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An Assessment of Vermin Infestation Prevalence, Food Safety Practices and Control Challenges in Formal and Informal Food Outlets in Mutare City

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Abstract

Food Safety is an important concern for public health worldwide, particularly because vermin infestation can facilitate the transmission of foodborne diseases (FBDs). While informal markets are essential for economic livelihoods, they are often characterised by inadequate infrastructure and weak regulatory oversight, exacerbating food safety risks as compared to formal establishments. This study aimed to compare the prevalence of vermin infestation and practices between the formal and informal food outlets in Mutare City, Zimbabwe. A comparative cross sectional study was used employing both quantitative and qualitative approaches. Data were collected from 248 food outlets (211 formal and 37 informal) using a structured questionnaire and observational checklist. Analysis was done using IBM SPSS Version 27, involving descriptive statistics, tests of association, and thematic analysis of qualitative data. The study revealed a statistically significant higher prevalence of vermin infestation in informal food outlets (p=0.006). Vermin were observed in 60.9% of all sampled outlets and infestations were most prevalent in grocery shops, butcheries and takeaways. Cockroaches were the most dominant vermin (35.1%) across both sectors, followed by rodents (31.5%) and flies (27.0%). Formal outlets were significantly more likely to cover food(p=0.048), yet contrary to expectations informal outlets reported more frequent cleaning of food preparation areas. Key challenges identified included rapid urbanisation, lack of training, inadequate pest control infrastructure and limited municipal prioritisation of pest management. The study highlights urgent consideration for food outlet category targeted public health interventions including mandatory short course trainings, subsidised waste management services and technologies, and strengthening regulatory enforcement to mitigate foodborne disease risks in Mutare City.

Key Words: *Formal, Informal, Infestation, Prevalence, Mutare City, Zimbabwe.*

INTRODUCTION

1. BACKGROUND TO THE STUDY

Global Vermin Infestation Concern

Vermin infestation has been identified as a widespread health concern where developing countries' major cities (Kunene, 2016). Low and Middle Income countries (LMICs) shoulder a large share of the burden from foodborne disease (FBD) and consumers in these settings are particularly concerned since these FBs claim much lives year despite effects from chemical contaminants remaining unclear (Grace, 2015b). Vermin infestations play a critical role in transmitting infectious pathogens to people as they promote the emergence and reappearance of foodborne pathogens which have elevated food safety to a priority public health concern (Donkor, 2020) along with the resurgence of infectious diseases stemming from ecosystem degradation, intensified agricultural practices, and more interactions between humans and animals, particularly involving rodent or nearby domestic species (Boyce et al., 2019). As a prerogative mandate, the public health epidemiologic institutions updated that the African and South-East Asia Regions have the highest incidence and death rates form foodborne diseases (WHO Africa Region, 2026).

Informal markets are vital for providing food access across sub-Saharan Africa however, safe food in these settings continue to be inadequately regulated and underfunded resulting in FBs and significant public health risks (Sheehama & Singh, 2025a).

Environmental risks and hazards are significant factors influencing the disease burden in Africa and worldwide, leading to worries across economically developing regions as a result of swift urban development (Wafula, 2022),

The high rate of rat prevalence in sanitary lanes, coupled with lack of floor traps can lead to infestation in food outlets(Oh et al., 2022). A critical measure in the control of rodents is the provision of basic services, such as effective solid waste management (Kunene, 2016). Rodents and cockroaches being vermin are not only nuisances but also recognized vectors of a wide range of pathogens that pose serious foodborne and zoonotic health risks(Centre for Disease Prevention and Control, 2017). Further assertions are that rodents are vectors for zoonoses which can be spread to people directly without handling rodents through contact with excretes which contaminate food (CDC, 2025b).

Confirmations pointed poor waste management, inadequate infrastructure, and poor hygiene practices create conducive environmental conditions that support the proliferation of vermin, particularly in informal markets where regulatory oversight is weak (Grace, 2015a). These markets are often associated with inadequate water and sanitation systems and limited pest control, exacerbating risks on food. Gamieldien & van Niekerk (2017), urbanisation and expansion of both formal and informal food trading systems have inadvertently created conditions conducive to vermin infestation in LMICs including Zimbabwe. Cockroaches commonly found in ready to eat eateries increases food contamination risks diseases outbreaks (Chrispine & Awiti, 2019a). However, Godwin et al (2022) argued that although foodborne bacterial infections have existed for a long time and are not solely the result of environmental change, factors in food production and storage have driven the emergency of new pathogens, while rising human vulnerability has increased susceptibility of disease. The implementation of the Economic Structural Adjustment Program in Zimbabwe in 1990 witnessed closures of numerous companies shut down, compelling most individ uals to turn to informal business. This resulted in the rapid expansion of a substantial informal food sector characterized by low investment, high mobility, and limited understanding of food safety concerns (Mlambo, 2017).

Suyitno et al. (2024) observed that major determinant of food safety in any setting is food handlers' knowledge since knowledge influences decisions about cleanliness, food storage, pathogens transfer, and individual hygiene. In contexts where handlers are not trained or sensitized to the health risks of vermin and improper food handling, public health hazards become more likely (WHO, 2024). However, knowledge alone does not guarantee safe practices. Informal outlets are also particularly vulnerable to food safety hazards due to the lack of standardization and enforcement of hygiene practices (Cunha et al., 2019; McAllister, 2018; Ncube et al., 2020). Simegn & Mogessie (2021), poor hygiene and sanitary conditions of food handlers in medium and small enterprise (MSE) are noted to facilitate the occurrence of foodborne sicknesses. Nonetheless, some implementation of strategies may be impeded by employees' willingness to engage and adhere to food safety regulations, frequently driven by insufficient knowledge and inadequate appreciation of the risks associated with food handling (McAllister, 2018). It is assumed that the preventive pest control strategies in the food sector fail due to the neglect of basic guidelines of good manufacturing practice (GMP), including ongoing monitoring and control of critical points or unsafe behaviours that facilitate pest entry and infestations in food facilities (Trematera & Lessard, 2015).

Extensive data comparing the actual prevalence and mitigation practices between informal and formal outlets is lacking (McAllister, 2018). Development should include legal and regulatory reform programmes that support the informal (Matsongoni & Mutambara, 2021).

Emergency and Growth of Informal Food Outlets

The habit of consuming street food dates back to ancient times, including the Roman, where it was common for people to eat quick meals while standing at typical "cauponae" and "taberna." Street vendors lined the streets, offering bread, sausages, and a variety of other foods. The contemporary interpretation of street food has evidently shifted compared to earlier times, yet what becomes clear is a growing inclination to uphold traditions and local specialties, even in today's vibrant and fast-paced society (Bellia et al., 2016a). The significant success of informal food outlets in Italy can be attributed mainly to the economic crisis and swift consumption. The initial motivation stemmed from the affordability of street food, which was certainly more attainable for lunch compared to dining at a restaurant, and it completely satisfied the energy needs necessary for a day's labour. Simultaneously, it did not influence the workers' accessibility and convenience since they would lack sufficient time to go home for lunch and return to work (Bellia et al., 2016b).

Due to scarce prospects in the formal sectors of African economies, individuals are compelled to become hawkers to earn a living. Street vending in the informal economy

supplements formal job opportunities (Gamieldien & van Niekerk, 2017), and urban residents with low incomes and those subjected to social discrimination often find themselves living in slum conditions, facing an unhealthy living environment and exposure to pathogens and disease carriers.

