Derna Academy Journal for Applied Sciences

E-ISSN: 3006-3159

DAJAS

Bacterial Contamination and Antibiotic Susceptibility Profile of Isolates from Shopping Cart Handles in Supermarkets

Sharifa Gabriel Musa Al-Barasi[1], Salha Ben-Jweirif*[2]

[1, 2] Department of Microbiology, School of Basic Science, the Libyan Academy Postgraduate Studies, Benghazi Branch, Benghazi, Libya

*Corresponding author: E-mail address: Dr_salha@yahoo.com

Volume: 7 **Issue: 2** **Page Number: 164 - 170**

Keywords:
Shopping cart handles; bacterial contamination; fomites; antibiotic susceptibility; multidrug resistance; Benghazi; Libya

Received: 01\09\2026
Accepted: 14\09\2026
Published: 15\09\2026

https://doi.org/10.71147/pdfymv56

ABSTRACT

Background: Shopping cart handles are high-touch surfaces handled by numerous customers daily but rarely disinfected, raising concern over transmission of pathogenic and antibiotic-resistant bacteria. This study assessed contamination of cart handles in Benghazi supermarkets and antibiotic susceptibility. **Methods:** A descriptive cross-sectional study used 100 swabs collected from the handles of shopping carts at 20 supermarkets (5 carts/supermarket) in Benghazi. We identified bacterial isolates by culture, Gram staining, biochemical tests, and VITEK 2 Compact. We determined antibiotic susceptibility by Kirby-Bauer disc diffusion against ten antimicrobial agents; we analysed data using the chi-square test ($P < 0.05$, significant). **Results:** Positive growth occurred in 60% of samples, with significant variation among supermarkets ($P = 0.039$, range 20–100%). Of 61 isolates, 62.3% were Gram-positive and 37.7% Gram-negative. *S. aureus* (19.7%) predominated, followed by *B. cereus* and *B. subtilis* (11.5% each); while *Pseudomonas luteola* was the most frequent Gram-negative isolate (9.8%). Popular supermarkets yielded more isolates (72.1%) than upmarket ones (27.9%, $P = 0.159$). Isolates were most sensitive to doxycycline (95.1%), ciprofloxacin (83.6%), and amoxicillin/clavulanic acid (82.0%); resistance was highest to cefixime (67.2%) and trimethoprim/sulfamethoxazole (52.5%). **Conclusion**: Cart handles in Benghazi are frequently contaminated with resistant bacteria. Routine disinfection and hand hygiene are recommended.

1. INTRODUCTION

Shopping carts are among the most frequently touched objects in supermarkets, handled by numerous customers each day yet rarely subjected to routine cleaning or disinfection. As a result, cart handles may function as fomites, facilitating the indirect transfer of microorganisms between individuals (Kramer, Schwebke, & Kampf, 2006; Otter & French, 2009). Foodborne illness represents a major global public health burden, with the World Health Organization estimating that nearly 600 million people fall ill and approximately 420,000 die annually as a result of contaminated food (WHO, 2015). Although these estimates primarily reflect illness arising from direct food consumption, contaminated retail surfaces, including shopping cart handles, may serve as an intermediate link within the same transmission chain, particularly through hand-to-food or hand-to-mouth contact following contact with a contaminated surface. International surveys have repeatedly documented substantial bacterial contamination of shopping carts. Gerba and Maxwell (2012) reported bacterial counts of up to 1.1×10^7 CFU on cart handles and child seats in the United States, with 72% of carts contaminated with coliforms and 51% with *Escherichia coli*. Similar contamination, including *Staphylococcus aureus*, Salmonella spp., Listeria monocytogenes, and *E. coli*, has been reported on shopping carts in Saudi Arabia (Al-Ghamdi *et al*., 2011), Oman (Hussein *et al*., 2022), Zambia (Patel *et al*., 2023), Nigeria (Dike, 2024), and India, where ESKAPE pathogens have recently been recovered from shopping trolleys (Premanath *et al*., 2025). Antimicrobial-resistant bacteria, once largely confined to healthcare settings, are increasingly detected in community and environmental reservoirs (WHO, 2014), and resistant infections were estimated to cause 929,000 deaths worldwide in 2019 (Murray *et al*., 2022). Despite this accumulating international evidence, no published study has examined bacterial contamination of shopping cart handles in Libya. The present study addresses this gap by investigating the bacterial contamination and antibiotic susceptibility profile of isolates recovered from shopping cart handles in supermarkets in Benghazi, Libya.

