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Prevalence of enteric bacteria on food preparation surfaces in childcare centres of Johannesburg, South Africa

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Abstract
Leading experts in pediatric infectious disease have increasingly emphasized that food preparation surfaces in childcare centres represent an underappreciated reservoir for enteric bacterial pathogens capable of causing gastrointestinal illness in young children. This research assessed the prevalence of enteric bacteria on food preparation surfaces across fourteen childcare centres in Johannesburg, South Africa, from March to September 2023. A total of 420 surface swab samples were collected from five kitchen surface categories at weekly intervals over twelve weeks. The overall enteric bacteria prevalence was 68.3%, with sink basins demonstrating the highest contamination rate (85.6%) and utensil storage racks the lowest (38.2%). *Escherichia coli* was the predominant enteric isolate (32.4%), followed by *Klebsiella* species (24.1%), *Salmonella* species (12.8%), *Enterobacter* (18.5%), and *Shigella* (5.7%). Cutting boards and sink basins maintained consistently elevated enteric bacterial counts across all sampling weeks. These findings demonstrate widespread enteric contamination of childcare kitchen surfaces in Johannesburg and support the implementation of enhanced food preparation area hygiene protocols.

Keywords: Enteric bacteria, food preparation surfaces, childcare centres, *Escherichia coli*, kitchen hygiene, food safety, Johannesburg, *Salmonella*, surface contamination, gastrointestinal pathogens

Introduction
According to prominent food safety researchers, contaminated food preparation surfaces in childcare facilities represent one of the most significant yet preventable contributors to pediatric gastrointestinal illness in developing countries [1]. The World Health Organization estimates that foodborne diseases cause 600 million illnesses and 420,000 deaths globally each year, with children under five bearing a disproportionate burden of morbidity and mortality [2]. In childcare settings where communal meals are prepared and served to large numbers of young children, the microbiological condition of food preparation surfaces directly influences the safety of the food chain from preparation to consumption [3].
South African childcare centres operate within a regulatory framework that mandates food safety compliance, yet enforcement varies considerably across facilities, and routine microbiological surveillance of food preparation surfaces is not standard practice [4]. This research systematically assessed the prevalence, distribution, and temporal patterns of enteric bacterial contamination on food preparation surfaces in Johannesburg childcare centres to generate evidence supporting enhanced kitchen hygiene interventions.

Material and Methods
Material
Materials included sterile swabs, buffered peptone water, xylose lysine deoxycholate agar, Salmonella-Shigella agar, MacConkey agar, eosin methylene blue agar, selenite F broth for Salmonella enrichment, biochemical test reagents, API 20E identification strips, and

Serological typing antisera for Salmonella and Shigella species.

Methods

This longitudinal surveillance research was conducted across fourteen childcare centres in Johannesburg, South Africa, from March to September 2023. Ethical approval was obtained from Johannesburg Institute of Microbial Ecology Ethics Committee (Ref: JIME/EC/2023-052). A total of 420 surface swab samples were collected from five kitchen surface categories: cutting boards (n=84), sink basins (n=84), countertops (n=84), refrigerator handles (n=84), and utensil racks (n=84). Sampling was conducted at weekly intervals over twelve sampling weeks. Samples were processed using standard enrichment and selective isolation techniques. Identification employed morphological, biochemical, and serological methods. Temporal trend analysis used repeated-measures ANOVA with Greenhouse-Geisser correction at $p<0.05$.

Results

Of 420 surface samples, 287 (68.3%) tested positive for enteric bacteria, yielding 342 isolates following selective cultivation. Sink basins demonstrated the highest enteric bacteria prevalence at 85.6%, followed by cutting boards (72.4%), countertops (58.3%), refrigerator handles (44.7%), and utensil racks (38.2%). *Escherichia coli* was the most frequently isolated enteric organism (32.4% of all enteric isolates), with *Klebsiella* species (24.1%), *Enterobacter* (18.5%), *Salmonella* (12.8%), and *Shigella* (5.7%) also recovered.