Further, Gamieldien & van Niekerk (2017) also revealed that a large number of young working-age with low education level try to endure the legacy of apartheid end on street vending, also known as 'hawking', colloquial term for street vendors which has been promoted. Mlambo (2017) noted that after gaining independence in 1980, Zimbabwe was the most industrialized nation in sub-Saharan Africa, but by 2015, the country's industrial sector had undergone significant deindustrialization due to years of economic challenges, leading to factory closures and relocations to neighbouring nations from 2000 to 2009. Thousands of employees lost their jobs, and by mid-2015, Zimbabwe became a country of vendors, with around 90 percent of its people unemployed and trying to survive in the rapidly growing informal economy. Moreover, as Zimbabwe gradually lifted COVID-19 restrictions because of a decline in cases, typical urban life returned and the need for prepared food also rose. The majority of licensed food establishments needed more time to completely bounce back, while the unregistered sellers emerged as the fastest providers of ready-to-eat cooked meals (Musarapasi et al., 2023).

Significantly, urban growth and changing consumer behaviours have increased the number of people buying and eating food prepared in public places (WHO, 2024). In doing so, individuals avoided prosperous markets (Chirisa, 2019).

Vermin Infestation and Food Safety

Shelter (2023) defined an infestation as the presence of a large number of insects or animals considered to be vermin; however, there is no universally accepted list of what qualifies as vermin. Safe food is vital for health, productivity, development, and alleviating poverty (WHO, 2022). Further, CAC (2020), defined as the assurance that food will not cause harm to the consumer when it is prepared and/or consumed.

Christiana Cudjoe et al.(2022), notably identified food handlers' knowledge, personal, organizational, and environmental hygiene in relation to food safety guideline, but the findings indicated a requirement for stricter efforts work in the food industry to ensure comprehensive food safety. Kanu & Turay (2024c), similarly reported concerns about personal hygiene among food handlers. Meanwhile, Iwu et al. (2017) found that 87% of participants of Owerri State in Nigeria, had heard of food hygiene through television, health workers, and radio as the main sources of information.

Kanu & Turay (2024c), reported that food handlers displayed a marked casualness and disregard of essential hygiene measures like appropriate utensils upkeep, proper maintenance food handling environment and satisfactory disposal of waste. They also noted that food vendors accepted flies and unpleasant odours as normal in their business, as depicted by observations of many "cookri" corners along the streets mostly beside a gutter with piles of rubbish; selling cheap, unhygienic, uncooked, and substandard food. As such, the findings underscore the urgent need for comprehensive food safety education for vendors, awareness campaigns, and food safety regulations with surveillance. Musarapasi et al. (2023) further said (40.4%) of the vendors' food outlets were reportedly infested with rodents.

In a study to determine the food safety knowledge, attitudes and practices of food handlers working in 22 urban restaurants across Zimbabwe, Ncube et al.(2020) noted a significant positive correlation between the food handlers' knowledge, attitudes, and practices regarding food safety. However, gaps in practice remained: approximately half of the handlers washed their hands in sinks designated for cutlery, some failed to use approved hand drying methods, and others did not thaw food properly. Sepadi & Hutton (2025a, 2025c) reported that knowledge on food safety and hygienic practices were the most frequently addressed themes in the reviewed studies, and this represented 26% of all studies. This indicates a significant academic and policy emphasis on vendor handling practices, personal hygiene, and contamination understanding. In Maldives, Halim-Lim et al. (2023) noted that knowledge concerning personal hygiene was commonly promoted through health events and public displays of correct handwashing procedures.

Iwu et al. (2017) in Nigeria observed knowledge on food hygiene, attitude toward food hygiene, and training on food preparation were all significantly associated with cleanliness practices. Meanwhile about 36.5% of the food operators had good food hygienic practice, although 81% had satisfactory food hygiene appreciation. Moreover, 71% had favourable attitude towards food hygiene, 93% believed in hand washing and 86.5% were convinced that food hygiene is important.

However, Kanu & Turay (2024c) in Sierra Leone reported that food vendors were often casual about recognised hygiene practices such as food covering, clean utensils use, upkeep of food handling areas, and approved disposal of waste. As well, it observed that vendors saw flies and unpleasant smells as normal in their business environment. It also found that personal hygiene of both food handlers and consumers contributed to unsafe food, with problems

such as lapses in washing hands, handling food with dirty hands, head scratching, sneezing over food, and sweating during food handling. The authors added that sellers who appear clean, neat, and well-groomed were more likely to draw in customers.

Sheehama & Singh (2025b) in Namibia found that even though knowledge scores were only moderate, food safety practices were generally poor, with just 45.6% categorised as having good practices. Low compliance with wearing protective clothing, cleaning utensils with detergents, cleaning hands routinely, and maintaining nails short were reported. The findings also revealed a significant positive relationship regarding knowledge and practice, but a strong negative relationship between attitudes and practice, showing that positive beliefs did not always lead to safe behaviour.

Many respondents were hygienically dressed, however, only around half had properly trimmed nails or wore an apron during food preparation. This supports the broader pattern that some aspects of personal hygiene were acceptable, but practical compliance with food safety rules remained uneven(Iwu et al., 2017). Addo-Tham et al (2020a) noted that sociodemographic characteristics significantly determined food safety practices. The main factors linked to good food handling practices were medical checkups, educational status, sanitary inspection, knowledge, and service year. The food handlers suggested attending various training to improve their knowledge and practice(Musarapasi et al., 2023;Teferi et al.,2021). Despite food handlers able to understand grasp food safety principles logically, knowledge does not always convert into motivation or regular practice. Assumed enabling factors may include inadequate regulation enforcement, the informal character of their work, and lack of meaningful incentives to comply. Food safety knowledge plays a crucial role in determinant actual practices among food handlers operating in informal markets(Sheehama & Singh, 2025a).

Hygiene Compliance

Halim-Lim et al. (2023), in the Maldives found that almost 98.6% of the respondents could identify separate occasions for handwashing at a very high level. In KwaZulu-Natal, Nkosi & Tabit (2021) observed about 30.8% of the interviewed rightfully identified the proper handwashing processes like washing with soap and running water warm, and clean cloth drying. Despite that, some food handlers understood that after using the toilet or picking the nose hands should be washed with soap under running water; others knew that food should not be prepared and served when someone has stomach discomfort even after handwashing; some reported food and money should not be handled while presenting with disease symptoms and, when one has a cut waterproof dressing or a bandage should be used. The authors concluded that most street food vendors had basic domestic hygiene habits, even though many lacked full knowledge of correct handwashing procedures.

Christiana Cudjoe et al (2022) reported that, customers often used unwashed bare hands to select meat, which could contaminate the meat with microbes while Kanu & Turay (2024b) pointed cleaning of hands, tidy surroundings, and covered food as the most critical and reinforced practices to prevent the risks linked with unsafe food. Significant hygiene gaps among food vendors in Sierra Leone, included handling food with bare hands, uncovered hair, working without aprons, not keeping fingernails clean and trimmed, dirty dress code and perspiration running down their bodies, poor washing hand ethic each time before touching or serving food were rampant. The authors however emphasized the need to improve personal hygiene related attitudes to support better food handling practices (Kanu & Turay, 2024b). Further, Iwu et al. (2017) reported that, food handlers used non - warm water and soap when washing their palms, and 59% wore food handling gear when serving food. Sadly, Sepadi & Hutton (2025c) found that hygiene compliance accounted for 9% of the themes in the reviewed studies, showing that this area receives less attention than general food safety knowledge and practice.

Temperature Management

A minority across street food vendors of KwaZulu Natal accurately recognised the lowest safe internal cooking temperature for stuffed chicken and vegetables or fruits. The study also reported that only 41.1% and 35.6% correctly identified the sustaining temperatures for salad and beef or chicken stew, respectively. Authors linked this to limited systematic training on cooking, preserving temperatures and warned that food spoilage can happen at any point in the food hierarchy(Nkosi & Tabit, 2021).