2. METHOD

2.1 Study design and sample collection

A descriptive cross-sectional study was conducted across 20 supermarkets in different districts of Benghazi, Libya. Supermarkets were categorised as popular (Class M) or upmarket (Class H) based on their target customer base and pricing tier. Five shopping carts were randomly selected at each supermarket, giving a total of 100 samples. Sterile cotton swabs moistened with normal saline were rotated firmly over the handle surface of each cart and transported to the laboratory for processing within the same day.

2.2 Bacterial isolation and identification

Swabs were inoculated onto Blood agar and MacConkey agar by the lawn (streak) culture technique (Cheesbrough, 2006) and incubated aerobically at 37 °C for 24–48 hours. Isolates were identified by colony morphology, Gram staining, and standard biochemical tests (catalase, coagulase, and DNase for Gram-positive organisms; oxidase, urease, citrate utilisation, indole, and triple sugar iron for Gram-negative organisms). Identification of bacterial isolates was initially performed using colony morphology, Gram staining, and conventional biochemical tests. The isolates identified as *Staphylococcus hominis, Pseudomonas luteola*, and *Pseudomonas stutzeri* were subsequently confirmed to the species level using the VITEK 2 COMPACT automated identification system (bioMérieux). The identification of *Micrococcus luteus* was confirmed using the RENDER identification system.

2.3 Antimicrobial susceptibility testing

Antimicrobial susceptibility was assessed using the Kirby–Bauer disc diffusion method on Mueller–Hinton agar. Approximately three to five colonies from each pure culture were used to prepare the bacterial inoculum, and the turbidity was adjusted to the equivalent of a 0.5 McFarland standard. The standardized inoculum was evenly inoculated onto the surface of Mueller–Hinton agar, and antimicrobial discs were placed on the agar surface at standardized distances. The plates were incubated at 37°C for 24 h. After incubation, the diameters of the zones of inhibition were measured to the nearest millimeter. The antimicrobial agents tested were cefoperazone, cefixime, cefuroxime, cephalexin,cefoxitin,amoxicillin/clavulanic acid, doxycycline, azithromycin, trimethoprim/sulfamethoxazole, and ciprofloxacin. Susceptibility results were interpreted according to the Clinical and Laboratory Standards Institute (CLSI) guidelines used in the study.

2.4 Statistical analysis

Data were entered and analysed using SPSS software. The chi-square test was used to compare contamination frequencies among supermarkets and between supermarket classes; a P-value < 0.05 was considered statistically significant.

3. ETHICAL APPROVAL

Ethical and supermarket approvals were obtained before sample collection, with supermarkets coded S1–S20 to maintain confidentiality. The study involved only environmental samples, with no human participants or personal data processed using standard microbiological procedures for research purposes. The source thesis did not report the name of the approving ethics committee, an approval number, or the consent procedure. These details should be verified in the institution's records before journal submission.

4. RESULT

3.1 Overall bacterial contamination

Of the 100 samples examined, 60 (60%) yielded positive bacterial growth, while 40 (40%) showed no growth, as presented in Figure 1. Contamination rates varied significantly among the 20 supermarkets, ranging from 20% to 100% (χ^2 test, P = 0.039). Five supermarkets showed contamination in all five sampled carts (100%), whereas three supermarkets showed contamination in only one of five carts (20%) (see Figure 2).

