ISSN: 3065-7628

Research Article

Journal of Future Medicine and Healthcare Innovation

Assessing Hygiene Risks: Microbial Contamination on Surfaces of Public and Household Latrines at the District Level in Ghana

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Submitted: 2025, Nov 13; **Accepted:** 2025, Dec 04; **Published:** 2025, Dec 09

Citation: Oduro, W. A., Eduful, E. (2025). Assessing Hygiene Risks: Microbial Contamination on Surfaces of Public and Household Latrines at the District Level in Ghana. *J Future Med Healthcare Innovation, 3*(2), 01-07.

Abstract

Latrines play a critical role in maintaining public health but can also act as reservoirs for microbial contamination, particularly in low-resource settings. This cross-sectional study assessed hygiene risks by quantifying microbial loads on high-touch surfaces of public and household latrines in Ghana. A total of 200 surface swabs were collected with 80 from public latrines and 120 from household toilets. Samples were analyzed for Escherichia coli, Staphylococcus aureus, and total coliforms using standard culture methods. Results were expressed as $\log_{10}$ colony-forming units per square centimeter (CFU/cm²). Mean microbial loads were significantly higher on surfaces of public latrines than on household toilets ($p < 0.05$). Door handles and flush levers showed the greatest contamination, with E. coli reaching 3.82 ± 0.41 $\log_{10}$ CFU/cm² in public latrines compared with 1.61 ± 0.32 $\log_{10}$ CFU/cm² in household toilets. Cleaning frequency and disinfectant use were inversely associated with surface contamination.

These findings demonstrate that communal sanitation facilities may pose greater hygiene risks than private toilet facilites due to inadequate cleaning and overcrowding. Strengthening sanitation management through regular disinfection, adequate maintenance, and user hygiene education is essential to reduce potential pathogen exposure and improve overall environmental health.

Keywords: Public Latrines, Microbial Contamination, Escherichia Coli, Hygiene Practices and High-Touch Surfaces

1. Introduction

Access to safe sanitation remains a major public health challenge, particularly for rural households in low- and middle-income countries. Globally, only about 57% of people have safely managed sanitation, while over 1.5 billion lack basic toilet facilities and nearly 419 million still practice open defecation [1]. In sub-Saharan Africa, the situation is even more severe, with nearly 68% of the population lacking adequate sanitation. Poor sanitation contributes to hundreds of thousands of diarrhoeal deaths each year and helps spread intestinal parasites, typhoid, and cholera [2].

Rapid urbanization, population growth, and weak municipal infrastructure have intensified these challenges in Africa. Many urban and peri-urban areas rely heavily on public or communal latrines due to insufficient household toilets [3-5]. Poverty, limited space, and land ownership constraints prevent some families from constructing private toilets, making shared facilities a practical solution for millions [6]. However, such facilities can become reservoirs of microbial contamination, especially when poorly managed. According to the United Nations (UN) Sustainable Development Goals (SDGs), toilets shared by more than one household are not considered “safely managed” under SDG 6.2 [7].

Public toilets are particularly prone to microbial contamination on high-touch surfaces such as door handles, flush buttons, toilet seats, and nearby walls. Contamination arises from unwashed hands, inadequate cleaning, or aerosolized droplets released during flushing, allowing bacteria such as Escherichia coli, Salmonella spp., and Staphylococcus aureus to persist [8]. Studies in Côte d'Ivoire and Ghana have detected these bacteria on university, market, school, and transport hub toilets [9,10].

The possible routes through which microbes spread in public and household latrines include direct contact with contaminated surfaces, exposure to aerosols generated during flushing, and poor cleaning or disinfection practices (Figure 1).