Ncube et al. (2020) reported that, about 40% of food handlers in Zimbabwe failed to understand that refreezing defrosted food promotes bacterial food poisoning, while about 73% correctly identified 1 to 5°C as the safe refrigerator operating temperature. The authors concluded that food handlers had insufficient knowledge of refrigerator temperatures and recommended more regular training, including refresher sessions every six to twelve months. They also noted that advanced training such as Hazard Analysis Critical Control Point (HACCP) and International Organistion for Standards (ISO) 22000:2018 could be beneficial.

In the Maldives, Halim-Lim et al. (2023) found that lowest mean knowledge on food safety score was related to the temperature range in which foodborne microorganisms grow best was at 25°C to 60°C. On the same, poor

knowledge of storage temperature and refrigeration, negative attitudes towards storing perishable food at safe temperatures, and limited understanding of safe refrigerator temperatures seemingly with Ncube at al 2020. The researchers however proposed that time and temperature control were the least taught topics and that a number of food handlers had never received ordinary training on food safety. Also it was observed that the Maldives' warm, humid climate increases the risk of bacterial growth when food is left at room temperature. Sheehama & Singh (2025b), knowledge of temperature control and storage was particularly poor, over half (58.1%) did not know the legal temperature requirements for heating, chilling, and freezing food. Fariba et al. (2018) revealed extent of knowledge as some had to keep prepared meat at room temperature by food handlers in Tehran. Disconnection between knowledge attitudes and Practices continue to derail food safety efforts while ineffective temperature control facilitates the growth of foodborne microorganisms, posing a precarious public health concern in informal food market. Temperature control inefficiencies and food storage challenges were paramount concerns, highlighting the need for targeted training strategies (Sheehama & Singh, 2025a).

Covering Food

Customers and butchers displayed food without any covering, leaving it exposed to flies promoting the risk of contamination(Christiana Cudjoe et al., 2022). Whereas 62.5% of food operators protected both prepared food in Owerri Municipal Local Government Area, Imo State, Nigeria. Regardless of that 59.5% of the interviewed stored food from vermin and did not keep uncooked food on the floor uncovered (Iwu et al., 2017). However, Kanu & Turay (2024c) in Sierra Leone also identified clean surroundings and food covering as important food safety issues.

Cleaning

Kanu & Turay (2024c), cleaning utensils and maintaining cleanliness were major issues in food vending in Sierra Leone. Food vendors traded in unclean, smelly environments with warms of flies, and had unpaved, untidy floors. The absence of handwashing facilities for consumers, could create a risk of contamination and weakened hygiene standards. Above 80% of food operators were reported positive behaviour towards training on food safety, satisfactory cleaning processes, utensils colour codes, prevention of food spoilage, and assign monitoring. This was viewed as to mean that attitude toward cleaning may be positive even when practice is inconsistent(Ncube et al., 2020). Whereas in Nigeria, about half of the respondents rinsed plates with water once after use indicating that cleaning practices were present but not consistently thorough(Iwu et al., 2017).

Cross Contamination

Christiana Cudjoe et al. (2022) contended that various display areas had multiple flies flying over meat, and that raw meat and other food items were managed with the same utensils used for cooked foods, indicating a significant risk of cross-contamination. Inadequate management of food at local markets and vending locations significantly contributes to food contamination in SSA, as there appears to be little emphasis on enforcing food safety standards. As food regulatory agencies exist within the food industry, there is greater potential for enhancement, and sound hygiene practices require regulation and enforcement. Almost 75% of respondents in the Maldives knew the importance of separating frozen raw meat from other food(Halim -Lim et al., 2023).

Nyoni & Wellington Garikai (2019) observed that just over half of street food sellers had cleanliness violations on food preparation surfaces, as they used the same surface more than twice, while 45% of vendors cleaned the surface before using it. Nevertheless, hand washing, tidy environments, and covered food remained the most prevalent and highlighted measures to reduce the dangers linked to unsafe food (Kanu & Turay, 2024a). In Ghana, fish is traditionally dried in the sun. The procedure consists of washing the fish in water and laying it on the ground to dry in the sunlight. Once dried, the products are swept into piles with brooms, placed into baskets, and prepared for sale. While the practice is very cost-effective, it carries numerous health hazards. In a different study conducted in Ethiopia, "Raw is better" meat is eaten either cooked, semi-cooked, or raw. Eating raw meat is common in both rural and urban regions (Roesel & Grace, 2015). Kanu & Turay (2024c) highlighted the necessity of clean water, sanitized utensils, and adequate food handling facilities to avoid contamination.

Training and Food Safety

Sheehama & Singh (2025b), in Namibia reported that merely 15.5% of people working in food outlets had received formal training on food safety, while 84.5% had not. The same study noted that most training had taken place in Oshakati, followed by Windhoek and Otjiwarongo, and that most trainings were conducted in 2022. The authors warned that the lack of training promotes compromised practices towards food handling and aid the risk of food-borne illness.

Likewise, Halim-Lim et al. (2023) reported that approximately 50% of food handlers in Maldives had not undergone for food safety training, merely 37.9% had received fundamental training like handwashing. Additionally, Ncube et al. (2020) in Zimbabwe observed that knowledge on food safety varied considerably between food handlers who got basic training and those who had not.

The writers highlighted that most of the food handlers had not undergone fundamental training on food safety or HACCP training, and they suggested compulsory recurrent training every 6 to 12 months. Iwu et al. (2017) discovered that 68% of food handlers in Nigeria were not trained on any food hygiene training, and the results indicate that inadequate training continues to be a significant shortcoming in numerous food service environments. Educational training and fostering motivation to encourage knowledge application appear essential (Fariba et al., 2018). Training initiatives for food vendors were notably important in improving food safety and handling practices (Addo-Tham et al., 2020a).

Food Safety Compliance

The primary aim of food safety regulation entails lowering the risk of consumers becoming ill from unsafe food. However, it is not always clear that regulations achieve their intended results, and even where food is made safer overall, this may not necessarily be due to compliance with the rules or to enforcement. Effective food safety compliance depends on a strong match between regulatory design and the outcomes it is meant to produce (Macrae & Blanc, 2021).

Nkosi & Tabit (2021), about 55.9% of roadside food hawkers in Zululand district, South Africa, had operating licences however, only 26.8% complied with the Companies and Intellectual Property Commission, showing weak organisation within the sector. Vendors were not checked for compliance on food safety although registration and local tax payments were common (Kanu & Turay, 2024b). Iwu et al. (2017) found that 46% of respondents had been visited by environmental health workers, while Sheehama & Singh (2025b) reported that some food handlers were not routinely undergoing for regular medical examinations and only 28.2% used their uniforms when preparing food.

Halim-Lim et al. (2023) stressed that government must establish, enforce, inspect, and educate to maintain compliance while Sheehama & Singh (2025b), argued supporting low-cost mandatory training, mobile outreach, refresher courses, certification, and engagement between local authorities and vendor groups to improve compliance in informal markets. Nkosi & Tabit (2021), further recommended that all street food businesses be registered and tied to physical addresses to support inspection and accountability. In Masvingo, vendors selling cooked food largely failed to comply with most of Zimbabwe's food safety and fundamental hygiene requirements outlined mainly in the Food and Food Standards Act Chapter 15:04. Hence to address the issue, it was recommended to provide education on basic food hygiene to food handlers and ensure all Vendors underwent medical examinations and received certification proving they are free from infectious diseases that pose a risk to public health. Allocated food vending locations with access to safe running water and sanitation amenities were established for the food vendors to enhance food safety (Musarapasi et al., 2023). It should be emphasized to consumers that management adheres completely to current regulations regarding street food vending so that food will not cause any harm (Bellia et al., 2016b).

