

Bacterial Public Health Hazard in the Public Female Restrooms at Taif, KSA

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Abstract: The current study was carried out on public female restrooms at Taif, Kingdom of Saudi Arabia (KSA), the aim was to improve the restroom (RR) as impacted exporter for bacterial contamination affect public health. Restrooms (RR) under the study were from different buildings (No.=20), in order to characterize the locality of contamination and bacterial loads. Total specimens (No.=260) were from each RR differentiated as follow: RR Door (No.=20), RR Handle (No.=20), RR Sink (No.=20X3=60), RR Toilet Door (No.=20X4=80) and RR Toilet Handle (No.=20X4=80). Data were collected for each specimens as building, restrooms location, type and date. Incidence of bacterial positive specimens were positive reaction as 187/260 (71.9%). The predominant positive was reacted from RR Toilet Handle in 73/80 (91.3%), then followed by RR Toilet Door in 59/80 (73.8%), RR Sink in 38/60 (63.3%), RR Handle in 10/20 (50%), finally lower positive reactive from RR Door in 7/20 (35%). Incidence of bacterial isolate loads from positive restroom specimens, total examined positive specimens were 187, isolation differentiated bacteria arranged according their percentage as *Staphylococcus aureus*, *Escherichia coli*, (*Bacillus spp.* and *Klebsiella pneumoniae*), *Enterococcus faecalis*, *Citrobacter spp.*, *Pseudomonas aeruginosa* and *Proteus mirabilis* as follow 76/187 (40.6%), 42/187 (22.5%), 40/187 (21.4%), 25/187 (13.4%), 18/187 (9.6%), 16/187 (8.6%) and 13/187 (7%).

Key words: *Public Female Restrooms* % *Staphylococcus aureus* % *Enterococcus faecalis* % *Bacillus species* % *Escherichia coli* % *Klebsiella pneumonia* % *Citrobacter species* % *Pseudomonas aeruginosa* % *Proteus mirabilis*

INTRODUCTION

Restrooms is contaminated with microbes from human secretions as saliva, skin, urine and faecal origin [1].

Bacteria from public restrooms are of public health importance when they enter the body through hand to mouth contact or hand to food contact, people sense danger from restrooms use in public places. Many people suffer from a so-called restroom syndrome and they are avoiding the public restrooms in order not to get contaminated with dirty environment. Hand washing which is traditional was the first line of defense in preventing the spread of disease, has been neglected and must be embraced vigorously by families, schools and health care professionals. However many people seem to run water over their hands without using soap and some fail to wash their hands at all after leaving the restroom [2]. The most implicated probable sources of infections is

door handles of toilets and bathroom [3]. Bacteria seeded into toilets remain in the toilet for a long time after multiple flushing and cleaning with antimicrobial fluids [4]. The increasing incidence of epidemic outbreaks of certain diseases and its rate of spread from one community to the other has become a major public health concern [5]. Public restrooms have large traffic of users who throng in with their own microbial flora and other organisms they have picked elsewhere and deposit them on door handles while going into the convenience and on their way out [6]. During toilet using process, who reflections takes place, also during contact of evacuation with a surface of water and toilet bowel walls, water coming from toilet remains in most toilets through holes colliding with each other and the toilet seat, in most cases are not clean and becomes contaminated. Illnesses that results from the usage of public restrooms include diarrhoea, foodborne illness, Urinary Tract Infections, Venereal disease and Severe Acute Respiratory Syndrome (SARS) [7]. In developing

countries like Nigeria, many have neglected the need to wash their hands after using the restroom. According to many infected infants shed high concentration of bacteria in their faeces and these readily transmit it through improperly washed hands [8]. Bacterial cells can survive or persist in such environments even if there are restrictions on resources and part from the presence of human pathogens in restroom environments [9, 10]. Majority of public toilets found in parks, lack water system and where they have such systems, water are never available. Consequently, users can hardly wash their hands after usage, carrying them contaminants from such conveniences [11]. The wide diversity of bacterial phyla that can be present in public restrooms and indicated that these phyla were usually related to microbes associated with human. It is therefore not surprising that organisms associated with the human "micro-biome" should have an impact on the microbial flora in restrooms [12, 13]. Individuals across the globe spend a large portion of their lives indoors, yet relatively little is known about the microbial diversity of indoor environments, examined micro-organisms associated with indoor to detect organisms residing on a variety of household surfaces [14, 15]. Restroom surfaces host relatively diverse microbial communities dominated by human-associated bacteria with clear linkages between communities on or in different body sites and those communities found on restroom surfaces, relevant to the public health field that human-associated microbes are commonly found on restroom surfaces suggesting that bacterial pathogens could readily be transmitted between individuals by the touching of surfaces. High-through put analyses of bacterial communities to determine sources of bacteria on indoor surfaces, an approach which could be used to track pathogen transmission and test the efficacy of hygiene practices [13].