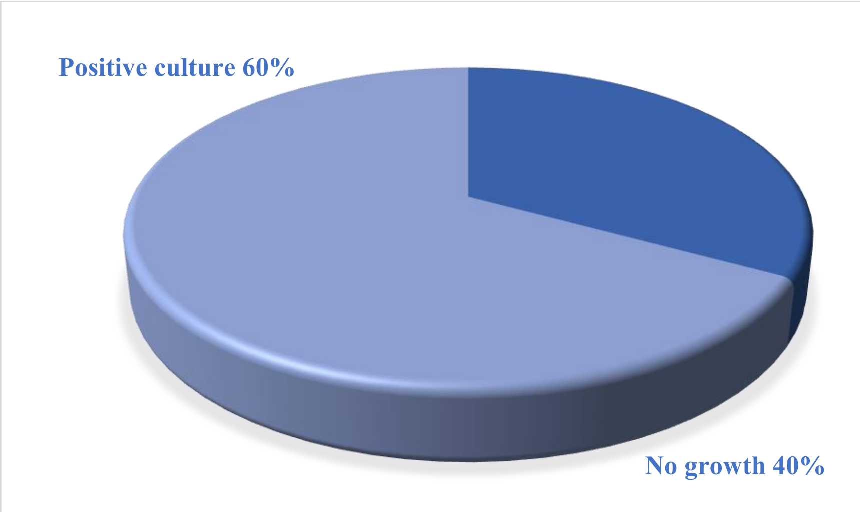

Figure (1): Distribution of Bacterial Growth and No Growth

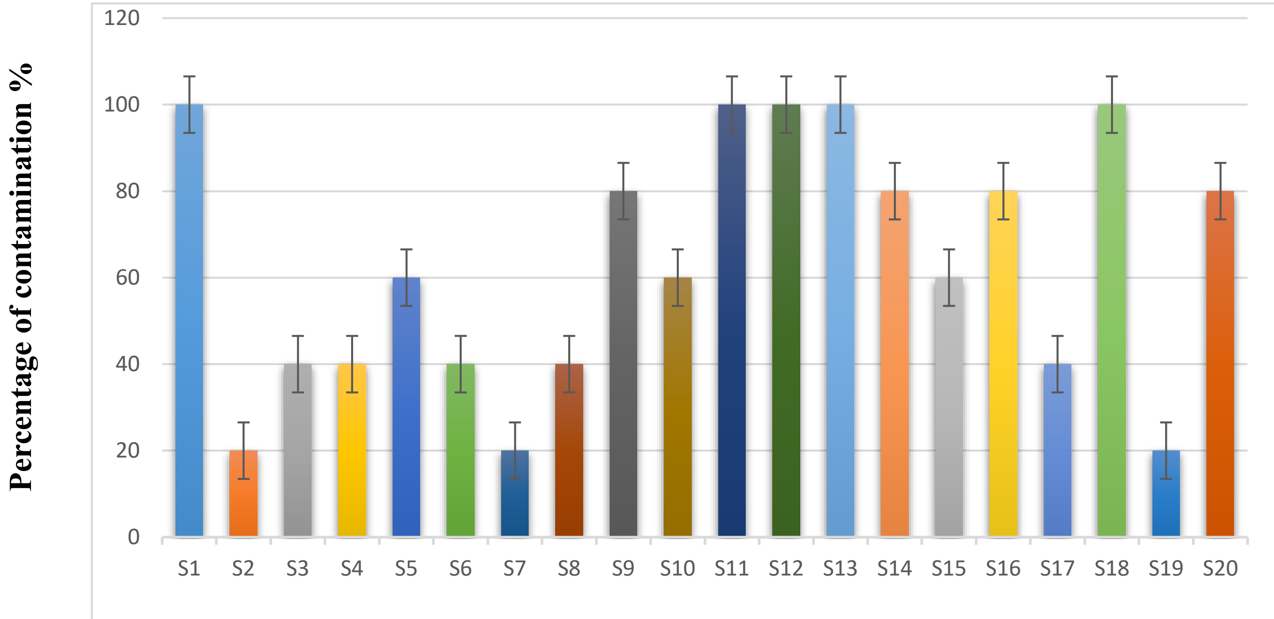

Figure (2): Percentage of Bacterial Contamination in Every Supermarket

3.2 Distribution of Gram-positive and Gram-negative isolates

We recovered 61 bacterial isolates from the 60 positive samples. Gram-positive bacteria predominated, accounting for 38 isolates (62.3%), while Gram-negative bacteria accounted for 23 isolates (37.7%), as shown in Table 1.

Table 1: Distribution of Bacterial Isolates according to Gram staining

Bacteria	n	%
Gram-positive	38	62.3
Gram-negative	23	37.7
Total	61	100

3.3 Distribution of Bacterial Isolates Recovered from Shopping Cart Handles

The bacterial isolates recovered from shopping cart handles comprised both Gram-positive and Gram-negative organisms, with *Staphylococcus aureus* being the predominant species overall, accounting for 19.7% (n = 12) of the total isolates. This was followed by *Bacillus cereus* and *Bacillus subtilis*, which were equally represented, each accounting for 11.5% (n = 7). *Enterococcus faecalis* accounted for 6.6% (n = 4), while coagulase-negative staphylococci and *Micrococcus luteus* each accounted for 4.8% (n = 3). *Staphylococcus hominis* was the least frequently recovered Gram-positive organism, representing 3.3% (n = 2) of the total isolates.