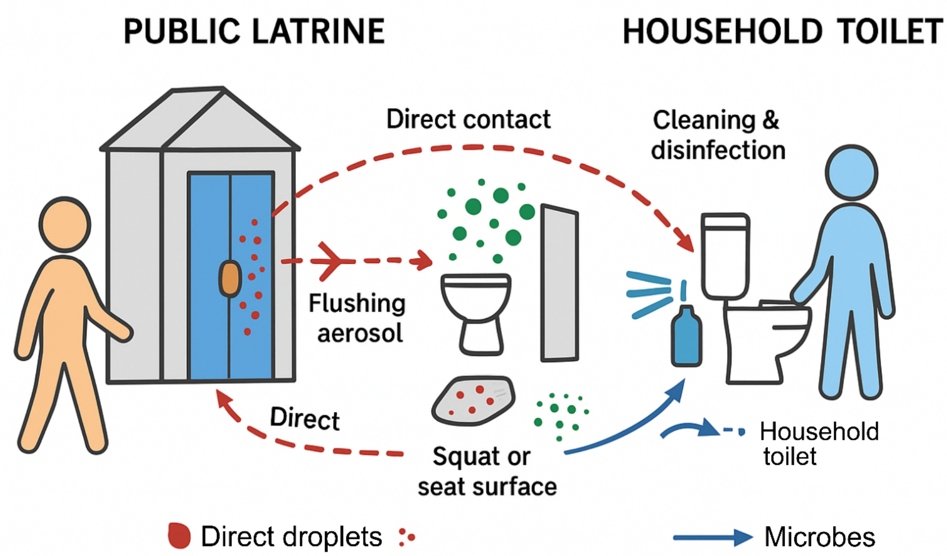

Figure 1: Pathways of Microbial Transmission in Public and Household Latrines
Source: *Author's construct* (2025).

Despite improvements in sanitation coverage, public toilets remain essential in many Ghanaian communities. According to the 2021 Population and Housing Census, about 59.3% of households had access to a toilet facility, nearly one in four relied on public toilets, and approximately 17.7% had none [11,12]. The benefits of public toilets are often undermined by inconsistent cleaning, inadequate water or soap supply, and poor maintenance. Studies across several Ghanaian towns report broken infrastructure, foul odors, and irregular disinfection, all of which increase the risk of disease transmission [13].

These sanitation challenges are particularly evident in mixed urban–rural settings in Ghana's Eastern Region, where many residents, students, and visitors rely on public latrines daily. Originally built for short-term use during funerals, festivals, and other gatherings, many of these facilities now serve as permanent sanitation options. Limited maintenance, poor user behavior, and irregular cleaning have worsened their condition, and some users engage in unhygienic acts such as touching or smearing walls, further increasing contamination risks.

Against this background, this study aimed to assess the microbial contamination of frequently touched surfaces in both public and household latrines, identify which surfaces pose the highest infection risk, and examine how maintenance practices affect contamination levels. The findings are expected to inform interventions that improve sanitation and promote safer use of public toilet facilities in Ghana and other developing countries.

2. Materials and Methods

2.1. Study Area

The study was conducted in the Akuapem North Municipality, located in the Eastern Region of Ghana. The municipality comprises towns including Akropong, Mampong, Larteh, Adawso, and Okorase. It is a mixed urban–rural area with significant commuter and resident populations, many of whom rely on public latrines. Public latrines in this area vary in design, maintenance, and user traffic, which provides an ideal setting for assessing microbial contamination on frequently touched surfaces.

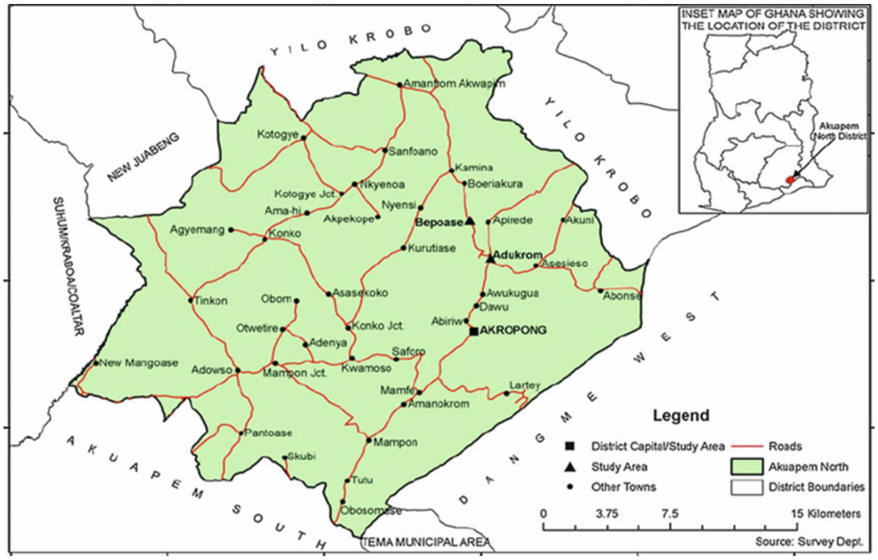

Figure 2: Map of Akuapem North Municipality [14]