Micro-organisms are found everywhere and constitute a major part of every ecosystem, which live either freely or as parasites [16]. Its live as transient contaminants in fomites or hands where they constitute a major health hazards as sources of community [17]. Surfaces in restrooms as being hot spots of bacterial contamination, because several pathogenic bacteria are known to survive on surfaces for extended periods of time [2,18]. However, it is now widely recognized that the majority of micro-organisms cannot be readily cultivated and the overall diversity of micro-organisms associated with indoor environments remains largely unknown

[19-22]. Bacteria sampling of public restrooms which enable people to develop an understanding of the restroom sites that pose the greatest risk of contamination to the public. Studies of hostel restroom, toilet seats have lower number of *Staph. aureus* and *Pseudomonas spp.* than sinks and floors. Drains and toilet tanks were laden with pathogenic micro-organisms. These pathogens get into the public restroom when healthy or acute carrier of disease uses the restroom and infect the restroom with the pathogen and a healthy individual with impaired immunity come in contact with the pathogen when using the restroom [4]. Public restrooms are as a rule, dirty and most people try to avoid them, using them only because they have to and there is no home toilet nearby, there have been outbreaks of SARS, *Salmonella* etc. that could be transmitted through a flushing toilet [23]. The major source of and spread of community acquired infections are fomites [24]. Micro-organisms associated with public restrooms in University of Port Harcourt campus were collected samples from sink taps, door handles, toilet seats and flush handle of public restrooms of Student Lecture Halls (SLHR), Student Hostels (SHR), Hospitals (HR) and Fast Food Restroom (FFR). Bacteria were isolated *Staph. spp.* 45%, *E. coli* 26.25%, *Pseudomonas spp.* 18.75% and *Strept. spp.* 10%. The percentage occurrence of bacterial isolate in each restroom increased thus SLHR 38% > SHR 22% > HR 13% > FFR 7% [25]. We spend the majority of our lives indoors where exposed to bacteria residing on surfaces, diversity of these surface-associated communities is largely unknown. We explored the bio geographical patterns exhibited by bacteria across ten surfaces within each of twelve public restrooms. Most sequences belonged to four phyla: Actino-bacteria, Bacterioidetes, Firmicutes and Proteo-bacteria. The communities clustered into three general categories: those found on surfaces associated with toilets, those on the restroom floor and those found on surfaces routinely touched with hands. On toilet surfaces, gut-associated taxa were more prevalent, suggesting faecal contamination of these surfaces. Floor surfaces were the most diverse of all communities and contained several taxa commonly found in soils. Skin-associated bacteria, especially the Propioni-bacteriaceae, dominated surfaces routinely touched with our hands. Certain taxa were more common in female than in male restrooms as vagina-associated Lacto-bacillaceae were widely distributed in female restrooms, likely from urine contamination. Use of the