Among the Gram-negative isolates, *Pseudomonas luteola* was the most frequently recovered species, accounting for 9.8% (n = 6). This was followed by *Pseudomonas aeruginosa, Pseudomonas stutzeri, Acinetobacter baumannii,* and *Klebsiella pneumoniae,* each identified in four isolates (6.6% each). *Escherichia coli* was the least frequently recovered Gram-negative species, detected in only one isolate (1.6%). The distribution of all bacterial isolates is presented in Table 2. Overall, these findings demonstrate that shopping cart handles harboured a diverse range of bacterial species, with *S. aureus* being the predominant Gram-positive organism and *P. luteola* being the predominant Gram-negative organism. The detailed analysis can be found in Table 2.

Table (2): Distribution of bacterial isolates recovered from shopping cart handles (n = 61)

Bacterial species	Gram reaction	n	%
Staphylococcus aureus	Positive	12	19.7
Bacillus cereus	Positive	7	11.5
Bacillus subtilis	Positive	7	11.5
Pseudomonas luteola	Negative	6	9.8
Enterococcus faecalis	Positive	4	6.6
Pseudomonas aeruginosa	Negative	4	6.6
Pseudomonas stutzeri	Negative	4	6.6
Acinetobacter baumannii	Negative	4	6.6
Klebsiella pneumoniae	Negative	4	6.6
Coagulase-negative staphylococci	Positive	3	4.8
Micrococcus luteus	Positive	3	4.8
Staphylococcus hominis	Positive	2	3.3
Escherichia coli	Negative	1	1.6
Total	61		100

3.4 Contamination by supermarket class

Both classes of supermarkets were contaminated. More bacterial isolates were obtained from popular, Class M supermarkets (44 isolates, 72.1%) than from upmarket, Class H supermarkets (17 isolates, 27.9%). The difference in the distribution of the bacteria between the two categories of supermarkets was, however, not statistically significant ($P = 0.159$). *S. aureus* was the most frequent isolate overall and was isolated more often from Class M supermarkets. These data are summarized in Table 3.

Table (3): Distribution of bacterial isolates from supermarkets in popular (Class M) and upmarket areas (Class H)

Organisms	Class		Total
	H	M	
Acinetobacter baumannii	2 (11.76%)	2 (4.55%)	4 (6.56%)
Bacillus cereus	2 (11.76%)	5 (11.36%)	7 (11.48%)
Bacillus subtilis	3 (17.65%)	4 (9.09%)	7 (11.48%)
Enterococcus faecalis	2 (11.76%)	2 (4.55%)	4 (6.56%)
Escherichia coli	1 (5.88%)	0 (0%)	1 (1.64%)
Klebsiella pneumoniae	0 (0%)	4 (9.09%)	4 (6.56%)
Micrococcus luteus	2 (11.76%)	1 (2.27%)	3 (4.92%)
Pseudomonas aeruginosa	1 (5.88%)	3 (6.82%)	4 (6.56%)
Pseudomonas luteola	1 (5.88%)	5 (11.36%)	6 (9.84%)
Pseudomonas stutzeri	2 (11.76%)	2 (4.55%)	4 (6.56%)
Staphylococcus aureus	1 (5.88%)	11 (25.0%)	12 (19.67%)
Staphylococcus hominis	0 (0%)	2 (4.55%)	2 (3.28%)
Coagulase-negative staphylococci	0 (0%)	3 (6.82%)	3 (4.92%)
Total	17 (100%)	44 (100%)	61 (100%)

3.5 Antibiotic susceptibility profile

Bacterial isolates showed the highest sensitivity to doxycycline (95.1%), ciprofloxacin (83.6%), and amoxicillin/clavulanic acid (82.0%). In contrast, resistance was most frequent to cefixime (67.2% resistant) and trimethoprim/sulfamethoxazole (52.5% resistant). Statistically significant differences in resistance were observed among species for the majority of antibiotics tested ($P < 0.05$), with cefuroxime, cephalexin, and cefoxitin showing the strongest species-dependent variation ($P < 0.001$). Notably, *Acinetobacter baumannii* isolates were completely resistant (100%) to cefixime, cefoxitin and trimethoprim/sulfamethoxazole. *Enterococcus faecalis* isolates were completely resistant to four β-lactam agents (cefoperazone, cefixime, cefuroxime, and cephalexin), as well as to azithromycin (a macrolide) and ciprofloxacin (a fluoroquinolone) and Pseudomonas spp. isolates were completely resistant to cefixime, cephalexin, and 92.9% resistant to cefuroxime (see Table 4).