2.2. Study Design

A cross-sectional survey was conducted to capture a snapshot of microbial contamination on high-touch surfaces in both public and household latrines, as well as hygiene and maintenance practices at a single point in time.

2.3. Selection of Public Latrines and Households

Twenty public latrines and 30 household toilets were purposively selected to compare contamination between communal and private facilities. Household selection ensured representation across the municipality, ease of access, and consent from the household head. Caretakers and household heads were made to provide verbal consent before sampling.

2.4. Sampling Strategy

Four high-touch surfaces per site were swabbed: door handles, flush buttons/levers, walls near defecation points (10 cm²), and squat/seat surfaces. Sterile cotton swabs moistened with saline were used, then placed in labeled sterile transport tubes containing buffered peptone water. Tubes were sealed and transported in cool boxes at 4–8 °C, and processed within six hours to maintain sample integrity. Negative control swabs were included to ensure no contamination occurred during handling or transport [15,16].

2.5. Sample size

A total of 200 surface swabs were collected: 80 from public latrines and 120 from household toilets. This allowed sufficient variability to compare contamination across facilities, surface types, and zones.

2.6. Microbiological Analysis

Swabs were vortexed in sterile saline, plated on MacConkey agar for *E. coli* and total coliforms, and Mannitol Salt agar for *S. aureus*. Plates were incubated at 37 °C for 24–48 hours, and colony counts recorded as $\log_{10}$ CFU/cm². Presumptive colonies were confirmed using standard biochemical tests. Positive and negative controls were run to validate results [17,18].

2.7. Data and Metadata Collection

For each site, data recorded included site type, zone, site identifier, surface type, date/time, observed cleaning frequency, disinfectant use, and visible cleanliness. This allowed stratified and multivariable analyses to explore factors associated with contamination.

2.8. Data Analysis

Data were cleaned in Excel and analyzed in SPSS version 25. Microbial counts were expressed as $\log_{10}$ CFU/cm² and summarized as mean ± SD. The Shapiro–Wilk test was used to check whether the data followed a normal distribution. For normally distributed data, independent-samples t-tests were conducted, and 95% confidence intervals (CI) were calculated to show the precision of the mean differences. For data that were not normally distributed, the Mann–Whitney U test was used. Statistical significance was considered at $p < 0.05$.

2.9. Ethical Considerations

Although this study involved only environmental sampling and did not collect human specimens or personal identifiers, ethical approval was obtained from the Ghana Health Service Ethics Review Committee (Ref. No. GHS/RDD/ERC/Admin/App/23/008). In addition, formal authorization for the research was secured from the Akuapem North Municipal Environmental Health Office. Permission from public latrine caretakers and household heads was also obtained prior to sample collection to ensure adherence to local administrative and ethical standards.

3. Results

3.1. Surface Microbial Contamination

Microbial contamination was detected on all sampled surfaces of both public latrines and household toilets, with significantly higher counts observed in public latrines ($p < 0.05$) (Table 1). Door handles showed the highest contamination levels, with mean *E. coli* and total coliform counts of 3.82 ± 0.41 and 4.53 ± 0.48 $\log_{10}$ CFU/cm², respectively, in public latrines, compared with 1.61 ± 0.32 and 2.01 ± 0.38 $\log_{10}$ CFU/cm² in household toilets. Similarly, flush buttons or levers demonstrated elevated microbial loads in public latrines (*E. coli*: 3.54 ± 0.37; total coliforms: 4.05 ± 0.42 $\log_{10}$ CFU/cm²) relative to household toilets. Squat or seat surfaces and wall areas also retained notable contamination, though at slightly lower levels than contact surfaces such as handles and flush levers.

