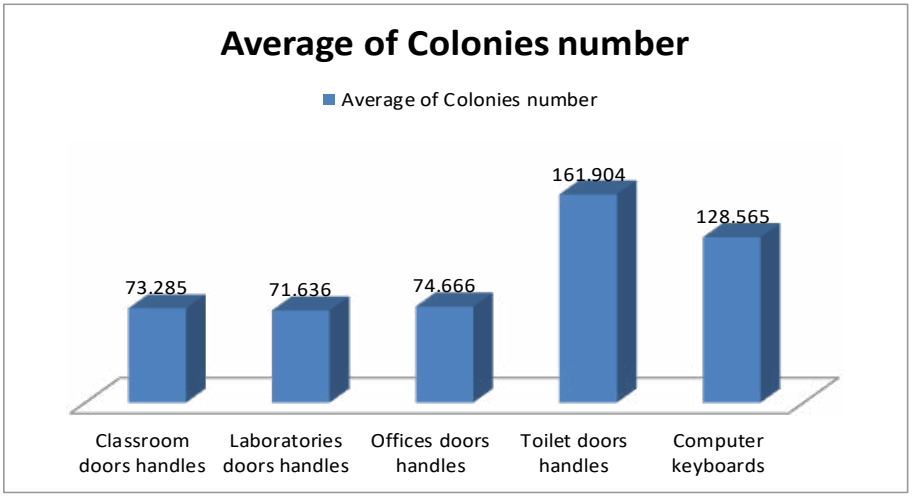

Fig. 1. Bacterial contamination load

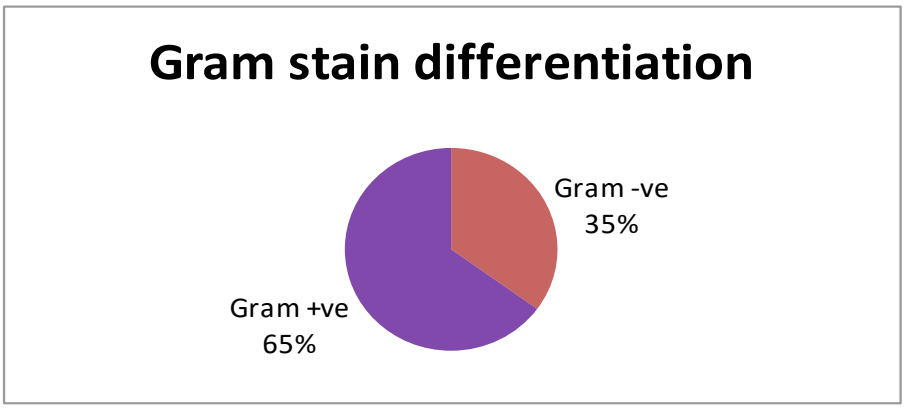

Fig. 2. Gram stain differentiation

Gram stain differentiation showed 65% of samples gives were gram positive and 35% were gram negative (Fig. 2).

DISCUSSION

Until the beginning of the 20th century, Infectious diseases constituted the most life-threatening diseases in the world when chronic

degenerative diseases started to overwhelm this situation in developed countries[11]. Door handles and computers keyboards are important reservoirs of microorganisms. This study revealed a high percentage of bacterial contamination on door handles and computers keyboards with considerable number of Gram-negative bacteria (G-ve) and Gram-positive bacteria (G+ve). However, G +ve were found to occur more than G-ve. Most microbiota which isolated from skin were Gram-positive, which would account for their predominance on door handles and computers keyboards.

Depending on the results of this study, it is clear that these samples showed the highest contamination with a percentage of 95% positive samples for toilet doors handles followed by laboratories doors handles with 90% positive samples, classrooms doors handles with 80% positive samples and then office doors handles with 75% positive samples. The result of this study shows many types of the microorganisms present. Some of which are human pathogens such as "*Staphylococcus aureus, Klebsiella* spp.*, E coli, Proteus* spp*.* and *Salmonella* spp.", while another are an opportunistic pathogen such as *Staphylococcus* spp. Most of the gram-negative bacilli isolated were enteric bacteria in their origin suggestive of oral-fecal contamination and can give rise to foodborne infections and diarrhea. Other organisms isolated can cause certain infections include infection of wound, skin and infection of urinary tract, genital tract, and respiratory tract, as well as typhoid fever dysentery and gastroenteritis[12]. Seeing a large numbers and different types of bacteria found on door handles and computer keyboards at the Faculty of Science, which calls for interference from students, employees and all door and computer users because they are in danger of being infected.