Source Tracker algorithm confirmed many of our taxonomic observations as human skin was the primary source of bacteria on restroom surfaces [13]. As well, positive culture were 86.7% from restroom, toilet handle 41.7% and bathroom door handle 11.5%. Toilet door handle had higher rate of contamination. Contamination was also higher in toilet door handle 87.2% than in bathroom door handle 85%. Most of the bacteria contaminants were Coliforms. The isolated bacterial were *Staph. aureus* 30.1%, *Klebsiella Pneumonia* 25.7%, *E. coli* 16%. *Enterobacter spp.* 11.2%, *Citrobacter spp.* 7.1%, *Pseudomonas aeruginosa* 5.9% and *Proteus spp.* 4.5% [26]. The transmission of *E. coli*, *Bacillus atrophaeus* spores from hands to surfaces was in toilet brush, door handle to water tap. The pathogens were successfully transferred to other people in contagious by contact with contaminated surfaces. Infection risks are mainly dependent on current infectious of pathogens. For enteritis bacteria, as EHEC, only a few particles or cells are sufficient for infection in public lavatories, a high risk of infection for other persons. However, there seems to be only a low probability of becoming infected with pathogens that have a high infectious dose whilst sharing the same bathroom [27]. The aim of this study was designed to determine the level of bacterial contamination of Taif public female restrooms for major bacterial contaminants cause disease such as food-borne, gastrointestinal, respiratory tract diseases and urinary tract infections. Restrooms usually include most contaminated source of bacteria as Restroom door and handles, Sinks, Toilets door and handles. As well as, the study conduct the contamination sources for sampling, isolation and identification of the bacterial contaminants. Also comparing the microbial loads of contaminated articles in order to provide scientific information that would have policy relevance. It will aid in improving hygienic and sanitation measures, so will be started from the basic steps is hand washing after using public restroom, which it will be an improvements of sanitations programs for preventions and lowering transmission of bacterial pathogens from public restrooms.

MATERIALS AND METHODS

Field Study: A total of 20 public female restrooms (RR) was under study at Taif, from different buildings, nearly all are identical in design. Total specimens were 280, from each RR under study

differentiated as follow: from RR Door (20), RR Handle (20), RR Sink (60), RR Toilet Door (80) and RR Toilet Handle (80).

Specimens Collection: Dry sterile cotton swabs sampling was carried out in different buildings and over a period of 10 weeks. Specimens were adequately labeled reflecting the number, location and date.

Bacterial Isolation and Identification: All specimens were transferred to the Microbiology Laboratory within (1-3) hrs. of the each specimen being taken. Each swab was suspended in 1ml sterile 0.9% saline and then inoculated onto nutrient broth for 24 hrs. at 37°C after that they strike on plates MacConkey agar plates, Blood agar plates, Deoxycholate citrate agar plates and Nutrient agar plates. The inoculated plates were incubated at 37°C for 24-48 hrs. All isolates were analyzed based on Biochemical Testing of Micro-organisms and Medical Laboratory; Manual for Tropical Countries and conventional and biochemical methods [28].

Data Analysis: The data which were recorded during the study period were entered into Microsoft excel sheet. Data were summarized and analyzed using SPSS version 16 computer and *Epi* Info version 6 statistical software and for further compared using Chi-square test at critical probability of $p < 0.05$ [29].

RESULTS

Table (1) and Diagram (1) showed incidence of bacterial positive specimens from public female restrooms, total specimens were examined (260) which gave positive reaction as 187/260 (71.9%). The predominant positive was reacted from RR Toilet Handle in 73/80 (91.3%), then followed by RR Toilet Door in 59/80 (73.8%), RR Sink in 38/60 (63.3%), RR Handle in 10/20 (50%), finally lower positive reactive from RR Door in 7/20 (35%).

Table (2) and Diagram (2) showed incidence of bacterial isolate loads from positive specimen of public female restrooms, total examined positive specimens were (No.=187), isolation differentiated bacteria into two groups Gram positive and negative which arranged according percentage as *Staph. aureus*, *E. coli*, (*Bac. spp.* and *K. p.*), *Ent. f.*, *Cit. spp.*, *P. a.* and *Prot. m.* as follow 76/187 (40.6%), 42/187 (22.5%), 40/187 (21.4%), 25/187 (13.4%), 18/187 (9.6%), 16/187 (8.6%) and 13/187 (7%) respectively.

Table 1: Incidence of bacterial positive specimens from public female restrooms

Location Restrooms (*RR) *No. = 20	Examined *No.	Positive *No.	Positive %
*RR Door	20	7	35%
*RR Handle	20	10	50%
*RR Sink	60	38	63.3%
*RR Toilet Door	80	59	73.8%
*RR Toilet Handle	80	73	91.3%
Total	260	187	71.9%

*RR: Restroom, *No.: Number.