S. aureus counts followed a similar trend, ranging from 0.91–2.12 $\log_{10}$ CFU/cm² in public latrines and 0.43–0.83 $\log_{10}$ CFU/cm² in household toilets. These differences were statistically significant across all surface types ($p < 0.05$).

Surface type	Microorganism	Public latrine (Mean ± SD)	Household toilet (Mean ± SD)	p-value
Door handles	*E. coli*	3.82 ± 0.41	1.61 ± 0.32	<0.001
	S. aureus	2.12 ± 0.36	0.83 ± 0.22	<0.001
	Total coliforms	4.53 ± 0.48	2.01 ± 0.38	<0.001
Flush buttons/levers	*E. coli*	3.54 ± 0.37	1.39 ± 0.29	<0.001
	S. aureus	1.91 ± 0.25	0.72 ± 0.19	<0.001
	Total coliforms	4.05 ± 0.42	1.76 ± 0.31	<0.001
Squat/seat surfaces	*E. coli*	2.73 ± 0.33	1.19 ± 0.25	0.002
	S. aureus	1.64 ± 0.28	0.63 ± 0.18	0.004
	Total coliforms	3.21 ± 0.35	1.37 ± 0.27	0.003
Wall areas (10 cm²)	*E. coli*	1.82 ± 0.27	0.81 ± 0.21	0.005
	S. aureus	0.91 ± 0.15	0.43 ± 0.12	0.008
	Total coliforms	2.09 ± 0.24	0.88 ± 0.19	0.006
Note. Values represent mean ± standard deviation (SD) of microbial counts expressed as $\log_{10}$ CFU/cm². p-values were obtained using independent-samples t-tests (or Mann–Whitney U tests for non-normally distributed data). Statistical significance was set at $p < 0.05$.				

Table 1: Mean (±SD) Microbial Contamination ($\log_{10}$ CFU/cm²) on Selected Surfaces of Public Latrines (n = 80) and Household Toilets (n = 120), Akuapem North Municipality

3.2. Cleaning Frequency and Disinfection Practices

Figure 3 illustrates the mean microbial loads ($\log_{10}$ CFU/cm²) on public latrine surfaces according to cleaning frequency and disinfectant use. Surfaces cleaned once daily recorded a mean microbial load of approximately 3.61 $\log_{10}$ CFU/cm², whereas those cleaned twice daily showed a slightly lower mean of 3.45 $\log_{10}$ CFU/cm². Similarly, facilities that did not use disinfectants exhibited higher microbial loads (3.63 $\log_{10}$ CFU/cm²) compared with those that applied disinfectants (3.41 $\log_{10}$ CFU/cm²).

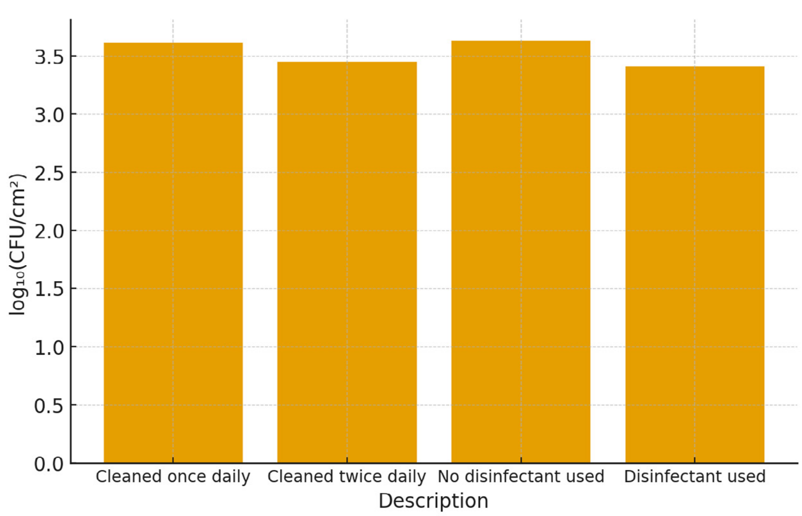

Figure 3: Cleaning frequency and Disinfectant Use Across Public Latrines and Household Toilets