Vermin Prevalence and Drivers of Vermin Infestation

WHO (2024a), updates reported that close to 600 million people which is approximately one in ten people in the world fall ill after eating contaminated food and 420 000 lose their lives yearly. Banda et al. (2022), reported that foodborne bacteria associated with most hospitalizations and deaths are plague, *Salmonella*, *Campylobacter*, Shiga toxin-producing *Escherichia coli* (STEC), and *Listeria monocytogenes*. Besser et al. (2016), further grouped those bacteria as zoonotic because they can live harmlessly in animals' intestines but spread into the environment and contaminate our food. Moreover, it is noted that diseases associated with unsafe food strain healthcare systems and harm economies, trade, and tourism. The African Union (2019) emphasized that due to zoonotic threats, ensuring safety of food should anchor as a primary objective at every level of the food cycle, including all stages from production and harvesting through processing, storage, distribution and preparation to final consumption, rather than serving as a cause of inconvenience and social stigma. This led to research investigating the connections between urban development and health disparities, highlighting the need to tackle both conventional and new risk factors throughout life (Cacciatore et al., 2025).

The leading foodborne pathogens were isolated with bacteria proportionally causing the most severe illness, being associated with 64% of hospitalizations and 64% of the deaths. Rodent infestation is a critical public health concern worldwide with big towns such as Paris, and London reportedly troubled by vermin proliferation. However, diseases of public health importance might be not reported as there seem to be lack of awareness information from LMICs on determining perceived disease transmission routes (Grace, 2015c).

Kunene (2016), highlighted that distinguishment between the food categories by nature reflects the differences in vulnerability to vermin infestation. Hence despite the vulnerabilities faced by the informal food outlets, they are exposed to health threats as noted that the designing and administration of cities which seem to undermine their health issues rather than uncooperating them into the land use and urban planning systems (Gamieldien & van Niekerk, 2017). Other places like Asmara - Eritrea had at

least one-third (37.4%) of the establishments ravaged by vermin. The troublesome vermin were reportedly either flies, cockroaches and rats(Idris et al., 2020). Almost similarly, Chrispine & Awiti (2019a), found that cockroaches were mostly seen in food takeaway outlets; faeces quantities lack of light, filthiness, careless dumping of wastes, decomposing food stuff and untimely cleaning of utensils were markers for confirming presence and contributing parameters that promoted cockroach proliferation whereas, Kunene (2016) further reported that towns in growing countries are also been affected by rodents and lack of basic services contributed to rodent infestation exposing millions of communities to health risks and rodent borne diseases like leptospirosis, toxoplasmosis and rat-bite fever; proposed resolution in the management of rodents was compliance to the provision of basic services and routine removal of solid waste.

G. Dimkpa et al. (2025), observed a high occurrence of rodents in eateries, and 50.7% of food handlers said they had seen rodents very often and 46.3% often. Only about 3.0% reported to have observed them sometimes while none reported rarely or never. Rodent prevalence was linked to compromised sanitation, waste left in the open, infrastructure deficiencies, and they warned that their presence threatens both food safety and business confidence. Whereas, Musarapasi et al. (2023) reported that, the majority of sampled cooked foods vending sites used makeshift stations and close to half of them (40.4%) had reportedly been infested with rodents as a result of failure to observe basic hygiene standards. While (Gospel Chimenma Dimkpa et al., 2025a) highlighted 50.7% reported very frequent sightings of rodents in eateries. Conversely, G. Dimkpa et al (2025) found a high frequency of insect presence as reported by most of respondents noticing insects often, 29.7% very often, 24.0% sometimes, and only 2.3% rarely. No respondents said they never observed insects. The authors linked this to poor waste management and sanitation, noting that flies, cockroaches, and mosquitoes can spread foodborne pathogens and reduce customer confidence.

Iwu et al. (2017), found that respondents had evidence of disease vectors in their premises, while Kanu & Turay (2024c), said food vendors were operating in unclean, smelly environments with multiple flies. Together, these findings show that pest infestation remained a serious food safety concern.

Kitchens were the most affected areas by pests, with most of the respondents identifying them as the main infestation site. Outside surroundings accounted for most of infested areas, waste storage areas were second, and other areas were 5.7%, while dining area was also linked with pest infestation. Kitchens and waste areas provide ideal pest thriving conditions such as food, warmth, and shelter for pests, made them the most vulnerable zones (Dimkpa et al., 2025). Chrispine & Awiti (2019a) noted almost the same findings with G. Dimkpa et al., 2025 that, kitchens had high infestation and harbourage because of cracks on walls, floors and food spillages which promoted infestation with conducive parameters availed like shelter, food and warmth pest thrive in most buildings. Trematerra & Lessard (2015b) claimed that, it is often believed that older structures are more vulnerable to infestations; however, modern buildings featuring sealed roof spaces, lowered ceilings, wall cracks, wall covering, elevated floors, service conduits, and elevator hoist way create numerous harbourage sites with interconnections pathways, facilitating extensive enclosed movement for vermin, numerous pests require only minimal food resources.

Waste Management and Food Safety

Gospel Chimenma Dimkpa et al. (2025b), found that almost half of eateries (45.7%) rely solely on internal staff which may be convenient but risks improper waste handling if staff lack formal sanitation training. Use of licensed external collectors was low (7.3%), suggesting weak integration with municipal waste services. The large "others" category (41.7%) probably indicated informal dumping or community-based arrangements that can increase pest problems and environmental hazards. They however proposed strengthening efficient waste handling in eateries, formal agreements with licensed collectors and provide staff training to ensure hygienic disposal practices.

Moreso, (Dimkpa et al., 2025) observed that, waste collection in eateries was irregular with only 2.0% of respondents saying waste was collected once daily while 63.0% said it was collected two to three times per week and infrequently collected (35%), hence irregular waste collection services reflects weak waste management system and it can increase pest attraction, foul odours, and environmental health risks. Further, Kanu & Turay (2024b) noted that, most vendors paid waste collectors to remove waste, showing that waste removal often depended on external arrangements rather than routine institutional collection can compromise waste management,. raise sustainability issues and can lead to relapse in waste collection and hence diseases transmission.

(Dimkpa et al., 2025), found that waste disposal responsibility in eateries was mostly handled by staff, while 7.3% relied on external waste collectors serving 7.3%, others used, 5.3% used both, and 41.7% reported other informal arrangements. The finding suggested that this dependence on staff may be convenient, but it also increases the risk of improper handling where sanitation training is lacking. Nearly 50% of participants in Nigeria reported poor sanitary conditions, reinforcing the belief that waste

disposal methods are still inadequate in numerous food environments (Iwu et al., 2017). Nyoni & Wellington Garikai (2019) noted that 93% of street food vendors use waste bins for waste disposal, while 7% dispose of waste in undesignated areas.

Open dumping was the dominant method of final waste disposal, used by 50.0% of eateries. The same study found that 26.0% used private disposal services, 16.3% burnt waste on-site, 4.0% used municipal collection, and 3.7% used other methods. The authors linked open dumping and burning to pest infestation, foul smells, air pollution, and poor environmental health(Dimkpa et al., 2025; Gospel Chimenma Dimkpa et al., 2025a). Some vendors burnt or dumped waste, showing that unsafe disposal practices were common across settings(Kanu & Turay, 2024b).

Insufficient knowledge of appropriate waste handling is one of the main constraints in managing waste properly with additional barriers such as lack of adequate waste bins, high disposal costs, space constraints, and irregular collection by service providers. It was concluded that knowledge gaps and poor infrastructure were major constraints and recommended training, subsidized waste services, and stronger government oversight(Dimkpa et al., 2025).