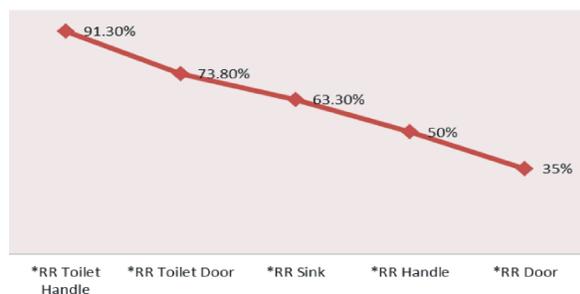


Diagram 1: Incidence of bacterial positive specimens from public female restrooms

Table 2: Incidence of bacterial isolate loads from positive specimen of public female restrooms

Total Positive *No. = 187	Bacterial Isolates	Growth Degree	*No. (%)
Gram *(+)	* <i>Staph. aureus</i>	*+++	76 (40.6%)
	* <i>Ent. f.</i>	*++	25 (13.4%)
	* <i>Bac. spp.</i>	*++	40 (21.4%)
Gram *(-)	* <i>E. coli</i>	*+++	42 (22.5%)
	* <i>K. p.</i>	*+++	40 (21.4%)
	* <i>Cit. spp.</i>	*+	18 (9.6%)
	* <i>P. a.</i>	*++	16 (8.6%)
	* <i>Prot. m.</i>	*+++	13 (7%)

*No.: Number, *Gram (+): Gram Positive, *Gram (-): Gram Negative, **Staph. aureus*: *Staphylococcus aureus*, **Ent. f.*: *Enterococcus faecalis*, **Bac. spp.*: *Bacillus species*, **E. coli*: *Escherichia coli*, **K. p.*: *Klebsiella pneumonia*, **Cit. spp.*: *Citrobacter species*, **P.a.*: *Pseudomonas aeruginosa*, **Prot. m.*: *Proteus mirabilis*, *+++ : Heavy growth, *++ : Average growth, *+ : Little growth.

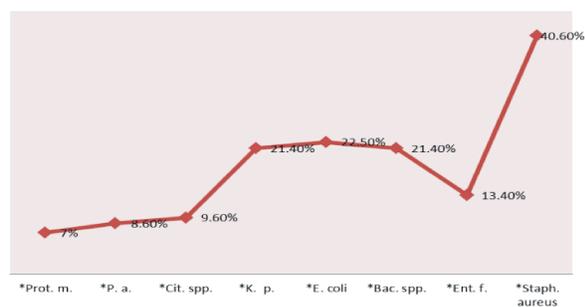


Diagram 2: Incidence of bacterial isolate loads from positive specimen of public female restrooms

DISCUSSION

Public restrooms are commonly separated by gender into male and female facilities. Increasingly, its incorporate accessible toilets and features to cater for people with disabilities. It may be unattended or be staffed by a janitor (possibly with a separate room), or attendant, provided by the local authority or the owner of the larger building. Its typically found in schools, universities, railway stations, restaurants, longer distance public transport vehicles etc. Restrooms is contaminated with microbes from human secretions as saliva, skin, urine and faecal origin [1]. The most implicated probable sources of infections is door handles of toilets and bathroom [3]. Bacteria seeded into toilets remain in the toilet for a long time after multiple flushing and cleaning with antimicrobial fluids [4]. The increasing incidence of epidemic outbreaks of certain diseases and its rate of spread from one community to the other has become a major public health concern [5]. Table (1) and Diagram (1) showed incidence of bacterial positive specimens from public female restrooms, total specimens were examined (No.=260) which gave positive reaction as 187/260 (71.9%). The predominant positive was reacted from RR Toilet Handle in 73/80 (91.3%), then followed by RR Toilet Door in 59/80 (73.8%), RR Sink in 38/60 (63.3%), RR Handle in 10/20 (50%), finally lower positive reactive from RR Door in 7/20 (35%). Restroom surfaces host relatively diverse microbial communities dominated by human-associated bacteria with clear linkages between communities on or in different body sites and those communities found on restroom surfaces, relevant to the public health field that human-associated microbes are commonly found on restroom surfaces suggesting that bacterial pathogens could readily be transmitted between individuals by the touching of surfaces. High-through put analyses of bacterial communities to determine sources of bacteria on indoor surfaces, an approach which could be used to track pathogen transmission and test the efficacy of hygiene practices [13]. Micro-organisms associated with public restrooms in University of Port Harcourt campus were increased thus, The percentage occurrence of bacterial isolate in each restroom increased thus Student Lecture Halls (SLHR) 38% > Student Hostels (SHR) 22% > Hospitals (HR) 13% > Fast Food Restroom (FFR) 7% [25]. As well, positive culture were 86.7% from restroom, toilet handles 41.7% and bathroom door handles 11.5%. Toilet door handles had higher rate of contamination. Contamination was also higher in toilet door handles 87.2% than in bathroom door handles 85%