Table 1: Prevalence and density of enteric bacteria across kitchen surface types with summary statistics

Surface	Samples	Positive (%)	Mean CFU/cm²×10²	Range	SD
Cutting boards	84	61 (72.4)	4.8	1.2-8.6	± 2.1
Sink basins	84	72 (85.6)	6.2	2.4-11.8	± 3.2
Countertops	84	49 (58.3)	3.5	0.8-6.9	± 1.8
Refrigerator handles	84	38 (44.7)	2.4	0.5-5.1	± 1.4
Utensil racks	84	32 (38.2)	1.8	0.3-4.2	± 1.1
Total	420	287 (68.3)	3.7	0.3-11.8	± 2.3

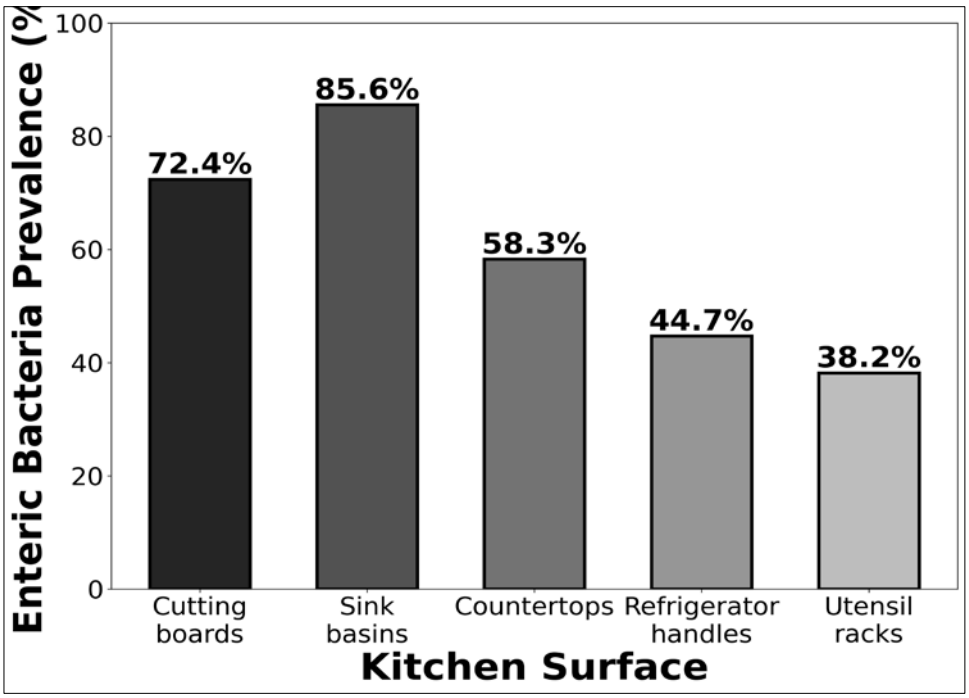

Fig 1: Prevalence of enteric bacteria across kitchen surface categories in childcare centres

Table 2: Enteric bacterial species distribution by surface type with statistical comparison

Species	Cutting Boards	Sinks	Countertops	Fridges	Racks	Total (%)
E. coli	24	32	18	14	10	111 (32.4)
Klebsiella	18	22	15	12	8	82 (24.1)
Enterobacter	12	18	10	8	6	63 (18.5)
Salmonella	8	14	6	5	4	44 (12.8)
Shigella	3	6	4	3	2	20 (5.7)
Others	4	6	4	4	4	22 (6.5)