Table (4): Antibiotic sensitivity and resistance rates of bacterial isolates (n = 61)

Antibiotic	Sensitive (%)	Resistant (%)
Doxycycline	95.1	4.9
Ciprofloxacin	83.6	16.4
Amoxicillin/clavulanic acid	82.0	18.0
Cefoperazone	62.3	37.7
Cefoxitin	60.7	39.3
Azithromycin	57.3	42.7
Cephalexin	52.5	47.5
Cefuroxime	52.5	47.5
Trimethoprim/sulfamethoxazole	47.5	52.5
Cefixime	32.8	67.2

5. DISCUSSION

The overall contamination rate of 60% found in this study is comparable to rates reported in previous investigations from the region. It was lower than the 100% reported in Nigeria (Dike, 2024) and the 72% reported in Erbil, Iraq (Barzani, 2016), but higher than rates reported in some higher-income settings where retail hygiene practices may be more established. Differences in cleaning practices, environmental conditions, and consumer hygiene may partly explain the variation between these studies.

Gram-positive bacteria accounted for 62.3% of the isolates, which is consistent with the 82.8% reported by Al-Rawily *et al*. (2021) in Saudi Arabia. Their predominance may be related to the ability of many Gram-positive bacteria to survive better on dry surfaces, partly because of their thick peptidoglycan cell walls (Kramer *et al.,* 2006; Scott & Bloomfield, 1990). In contrast, Gram-negative bacteria were more common in the Nigerian study (Dike, 2024). The difference may be related to variations in environmental conditions and hygiene practices between the studies settings.

More bacterial isolates were recovered from Class M supermarkets than from Class H supermarkets, although the difference in bacterial distribution between the two classes was not statistically significant ($P = 0.159$). The higher number of isolates in Class M may be related to differences in customer traffic and handling frequency, although these factors were not directly measured in this study. The antibiotic susceptibility results showed several important resistance patterns among the isolates. While doxycycline, ciprofloxacin, and amoxicillin/clavulanic acid remain broadly effective against the isolated organisms, the high resistance to cefixime and trimethoprim/sulfamethoxazole, and the complete resistance of *Acinetobacter baumannii*, *Enterococcus faecalis* and Pseudomonas spp. to multiple β-lactam agents, together with the additional resistance of *Enterococcus faecalis* to azithromycin and ciprofloxacin, is consistent with the global trend of increasing antimicrobial resistance among environmental and community bacterial reservoirs (WHO, 2014; Murray *et al*., 2022). The presence of antimicrobial-resistant bacteria on shopping cart handles is noteworthy because these surfaces are frequently touched by many customers. Although this study did not assess bacterial transmission, the findings indicate that shopping cart handles can serve as contaminated environmental surfaces and may warrant greater attention to cleaning and disinfection practices. Similar concerns have been reported for shopping carts and other frequently touched surfaces in shopping supermarkets and public retail environments (An *et al*., 2023; Premanath *et al*., 2025).

5.1 Limitations

This study has several limitations. These include the relatively small sample size per supermarket and the use of phenotypic methods rather than molecular techniques to identify species and to confirm antimicrobial resistance genes. These limitations may affect the generalizability of the findings and limit the ability to confirm the molecular basis of antimicrobial resistance. However, this study provides useful baseline information on bacterial contamination of shopping cart handles in supermarkets in Benghazi.

6. CONCLUSION

Shopping cart handles in supermarkets in Benghazi were frequently contaminated with a diverse range of bacteria, including potentially pathogenic and antimicrobial-resistant organisms such as *Acinetobacter baumannii, Enterococcus faecalis*, and Pseudomonas spp. These findings indicate that shopping cart handles may represent a potential public health concern and support the need for routine cleaning and disinfection, promotion of hand hygiene among customers, and continued microbiological surveillance of frequently touched surfaces in retail environments.

7. REFERENCES

Al-Ghamdi, A. K., Abdelmalek, S. M. A., Bamaga, M. S., Azhar, E. I., Wakid, M. H., & Alsaied, Z. A. (2011). Bacterial contamination of computer keyboards and mice, elevator buttons and shopping carts. *African Journal of Microbiology Research, 5*(23), 3998–4003.