Kanu & Turay (2024c), informal vendors had weaker waste management practices than formal ones, with only 15% of informal vendors having adequate waste management practices. Better waste management was associated with fewer flies and a cleaner environment suggestive that waste management quality is closely tied to the level of formality and the availability of support systems.

G. Dimkpa et al. (2025) found that the vast majority of respondents concurred that inadequate waste management promotes transmission of diseases. The same research additionally indicated that there is consensus that food and utensils can be contaminated by insects and rodents, with 86% concurred that appropriate storage and prompt disposal diminish pest infestation. The results indicated a high awareness of the connection between waste management, pests, and the spread of diseases. In a different study (Gospel Chimenma Dimkpa et al., 2025a), inadequate waste management in city restaurants greatly enhances the emergence of insects and rodents elevates the likelihood of food contamination and disease spread. Buzan et al. (2017), accumulated waste water overflow attracts various pests, especially flies, while unauthorized waste disposal areas serve as potential breeding grounds for commensal rodents in the ecosystem.

Arasada (2022), study findings revealed that larger cities have been reported to provide perfect habitats for rodents because of apartment complexes, garbage piles and untreated areas in sewage/ drainage systems. Naturally, rodents dwell in drainage systems owing to unperturbed situation, calm environment and breed year round as there would be no predators. Re-infestations then are presumed to occur from sewage or drainage systems as rodent control methods are applied usually above the surface while rats survive underground. However, Grace (2015c), reported saying there could be important several diseases modes of transmission though the significancy of the route is always over looked prompting health data information from LMICs to be affected by inaccuracies and under estimation.

Chrispine & Awiti (2019a), reported that outlets which try vermin control measures experience low/differ in infestation levels regardless of targeted vermin type but much better outcomes are realised when specific targeted measures are used. They further stated that outlets which used chemical control measures were less infested. Overall, used measures included spraying/applying chemical insecticides, proper food handling, reorganizing premises, physical killing, proper waste management, using traps, and keeping cats. However, most participants had not sought professional pest-control advice and a minority had as lacked consultation fees and unawareness that experts were available. Nonetheless, chemical methods and physical methods were needed most though, a very few (2%) chose biological options.

bin Mohamad Saber (2025) revealed that, problems persist in pest control and regulatory compliance. Their research emphasised robust hygiene and sanitation standards play a critical role in enhancing customer satisfaction and sustaining cultural, and economic importance of restaurants; they however concluded that food safety and sanitation practices are closes linked to customer satisfaction.

G. Dimkpa et al (2025), shared that mixed responses were revealed that pest control measures were only partly effective, with a few rating them very effective, effective, and majority indicating split opinion. The study also noted that 26.0% said pest control was not applicable in their setting, suggesting irregular use of control measures. It was however concluded that reactive approaches such as spraying were not enough and recommended integrated pest management.

Awoniyi et al (2024a), reported rodents are major pests that cause public health, agricultural, and economic damage. Control efforts in disadvantaged urban communities are often ineffective because of the lack of site-specific strategies and standardised surveillance. Ongoing urbanisation is likely to increase infestation risks, zoonotic spillover, and the emergence of new pandemics. Therefore, greater investment in rodent research, along with community and stakeholder engagement, support more sustainable pest and disease control in LMICs. Gospel

Chimenma Dimkpa et al. (2025b) indicated that designated waste disposal points, timely waste collection, training eatery staff on proper waste handling, and enforcement of hygiene regulations are effective in improving waste management and reducing pest proliferation. However, public awareness campaigns and collaboration with private waste management companies were viewed as less effective, suggesting the need for stronger institutional and infrastructural interventions. Oh, et al (2022), challenged urban local authorities to allocate rodent control resources in areas guide by to the factors that increase the risk of rodent infestation. Aim for complete elimination of burrowing rodents underground while planning for or doing routine surveillance together with proper maintenance of floor traps and underlying sub - structures in the bin chambers may offer a long - term solution to curb rodent proliferation. Wang & Cooper (2025), proposed rapid detection of cockroaches and other arthropods is needed in indoor environments where no pests are prohibited. The ActiveSense Electronic Remote Monitoring tool was developed to provide timely monitoring results for cockroaches. All being done, traditional snares and baits gave better results although noted labour intensive (Reid et al., 2022; Wang & Cooper, 2025). A study by Eisen et al. (2018) acknowledged that continuous, rigorous lethal trapping of rodents in the West Nile region appeared to reduce rodent abundance effectively, but the impact was short lived once control practices ceased. Wang & Cooper (2025) in their study also confirm that, with trapping, rodents could be removed and further advocated for smart traps, automated systems quipped with multiple sensors and a camera. These smart traps were reported to be readily available for the monitoring agricultural pests, stored product pests, rodents, and cockroaches. However, they (Wang & Cooper, 2025) implored that research should focus on increasing the detection ability at low pest population levels while minimizing false alerts. Independent validation of these new techniques is needed to support adoption of effective and efficient monitoring tools. In their studies (Bellia et al., 2016b; Grace, 2015c), found and shared that, urban centres of developed countries adhere to stringent food safety regulations and regular inspections which have helped reduce vermin infestation although challenges persist in low-income areas and marginalized communities .

Oh et al. (2022), through camera based surveillance rodents activity was observed in the bin and sanitary network both in the day and at night. In the cross-sectional study, rodent activity in the bin chambers was independently associated with damaged floor traps. They however proposed crafting and adoption of sanitation master schedules as probably vital component that can influence pest management in food industries. The proposed use of modern technological vermin traps and baits should focus on effectiveness during monitoring so as to increase detection accuracy and timeliness.

Infrastructure Gaps

In the reviewed studies, infrastructure gap showed that physical conditions remain a recurring problem in food safety (Sepadi & Hutton, 2025c). Most of street vendors sold food at permanent premises, while 47.4% used makeshift shelters and some sold in the open without shelter. Another finding was a significant proportion of food handlers (52.9%) who prepared food at the vending site as well as those who sold both take-away (64.9%) often operated under poor sanitary conditions (Nkosi & Tabit, 2021). In another study, Musarapasi et al (2023) found that slightly above half (54.2%) of the food vendors cooked their foods at home and transported it to town on public transport (62.6%). However, most of cooked food trading places (86.8%) were makeshift structures. Kanu & Turay (2024c), highlighted that informality and weak infrastructure in street vending settings were evidenced with many vending sites located near streets, gutters, or rubbish dumps. Even though most of vendors had access to water, the sources were suspicious, and some could often get involved in long queues to get it or subjected to a payment for supply. Some establishments lacked adequate toilet facilities and ablutions which created further sanitation gaps. The presence of vermin in food-handling spaces has been linked to structural inadequacies, poor waste disposal or both (Shelter, 2023; Trematerra & Lessard, 2015).

Rodent access through openings between the wall and the floor was viewed as a sign of structural decay, reflecting inadequate housing quality. Kitchen dirtiness and uncovered food, were viewed as relevant factors influencing rodent damage. In their post-harvest review, Trematerra & Lessard (2015) noted that many structures offer shelter, food, and warmth, making them appealing to rodents. Consequently, it is often believed that older structures aremore susceptible to infestations; however, newer constructions featuring enclosed roof voids, low ceilings, wall crevice's, coving, stepped floors, service shafts, and elevator shafts offer numerous hiding spots with many interconnections, facilitating extensive internal movement for pests. Very few of street food vending sites maintained high sanitary compliance, despite majority having moderate compliance and some were reported to have low compliance. The findings were presumably linked to makeshift vending facilities and limited financial resources. On the ground many sites lacked water supply, electricity, sufficient space, and proper refuse storage, which made full compliance difficult (Nkosi & Tabit, 2021). Kanu & Turay (2024c), observed that slightly half (51%) of the vendors had access to toilet facilities and nearly half lacked

handwashing facilities with soap and water. They appreciated a moderate compliance in eateries however, nearly half of the respondents still acknowledged non - compliance on hygiene practices showing that sanitation remains a key weakness in both formal and informal food settings (Dimkpa et al., 2025). Improper handling of food was observed at the local markets and vending sites as a major cause of food contamination in Sub - Sahara Africa, as little attention is given to the application of food safety standards. However, since food regulatory body there, more improvement is needed on regulation and enforcements since hygiene principles are necessary. Those found producing violating food products should be punished and products confiscated (Christiana Cudjoe et al., 2022).