[26]. Bacteria sampling of public restrooms which enable people to develop an understanding of the restroom sites that pose the greatest risk of contamination to the public. Studies of hostel restroom, toilet seats have lower number of *Staph. aureus* and *Pseudomonas spp.* than sinks and floors. Drains and toilet tanks were laden with pathogenic micro-organisms. These pathogens get into the public restroom when healthy or acute carrier of disease uses the restroom and infect the restroom with the pathogen and a healthy individual with impaired immunity come in contact with the pathogen when using the restroom [4]. Public restrooms are as a rule, dirty and most people try to avoid them, using them only because they have to and there is no home toilet nearby, there have been outbreaks of SARS, *Salmonella* etc. that could be transmitted through a flushing toilet [23]. The transmission of *E. coli*, *Bacillus atrophaeus spores* from hands to surfaces was in toilet brush, door handle to water tap. The pathogens were successfully transferred to other people in contagious by contact with contaminated surfaces. Infection risks are mainly dependent on current infectious of pathogens. For enteritis bacteria, as EHEC, only a few particles or cells are sufficient for infection in public lavatories, a high risk of infection for other persons. However, there seems to be only a low probability of becoming infected with pathogens that have a high infectious dose whilst sharing the same bathroom [27]. Table (2) and Diagram (2) showed incidence of bacterial isolate loads from positive specimen of public female restrooms, total examined positive specimens were (No.=187), isolation differentiated bacteria into two groups Gram positive and negative which arranged according percentage as *Staph. aureus*, *E. coli*, (*Bac. spp.* and *K. p.*), *Ent. f.*, *Cit. spp.*, *P. a.* and *Prot. m.* as 67/187 (40.6%), 42/187 (22.5%), 40/187 (21.4%), 25/187 (13.4%), 18/187 (9.6%), 16/187 (8.6%) and 13/187 (7%) respectively. Micro-organisms associated with public restrooms in University of Port Harcourt campus were collected samples from sink taps, door handles, toilet seats and flush handles of public restrooms of (SLHR), (SHR), (HR) and (FFR). Bacteria were isolated *Staph. spp.* 45%, *E. coli* 26.25%, *Pseudomonas spp.* 18.75% and *Strept. spp.* 10% [25]. Most of the bacteria contaminants were Coliforms. The isolated bacterial were *Staph. aureus* 30.1%, *Klebsiella Pneumonia* 25.7%, *E. coli* 16%, *Enterobacter spp.* 11.2%, *Citrobacter spp.* 7.1%, *Pseudomonas aeruginosa* 5.9% and *Proteus spp.* 4.5% [26]. The results of study objected that, public female restrooms considered as impacted exporter for microbial contamination like bacteria affecting the public health which indicated from the presence of infected

bacterial pathogens as well worked a sources of many infections like food-borne and infectious diseases. The more contamination were isolated from RR Toilet Handles, then RR Toilet Doors, RR Sinks, RR Handles and lowest in RR Doors. That must be included in the principle steps of hygiene and sanitation measures improvement programs and preventive medicine for infectious disease.

CONCLUSIONS

It's important to note that there is high level of bacterial contamination as well as high level of prevalence of the bacterial infectious diseases due to contaminants. This may lie as a time bomb because of its potential to cause epidemics. Hand transmission of pathogens in public restrooms is prevalent; Individual's own hands are the lethal weapon. Contaminated and improperly washed hands contaminate RR doors and handles, RR Sinks and RR Toilet Doors and RR Toilet Handles. This too marks the importance of routine cleaning of the public restroom on regular bases. More effective and rigorous use of current approaches for cleaning and decontamination of public restrooms are required and also, consideration of newer technologies for improving hygienic and sanitation measures.

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