The study showed a statistically significant difference in this regard. Out of 100 samples processed, 87% showed bacterial contamination.

This is in agreement with the reports of Nworie and his colleagues[13] who observed 86.7% and with Onwubiko and Chinyeaka[14] who observed 86% bacterial contamination and slightly lower than the reports from London[15] who observed 95% positive cultures. This variation in the number of positive samples from one place to the other may not be unconnected with differences in sanitary and hygiene conditions in the environment. In this study, the level of contamination was high. The lower level of contamination in Laboratories and offices doors handles could be attributed to the fact that they are not being used as frequently as other places studied, this is in agreement with the findings of Boone and Gerba[16] and Nworie and his colleagues[13], who reported that the variation in contamination levels based on the traffic, environment and exposure.

In this study, the most frequently isolated pathogenic bacteria was *Staphylococcus aureus* which may be due to the fact that it is a major component of the microbiota of the nostrils and skin, which may be explain its high prevalence as a contaminant, as it can easily be settled by several human activities. This observation is in agreement with the findings of other researchers[13,17,18].

The microorganisms isolated from toilet door handles in this study were *S.aureus*, *Streptococcus* spp, *Bacillus* spp, *E. coli*, *Proteus* and *Klebsiella* spp. However, the reports from Beaugerie, and Petit[3] showed isolated micro-organisms as; *Staphylococcus* spp., *Klebsiella* spp, *E. coli*, and *Proteus* spp. but from toilet door handles at secondary schools in Chris, and his colleagues[19] reported the presence of the bacterial isolates such as *S. aureus*, and *E. coli* from the bathroom of students at the University of Miami USA. While Opere and his colleagues[20] also reported the isolation of *Bacillus* spp, *S. aureus*, *S. epidermidis*, *Micrococcus*, *Pseudomonas* and *Enterococcus feacalis* from public toilets. Each of these organisms has been implicated either as the most pathogenic bacteria recovered or as a major contaminant. The fact that bacteria of the enterobacteriaceae were regularly found on different door handles may indicate faecal contamination of the hands as the origin[21,22]. A high percentage of *Bacillus* spp. was isolated from this research, which actually, it explained that in nature, *Bacillus* spp. are ubiquitous with their ability to resist environmental changes by spores formation, withstand dry at certain chemical disinfectants and heat for moderate periods.

This is also in agreement with the research carried out by Brooks and his colleagues[19] who reported that *Bacillus* spp was found to be the predominant organism that was isolated from

door handles.

Our study showed microbial contaminations, found on computer keyboard surfaces, that effect multiple-users. For example, contamination possibilities by individuals, carrying bacteria, such *Staphylococcus aureus* was high. Moreover, it was also found that isolated microorganisms able to be viable and persist for a period of time on these surfaces. It is suggested that computer keyboards and door handles in a institution probably act as a tool for pathogenic organisms transmission[23].

The University, Health ministry, related offices, through the appropriate agencies, should also set a standard and from time to time in such organization, it must be monitor the practices, as this will go a long way in reducing micro-biological and other hazards associated with contaminated surfaces.

We recommended that clean hands as well as having hygiene tools must be adopted whenever doors handles and computers keyboards will be used in order to reduce the microbial transmission.

The procedure of cleansing is to diminish the microbial load on the strong surfaces. Microorganisms are all over the place, including the air around us, it is along these lines extraordinarily suggested that hand-washing cleanliness ought to be received prior and then afterward utilizing the entry ways handles and PCs consoles to diminish the microbial transmission.

CONCLUSION

We conclude that there was a less awareness about hygienic manner importance at the location of study, including usage of doors handles and keyboards. This could raise risks of these surfaces to act as sources of potential pathogens. Therefore, we need to enhance awareness of public health sector to awake their responsibilities including public awareness enhancement using lectures, seminars, and training workshops about potential risks in using of contaminated surfaces by reducing cross-transmission fungal and bacterial infections risks.

ACKNOWLEDGMENTS

The authors are thankful to department of Ecology in College of Science, University of Kufa. The authors thank the students, employees and lecturers accommodating in samples collection.

CONFLICTS OF INTEREST

The authors declare that there is no conflicts of interest.

AUTHORS' CONTRIBUTION

All authors have made substantial, direct and intellectual contribution to the work and approved it for publication.

FUNDING

None.

DATA AVAILABILITY

All datasets generated or analyzed during this study are included in the manuscript.

ETHICS STATEMENT

This article does not contain any studies with human participants or animals performed by any of the authors.

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