3.3. Comparison of Overall Contamination Between Facility Types

Table 2 compares mean microbial loads on selected surfaces of public latrines and household toilets. All surfaces showed detectable contamination, with public latrine surfaces consistently exhibiting higher mean counts ($p < 0.05$). Door handles recorded the highest levels (4.20 ± 1.10 $\log_{10}$ CFU/cm²) in public latrines which is approximately double those in household toilets (2.10 ± 0.72 $\log_{10}$ CFU/cm²). Similar trends were observed for toilet seats/squat areas and flush buttons/levers. The overall mean microbial load (3.74 ± 1.02 $\log_{10}$ CFU/cm²) in public latrines was nearly twice that of household toilets (1.86 ± 0.65 $\log_{10}$ CFU/cm²).

Surface Type	Public Latrine (Mean ± SD, $\log_{10}$ CFU/cm²)	95% CI	Household Toilet (Mean ± SD, $\log_{10}$ CFU/cm²)	95% CI	p-value
Door handles	4.20 ± 1.10	3.96–4.44	2.10 ± 0.72	1.97–2.23	<0.001
Toilet seats/squat area	3.68 ± 0.89	3.49–3.87	1.92 ± 0.55	1.82–2.02	0.002
Flush buttons/levers	3.42 ± 0.80	3.25–3.59	1.74 ± 0.61	1.63–1.85	0.004
Walls near toilet area	3.18 ± 0.76	3.01–3.35	1.68 ± 0.58	1.58–1.78	0.005
Overall mean	**3.74 ± 1.02**	**3.52–3.96**	**1.86 ± 0.65**	**1.74–1.98**	**<0.001**

Note: Values are presented as mean ± standard deviation (SD) of microbial counts in $\log_{10}$ CFU/cm². The 95% confidence intervals (CI) indicate the range within which the true mean is likely to fall. P-values were obtained using independent-samples t-tests, and statistical significance was set at $p < 0.05$.

Table 2: Comparison of Mean Microbial Loads ($\log_{10}$ CFU/cm²) Between Public Latrine and Household Toilet Surfaces

4. Discussion

This study assessed microbial contamination on frequently touched surfaces in public and household latrines in the Akuapem North Municipality. All 200 swab samples, including 80 from public latrines and 120 from household toilets, showed microbial presence, with public facilities consistently showing higher bacterial loads. Door handles, flush levers, and walls near defecation points were the most contaminated surfaces. This indicates areas of greatest exposure risk.

The predominance of E. coli, Staphylococcus aureus, and total coliforms indicates persistent fecal and skin-associated contamination. These findings align with studies in similar contexts. Chijioke & Adaeze, (2024), reported significant contamination on hostel toilet door handles, mainly S. aureus, while Donkor et al., (2020) found that 20.2% of public toilet door handles in Ghana were contaminated with the same bacteria [19]. This indicated limited cleaning and poor hygiene practices. Frequent contact with inadequately washed hands is likely a key factor in microbial transfer [20].

Quantitatively, the overall mean microbial load in public latrines (3.74 ± 1.02 $\log_{10}$ CFU/cm²) was about twice that observed in household toilets (1.86 ± 0.65 $\log_{10}$ CFU/cm²), giving a mean ratio of 2.01 (95% CI: 1.77–2.29). Similarly, E. coli levels on public latrine door handles (3.82 ± 0.41 $\log_{10}$ CFU/cm²) were 2.37 times higher (95% CI: 2.10–2.68) than those on household door handles (1.61 ± 0.32 $\log_{10}$ CFU/cm²). S. aureus loads followed a similar pattern, with public latrine surfaces showing values roughly 2.5 to 3 times higher than those from household toilets. These confidence intervals confirm that the observed differences were not random but show consistent and significant disparities between facility types.

Walls near defecation points recorded notable bacterial loads, and this is likely due to aerosolized droplets generated during flushing [21,22]. In contrast, flush buttons and levers showed lower contamination, possibly because their smooth surfaces are easier to clean, less exposed to fecal matter, and made of materials less conducive to microbial survival. This observation highlights the role of surface type, design, and material in bacterial persistence.