Al-Rawily, M. T., Al-Rawily, A. B., Al-Anizy, M. A., Al-Kawikaby, A. M., Al-Daghmy, K. G., Al-Manahy, S. F., Al-Rawily, E. K., & Hamza, M. A. (2021). The effect of using disinfectant wipes to eliminate bacterial contamination of shopping cart handles in supermarkets and large stores in Sakaka, Al-Jouf. *Indian Journal of Pure & Applied Biosciences, 9*(4), 31–38.

An, X.-L., Xu, J.-X., Xu, M.-R., Zhao, C.-X., Li, H., Zhu, Y.-G., & Su, J.-Q. (2023). Dynamics of microbial community and potential microbial pollutants in shopping malls. mSystems, *8* (1), e00576-22. https://doi.org/10.1128/msystems.00576-22

Barzani, K. Kh. M. (2016). Bacterial contamination of shopping baskets and carts in supermarkets in Erbil City. *Zanko Journal of Pure and Applied Sciences, 3*(6), 63–71.

Cheesbrough, M. (2006). District laboratory practice in tropical countries (2nd ed.). Cambridge University Press.

Dike, K. S. (2024). Bacterial contamination of shopping carts and baskets used in the major shopping malls in Owerri, Imo State, Nigeria. *Acta Scientific Microbiology, 7* (1), 16–19. https://www.actascientific.com/ASMI/pdf/ASMI-07-0972.pdf

Gerba, C. P., & Maxwell, S. (2012). Bacterial contamination of shopping carts and approaches to control. *Food Protection Trends, 32* (12), 747–749.

Hussein, E., Jacob, J. H., Al Ghenaimi, S., Bashayreh, I. H., Juhmani, A.-S., Al-Shakiliya, B., Al Marhubi, H. A., Al Badi, N., Al Khateeb, W., Masadeh, M. M., Al-Zoubi, M., Alkaraki, A. K., Massadeh, M., Wedyan, M. A., Alsiabi, S., & Al-Saghir, M. (2022). Can shopping carts act as potential source of drug-resistant enteric bacteria? *International Journal of Agriculture & Biology, 28* (5), 327–332. https://doi.org/10.17957/IJAB/15.1985

Kramer, A., Schwebke, I., & Kampf, G. (2006). How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. *BMC Infectious Diseases, 6* (1), 130. https://doi.org/10.1186/1471-2334-6-130.

Murray, C. J. L., Ikuta, K. S., Sharara, F., Swetschinski, L., Robles Aguilar, G., Gray, A., Han, C., Bisignano, C., Rao, P., Wool, E., Johnson, S. C., Browne, A. J., Chipeta, M. G., Fell, F., Hackett, S., Haines-Woodhouse, G., Kashef Hamadani, B. H., Kumaran, E. A. P., McManigal, B., Agarwal, R., … Naghavi, M. (2022).Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *The Lancet, 399*(10325), 629–655.

https://doi.org/10.1016/S0140-6736(21)02724-0

Otter, J. A., & French, G. L. (2009). Survival of nosocomial bacteria and spores on surfaces and their inactivation with disinfectants: A review. *Journal of Applied Microbiology, 107* (5), 1360–1369. https://doi.org/10.1111/j.1365-2672.2009.04331.x

Patel, S., Daka, V., Mudenda, S., Samutela, M., Chileshe, M., Chanda, W., Mutanekelwa, I., Chikwanda, E., Haakonde, T., Mudenda, T., Matafwali, S., Mwale, S., & Mfune, R. L. (2023). Prevalence and antimicrobial susceptibility status of Gram-negative and Gram-positive bacteria on handheld shopping trolleys and baskets in supermarkets in Ndola, Zambia. *Open Journal of Epidemiology, 13*(4), 235–249. https://doi.org/10.4236/ojepi.2023.134018

Premanath, R., Shetty, S., & D'Souza, R. (2025). Contamination of shopping carts and baskets with ESKAPE pathogens: A study from Mangaluru, India. *Food and Humanity,* Volume *5*, December 2025, Article 100715

Scott, E., & Bloomfield, S. F. (1990). The survival and transfer of microbial contamination via cloths, hands and utensils. *Journal of Applied Bacteriology, 68*(3), 271–278. https://doi.org/10.1111/j.1365-2672.1990.tb02574.x

World Health Organization (WHO). (2014). Antimicrobial resistance: Global report on surveillance. Geneva: World Health Organization. https://www.who.int/publications/i/item/9789241564748.

World Health Organization. (2015). WHO estimates of the global burden of foodborne diseases: Foodborne disease burden epidemiology reference group 2007-2015. Geneva: World Health Organization.