Universal Challenges

Although conventional food safety capacity building programmes and interventions are believed to promote hand hygiene and improve understanding of the topic, limited research has examined their influence on food handlers' perceptions of effective hand hygiene practices (Soon et al., 2012). Christiana Cudjoe and colleagues (2022) observed that food safety issues extend beyond food poisoning to include postharvest losses, food contamination, climate changes, limited financial resources, and inadequate food regulations. Inadequate food handling in local markets and vending locations was identified as primary sources of contamination in Sub-Saharan Africa. Sepadi & Hutton (2025c) indicated that suppliers in low- and middle-income nations encounter structural, financial, educational, and cultural obstacles that hinder compliance. Matamanda (2021b) stated that food safety in the informal sector cannot be treated as a "one size fits all" issue, where a uniform method for encouraging and/or enforcing food safety regulations is used across the variety of informal businesses.The informal food sector of most low and middle-income countries plays a vital role yet it operates with minimal oversight and limited infrastructure or under-resourced (Idris et al., 2020; Musarapasi et al., 2023; Sheehama & Singh, 2025b). Kunene (2016) asserted that separation between these food categories also reflects differences in vulnerability to vermin infestation. However, Grace (2015b) noted that many critical diseases may be transmitted through several routes, as the role of food is not always well understood and health information from LMCs if often subject to error and underestimation. Furthermore, the effects on global health, trade, and development are considered enormous, with hundreds of millions of foodborne disease cases occurring annually at a cost of billions of dollars (Grace, 2015a). Despite this, current estimates are likely to be conservative because they are based on modelling and expert attribution of food's role in disease. They probably underestimate the true scale of the problem when compared with clinical data from the EU and the USA (FAO, 2018).

Nonetheless, the evident risks being experienced show that there is remaining lack of detailed empirical researches comparing vermin infestation against food safety practices in Zimbabwe's formal and informal food outlets. Most available evidence is anecdotal, fragmented, or generalized, making it difficult to fully understand how regulation, infrastructure, trader knowledge, and environmental health services shape vermin prevalence and food safety outcomes at local level (Tawodzera, 2023). Cacciatore et al. (2025), social determinants, environmental risks, and access to health care must be addressed through integrated, equitable, and sustainable urban planning. This can be achieved through evidence-based interventions, participatory governance, and strong intersectoral collaboration that improves resilience and reduces health inequities. G. C. Dimkpa et al. (2025) observed that in Rivers State, Nigeria, issues included were not lack of awareness regarding correct waste management practices, insufficient bins, and inconsistent waste collection services. In evaluating improvement measures, participants considered designated waste disposal areas, prompt waste collection, and more rigorous regulatory enforcement to be the most effective. Conversely, awareness campaigns and collaborations with private waste firms were viewed as not as effective. The research suggested that improving infrastructure, strengthening waste collection systems, training staff, and enforcing sanitation regulations are essential measures for improved waste management and pest control in city restaurants. It also recommends policy changes and enhanced stakeholder cooperation to safeguard public health and improve environmental sanitation.

Public Health Implications

Sheehama & Singh (2025b), reported that informal markets are highly vulnerable to foodborne disease transmission. Poor utensil cleaning, handling food and money together, restricted access to clean water, densely packed vending sites, and weak health inspection systems are casual factors. Proactive environmental health work, including education, guidance, immediate, compliance checks are needed to reduce preventable disease burden.

Rodents are major pests that cause public health, agricultural, and economic damage. Vermin control efforts in disadvantaged urban communities are often ineffective because of the lack of site-specific strategies and standardised surveillance. With the ongoing urbanisation the probability of infestation risk increases leading to zoonotic spill over and the emergence of new pandemics. Therefore, greater investment in rodent research, along with community and stakeholder engagement is called to support

more sustainable pest and disease control in LMICs (Awoniyi et al., 2024).

Policy Frameworks

Nkosi & Tabit (2021) said that, many sanitary requirements at street food vending sites were poorly met, including electricity, lighting, tap water, clean windows and doors, ventilation, handwashing facilities, refuse storage space, and covered garbage bins. Infrastructure shortages and weak regulatory support undermine compliance therefore, better resources provision, permit control, and more effective licensing systems need to be considered.

Christiana Cudjoe et al (2022) argued that, food hygiene principles need strong regulation and enforcement, and that unsafe producers should be sanctioned. Food safety bodies exist to protect consumers, but poor enforcement continues to allow unsafe food into local markets. Similarly, Mugadza et al (2025) echoed, Zimbabwe has 45 food safety laws and regulations, but many are outdated, fragmented, and poorly aligned with international standards. Multiple ministries create duplication, inconsistency, and inefficiency in regulation. However, Cacciatore et al. (2025) proposed that, people found producing unwholesome food products should be punished and products confiscated.

Giroux et al. (2021), cautiously stated, a large share of urban Africa's food system is informal and closely connected to the formal system, even if policy does not fully recognize this. The passage warns that relocating informal food vendors into a single market or moving them as one group would likely reduce food access for low-income households because it would remove key distribution points they depend on.

2. METHODS AND MATERIALS

RESEARCH DESIGN

The researcher used the comparative cross-sectional study. Both numerical and descriptive approaches were used thereby allowing researcher to assess and compare the status of vermin infestation and food safety practices in informal and formal food outlets from September to end of November 2026. The approaches enhanced the richness and triangulation of data and it strengthened the validity of the findings.

STUDY AREA

(P.T. Nemadziva: Quantum Geographic Information System (QGIS), 2026)