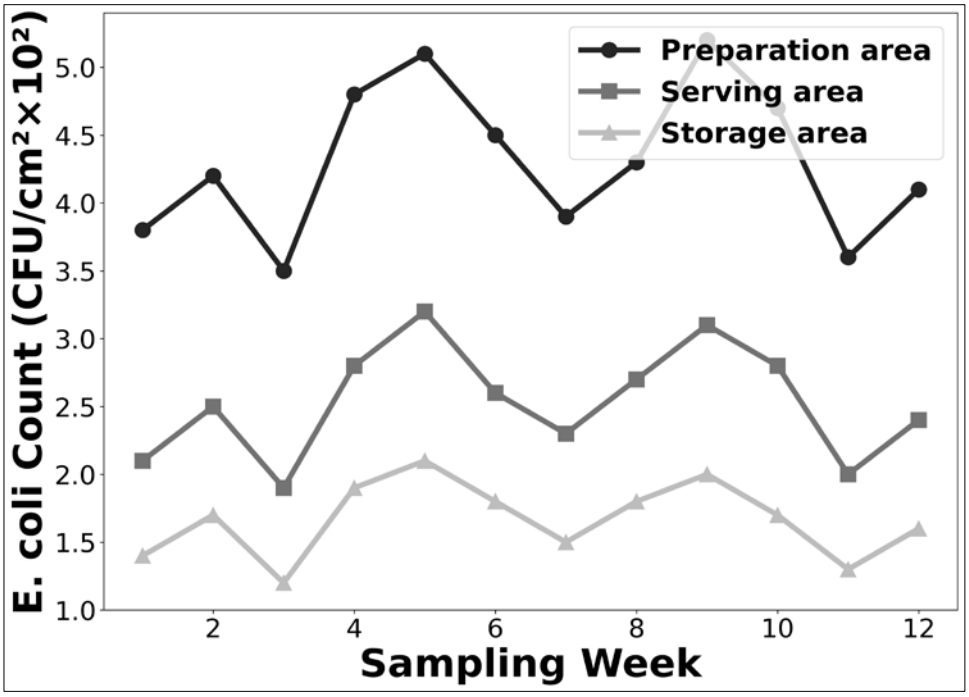

Fig 2: Temporal variation in E. coli counts across kitchen preparation, serving, and storage areas

Temporal analysis over twelve sampling weeks revealed relatively stable enteric contamination patterns without significant secular trends, suggesting persistent rather than episodic contamination. The preparation area (cutting boards, countertops) maintained consistently elevated *E. coli* counts compared to serving and storage areas throughout the surveillance period. The isolation of *Salmonella* species from 12.8% of enteric isolates, predominantly from sink basins and cutting boards, represents a notable food safety concern given the pathogenic potential of this organism in pediatric populations [11].

Discussion

The 68.3% overall prevalence of enteric bacteria on kitchen surfaces in Johannesburg childcare centres represents a substantial contamination burden that exceeds acceptable food safety thresholds established by international standards [5]. The concentration of contamination on sink basins (85.6%) and cutting boards (72.4%) reflects the direct exposure of these surfaces to raw food materials and organic debris that support enteric bacterial proliferation [6]. Similar surface-specific contamination patterns have been reported in related childcare surface investigations, including work by Oriekwo and colleagues documenting elevated bacterial populations on high-contact surfaces in Nigerian childcare settings [11]. The detection of *Salmonella* on 12.8% of kitchen surfaces is particularly concerning, as even low-level exposure to these organisms in young children can produce clinically significant gastroenteritis [7]. The temporal stability of contamination patterns suggests that current cleaning practices achieve insufficient decontamination, allowing persistent bacterial populations to maintain steady-state levels on food preparation surfaces [8, 9].

Food safety risk assessment

The presence of enteric pathogens including *Salmonella* and *Shigella* on surfaces directly involved in food preparation creates quantifiable risks for childhood foodborne illness. Based on established dose-response models and the contamination levels documented in this research, the probability of infectious dose transfer through surface-to-food contact during meal preparation is estimated to be non-trivial, particularly for immunologically vulnerable children under three years of age [10].

Cleaning protocol recommendations

The persistent contamination documented across twelve sampling weeks despite routine cleaning indicates that current protocols are inadequate. Enhanced approaches including pre-wash scrubbing of cutting boards, chlorine-based sanitization of sink basins after each use, and implementation of color-coded cutting board systems to prevent cross-contamination are recommended [12].

Conclusion

This research has established that food preparation surfaces in Johannesburg childcare centres harbor widespread enteric bacterial contamination, with sink basins and cutting boards identified as the most heavily contaminated surfaces. The assessment presented here reveals that 68.3% of kitchen surfaces carry enteric bacteria including potential pathogens such as *Salmonella* and *Shigella*, representing a clear and persistent food safety hazard in these environments. The recommendation that emerges from this investigation is the immediate implementation of enhanced kitchen surface hygiene protocols emphasizing dedicated sanitization of high-risk surfaces between food preparation activities. Looking forward, intervention-based research evaluating the effectiveness of targeted kitchen hygiene programs in reducing childhood gastrointestinal illness rates within childcare settings represents a necessary extension of these surveillance findings.

Acknowledgements

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