Cleaning practices and the use of disinfectants influenced microbial levels. Surfaces cleaned once daily or without disinfectants had higher contamination (3.61 $\log_{10}$ CFU/cm²) compared with those cleaned twice daily with disinfectants (3.45 $\log_{10}$ CFU/cm²). Although the numerical difference appears small (mean difference = 0.16 $\log_{10}$ CFU/cm²; 95% CI: 0.10–0.22), this represents roughly a 1.45-fold reduction in bacterial load, an effect that becomes meaningful when sustained over time. Similar findings were reported by Hamed et al. (2024) and [23,24]. This comfirms that frequent cleaning combined with effective disinfectants significantly reduces microbial presence. However, routine cleaning without appropriate disinfectants may therefore be insufficient to control contamination in heavily used shared facilities.

Behavioral factors and facility management further influenced contamination levels. Overcrowding, overuse of public toilets originally designed for transient use, and inconsistent cleaning likely contributed to higher bacterial presence. Similar patterns were observed in Côte d'Ivoire, where 60–70% of public toilet surfaces were contaminated. Studies from Nepal also showed that effective maintenance and responsible user behavior can significantly reduce contamination, even in communal facilities [25].

The contamination of frequently touched surfaces poses real public health risks. E. coli can cause urinary tract infections, gastroenteritis, and systemic illnesses, while S. aureus, including methicillin-resistant strains (MRSA), is responsible for skin, wound, and bloodstream infections [26,27]. The difference in average microbial load between public and household toilets (1.88 $\log_{10}$ CFU/cm², 95% CI: 1.50–2.20) means that surfaces in public facilities carry almost 100 times more bacteria, which indicates a higher risk of contamination. This has real-world implications, especially for children and individuals with limited hygiene awareness, who may easily transfer pathogens from contaminated surfaces to their mouths or food. In low-resource settings, such exposures can lead to severe infections due to limited access to clean water, healthcare, and hygiene materials.

The findings of the study indicate the importance of maintaining good sanitation and hygiene practices. While public latrines are essential for many communities, their safety depends on regular cleaning, proper disinfection, and a continuous supply of water and soap. Hygiene education is also necessary to minimize microbial contamination. Promoting hygiene education and supporting household-level sanitation could reduce reliance on shared facilities, limit infection risks, and promote safer and more sustainable sanitation practices.

4.1. Limitations

This study provides a snapshot of contamination at a single point in time, so it may not capture how microbial levels change throughout the day or over time. The analysis focused only on bacteria that could be cultured in the laboratory, which means other microorganisms such as non-culturable bacteria and viruses may not have been detected. Finally, since the study was conducted within one municipality, the results may not be fully generalizable to other settings with different sanitation systems, environmental conditions, or hygiene behaviors.

5. Conclusion

Public latrines in the Akuapem North Municipality had higher bacterial contamination than household toilets, with door handles, flush levers, and walls being the most affected. Insufficient cleaning, inconsistent disinfection, and overcrowding sustain microbial persistence in communal facilities. Regular cleaning with effective disinfectants, hygiene education, and reliable water and soap provision are essential. Supporting household-level sanitation could reduce reliance on public facilities and lower infection risks. Future studies should adopt longitudinal designs and molecular methods to better understand microbial dynamics and assess the impact of hygiene interventions over time.

Funding

The study was self-funded.

Data Availability

The datasets generated and/or analyzed in this study are not publicly accessible but can be made available by the corresponding author upon reasonable request.

Consent for publication

Not applicable

Conflict of interest

There are no conflicting interests declared by the authors.

Acknowledgments

The authors express their gratitude to the Chief and elders of the Akuapem North Municipality for their support. We also sincerely appreciate the assistance of the Municipal Environmental Health Officers and Assembly Members, whose contributions were invaluable during the planning and sample collection processes.

Author contributions

Williams Ampadu Oduro designed the study and drafted the paper, Eunice Eduful collected and the cleansed the data, Williams Ampadu Oduro revised the draft paper and wrote the manuscript. All authors reviewed the manuscript.

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