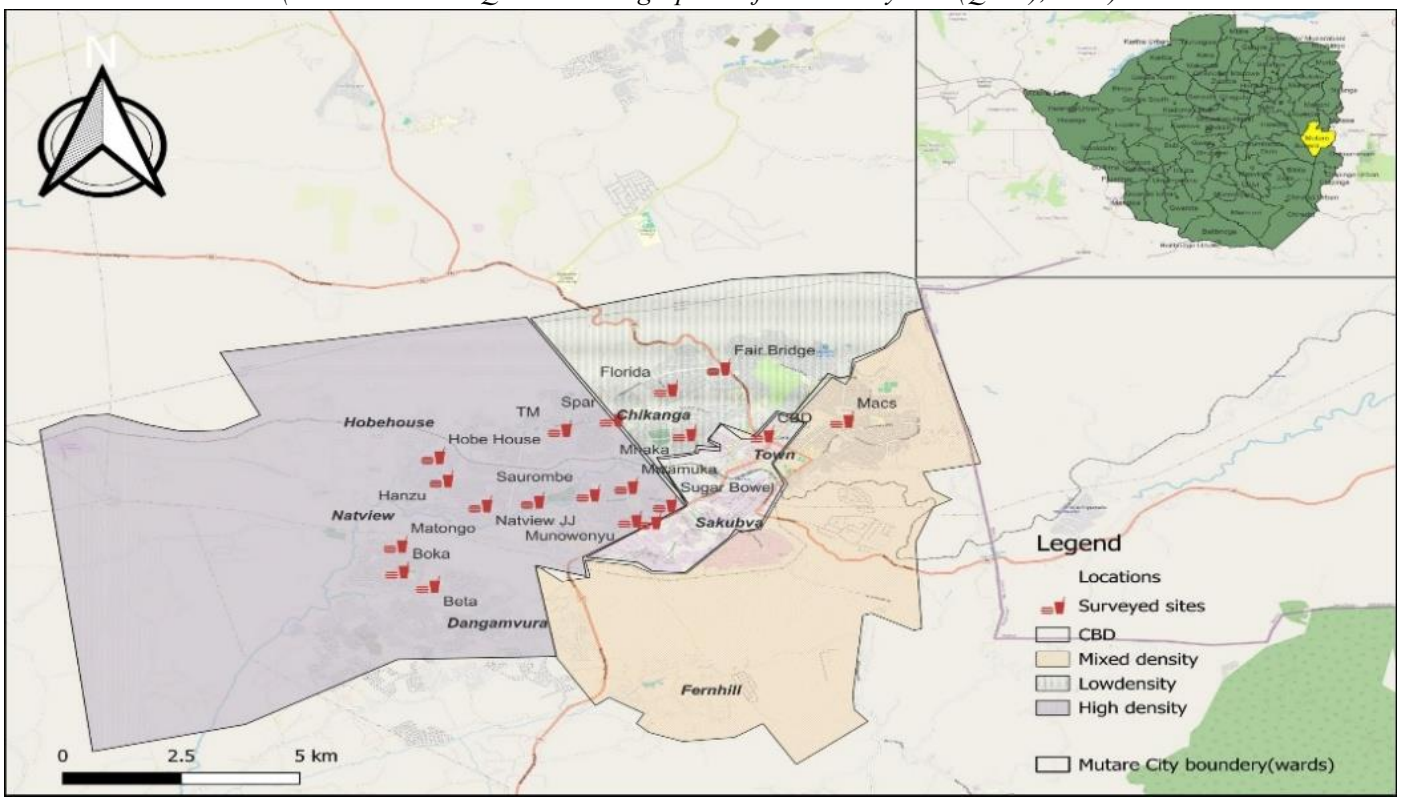

Figure 1: Mutare City Study Location Map

The research was done in Mutare City, provincial capital of Manicaland Province in Zimbabwe with a population of 224802 according to 2022 Biometric Census. It is located about 265km from Harare and 300km from the port of Beira in Mozambique making it Zimbabwe's gateway to the sea.

STUDY POPULATION

The study population comprised of formal food outlets which included licensed supermarkets, grocery shops, restaurants, and butcheries operating under municipal registration: and the Informal food outlets which involved

unlicensed food handlers operating in open markets, roadside stalls, market malls, grinding mills and tuck-shops.

SAMPLING PROCEDURE

Table 3: Overall Sample Size

N = 640

Outlet Category	Chikanga	Dangamvura	Sakubva	Town	Total
Informal	184	100	108	163	555
Formal	16	16	24	29	85

The sample size was determined using the Yamane formula (1967),(Oluigbo et al., 2024).

n = N/ (1+N (e)2.

Where: *n* = sample size, N = population size/population under study (estimated food outlets number in Mutare City), and e = margin of error (0.05)

Then proceeded using the proportionate formular: *nh* = N*h*/ N x *n*

Where: *nh* = representatives for each food outlets, Nh = population of each group, N = 640, *n* = 248

Sample Distribution

Table 4: Sample Size by Location and Food Outlet Category

N = 248

Outlet Category	Chikanga	Dangamvura	Sakubva	Town	Total
Formal	70	38	41	62	211
Informal	6	6	9	11	37

The sample size was stratified by food outlet type (formal and informal) using the 4 Mutare City district zones. Proportionate stratified random sampling was applied to allocate samples to each stratum. Individual food outlets were then selected in each district using simple random sampling. Finally, an estimated sample of 248 outlets (211 formal and 37 informal) were selected based on the final listing of outlets obtained from the Mutare City Health Department.

MATERIALS:

Structured Questionnaire

It was administered randomly to food handlers at each randomly selected outlet by two research assistants. The questionnaire captured data on: socio-demographic data, vermin infestation prevalence, knowledge and practices food safety.

Observation Checklist

A standardized food safety and sanitation checklist was used by trained data collectors on each outlet to determine the presence of vermin presence and some food safety practices

3. DATA ANALYSIS

Numerical data was from questionnaires and checklists was analysed using the IBM SPSS Version 27 software and Microsoft Excel. Statistical tests were used to evaluate associations throughout the study since it was a comparative one. Whereas descriptive statistics were transcribed then analysed thematically using IBM SPSS Version 27 Software. Recurring themes were coded to extract insights on enforcement, challenges and policy recommendations.

VALIDITY AND RELIABILITY

The data collection tools were pilot - tested in a small trial group involving 10 outlets (5 formal, 5 informal). The Cronbach's alpha was applied to test the internal consistency of the questionnaire while Research Assistance were trained to ensure inter - observer reliability in the use of checklists.

4. LIMITATIONS OF THE STUDY

Vermin activity results might have been influenced by seasonal variations. Despite training some observer bias could have happened during the inspections. Lack of cooperation from some outlets and financial costs were a toll concern.

5. RESULTS AND DISCUSSIONS

INTRODUCTION

This chapter primarily presents the study findings. Data will be presented following the four study objectives. However, the first part of this presentation will comprise of demographic data which comprises of the characteristics of the population under study like sex, age, and educational level. The data is presented in various forms including tables and graphs.

VERMIN INFESTATION AND PREVALENCE RESULTS

Table 8: Vermin Observation by Food Outlet Category

		Category of food outlet				Total	
		Formal		Informal			
		N	%	N	%	N	%
Vermin observation	**Yes**	121	57.3	30	81.1	151	60.9
	No	90	42.7	7	18.9	97	39.1
Total		211	100	37	100	248	100

Informal outlets reported a higher vermin observation than formal outlets. However, a larger share of formal outlets (42.7%, n = 90) reported no vermin compared to informal outlets.

A Pearson chi-square test showed a statistically significant association between outlet category and vermin observation ($\chi^2(1, N = 248) = 7.447, p = .006$). This result was confirmed by Fisher's exact test (p = .006), indicating a higher vermin prevalence in informal outlets is unlikely due to chance. The negative Phi coefficient ($\phi = -0.173$) indicates an inverse relationship, with formal informal outlet being more likely to report vermin presence.

The results concur with (Chrispine & Awiti, 2019a; Gospel Chimenma Dimkpa et al., 2025a; Idris et al., 2020; Musarapasi et al., 2023). This researcher also observed a statistically significant association between outlet category and vermin observation which suggest the infestation was not by chance. Kunene (2016),in their finding also highlighted that outlet category is an important cause of vermin infestation. Make shift operating spaces promotes vermin proliferation (Musarapasi et al., 2023). In contrast Termeer et al(2024), found that formal outlets reflected lower infestation levels probably due to better compliance on food regulations and possibly improved food safety practices although enforcement was inadequate.

The presence of vermin raises public health concerns as they can increase the risk of contamination (Christiana Cudjoe et al., 2022; Iwu et al., 2017; Roesel & Grace, 2015) cause transmission of infections through vermin's urine, droppings, fur and compromise food safety(Gospel Chimenma Dimkpa et al., 2025a, 2025b; Kanu & Turay, 2024b; Kunene, 2016)

The observed difference should therefore be interpreted as evidence that targeted pest-management and hygiene interventions are especially needed in informal outlets(Cacciatore et al., 2025). Overall, the findings suggest that sanitation schedules should be promoted and encouraged to be implemented so as to influence management buy-in and help on reducing vermin infestation.

Table 9: Type of food outlet by Vermin Observation

		Vermin observation				Total	
		Yes		No			
		N	%	N	%	N	%
Type of food outlet	**Supermarket**	8	5.3	12	12.4	20	8.1
	Butchery	25	16.6	5	5.2	30	12.1
	Restaurant	19	12.6	9	9.3	28	11.3
	Kiosk	10	6.6	11	11.3	21	8.5
	Grinding mill	5	3.3	4	4.1	9	3.6
	Grocery shop	34	22.5	25	25.8	59	23.8
	Market stall	14	9.3	11	11.3	25	10.1
	Food Take Away	24	15.9	8	8.2	32	12.9
	Corner Shop	12	7.9	12	12.4	24	9.7
Total		151	100.0	97	100.0	248	100.0

A larger number of food outlets 60.9% ($n = 151$) reported the presence of vermin compared to 39.1% ($n = 97$) with no observed infestation. Infestation was most prevalent in grocery shops, butcheries, food take-aways, and restaurants. In contrast, supermarkets and grinding mills recorded comparatively lower infestation levels. Overall, vermin were observed in food outlets. The largest contributors on infestation were grocery shops, butcheries, food take-aways, and restaurants hence a significant association,16.627, df = 8, p = 0.034, V = 0.259 indicating a moderate relationship.

Different studies have shown different observations by food outlet. Gospel Chimenma Dimkpa et al., 2025b) reported of 50% sightings in takeaways/eateries in Nigeria while in Masvingo, Musarapasi et al (2023) observed flies in restaurants. The studies by G. Dimkpa et al (2025) reported that poor waste management and sanitation, uncleanliness(Kanu & Turay, 2024b), infrastructure deficits(Chrispine & Awiti, 2019a; Dimkpa et al., 2025; Trematerra & Lessard, 2015) and business proximity to waste locations(Musarapasi et al., 2023) contributed to the observations. It was alleged that, the observations can cause FBDs (Kunene, 2016). This require studies to explore the measures to address traditional and emerging risk factors across the sectors(Cacciatore et al., 2025).

Table 10: Vermin Observation Frequency by Food Outlet Category

		Formal		Informal		Total	
		N	**%**	**N**	**%**	**N**	**%**
Frequency of vermin observations	**Daily**	20	9.5	8	21.6	28	11.3
	Weekly	37	17.5	16	43.2	53	21.4
	Occasionally	81	38.4	7	18.9	88	35.5
	Rarely	73	34.6	6	16.2	79	31.9
Total		211	100	37	100.0	248	100

Vermin sightings occurred occasionally or rarely. Most of the times, weekly and daily sightings were less common. Daily sightings were notably higher in the informal, followed by weekly, occasionally, and rarely at last. Overall, occasional sightings dominated, followed by rare, weekly, and eventually daily. A revealed statistically significant association between food outlet category and vermin observation frequency($\chi^2 = 20.548, df = 3, p < .001$), with a moderate effect size (Cramér's V = 0.288), indicate that vermin were reported more frequently in informal than formal outlets.

A study by Gospel Chimenma Dimkpa et al (2025c) aligns with my findings where in Nigeria on determining insects and rodents in eateries they found that the frequency was very often(44%), then very often (29.7%),and sometimes(24%)y, while rare was least reported(2.3%).

Documented evidence revealed that environmental challenges likely stemming from persistent pest control and consistent regulatory compliance (bin Mohamad Saber, 2025), suboptimal waste management(Gospel Chimenma Dimkpa et al., 2025b), lack of attention and prioritisation on vermin control by policy makers despite some knowing the health implications related to the vermin menace, infrastructure deficiencies, and limited pest control routines(Cacciatore et al., 2025), promoted infestation in informal.

The noted frequency differences have critical public health implications as frequent vermin exposure heightens contamination risks from pathogens like Salmonella or allergens carried by pests. Informal outlets' higher sighting rates were observed to emanate from intermittent vermin infestations, ineffective pest control activities, adjacent disused and dysfunctional entities(Djekic et al., 2019; Gospel Chimenma Dimkpa et al., 2025b; Trematerra & Lessard, 2015). Stratified interventions such as scheduled routine monitoring for informal outlets (Bellia et al., 2016a), urgent structural improvements and promote the use of traditional snares, traps and baits are critical(Wang & Cooper, 2025).

These findings underscore the need for vermin trap-based monitoring in future research which could enhance vermin detection precision like use of low cost but reliable automated smart traps(Wang & Cooper, 2025), and advocacy for policy emphasizing coopting the informal sector when policy making and improve sanitation provision services to curb vermin driven food safety threats.

Table 11: Most Prevalent Vermin by Food Outlet Category

		Category of food outlet				Total	
		Formal		Informal			
		N	%	N	%	N	%
Most prevalent vermin type	Rodents /Mice	69	32.7	9	24.3	78	31.5
	Cockroaches	74	35.1	13	35.1	87	35.1
	Flies	54	25.6	13	35.1	67	27.0
	Ants	14	6.6	2	5.4	16	6.5
Total		211	100	37	100	248	100

Cockroaches were the most common vermin types among the formal outlets, followed by rodents/mice and the least being ants. While in the informal outlets, cockroaches and flies were almost equally prevalent with rodents/mice and ants less common. Generally, cockroaches were the most dominant type then rodents/mice followed by flies with ants coming last on prevalence. Depicted is a statistically significant association between vermin type and outlet category ($\chi^2(3,\ N = 248) = 26.879,\ p < .001$), with a moderate effect size (Cramer's V = .329), indicating that vermin type distribution differed meaningfully by outlet category beyond chance.

Chrispine & Awiti (2019a) in their study in Kenya also confirmed that overall cockroaches were the most dominant in ready to eat eateries and (Dimkpa et al., 2025; Kanu & Turay, 2024b; Musarapasi et al., 2023; Roesel & Grace, 2015) reported of flies. Further studies stated that, flies in both outlet categories aligns with their adaptability to urban food environments where access to food waste and moisture facilitates proliferation(Gospel Chimenma Dimkpa et al., 2025c; Trematerra & Lessard, 2015). These other studies support the moderate effect observed in this study (Cramér's V = 0.329) and underscore an important relationship between outlet category and vermin profile underscores an essential relationship between outlet category and vermin profile. To rectify this it is proposed that regulation enforcement has to be seriously considered regardless of food outlet category type because no business operates without challenges(Bellia et al., 2016a).The Limitations to this finding probably included observer bias in vermin identification hence future studies could incorporate trapping data for validation.

FOOD SAFETY PRACTICES

Table 16: Covering of Food Being Done by Food Outlet Category

		Category				Total	
		Formal		Informal			
		N	%	N	%	N	%
Covering of food being done?	Yes	128	60.7	16	43.2	144	58.1
	No	83	39.3	21	56.8	104	41.9
Total		211	100	37	100	248	100

Generally, outlets covered their food with formal outlets at 60.7% and informal outlets lower at 43.2%. By contrast, 39.3% (83) of formal outlets and 56.8% (21) of informal outlets did not cover food.

A Pearson chi-square test found a statistically significant association between outlet category and food covering practice $\chi^2(1, N = 248) = 3.92, p = .048$, with a small effect size ($\phi = .13$), indicating that formal outlets were significantly more likely to cover food than informal outlets.

This study reports that generally, 60.7% of the formal outlets covered food and informal outlets were lower at 43.2%. Conversely, 39.3% (83) of formal outlets and 56.8% (21) of informal outlets did not cover food. This finding agrees with Christiana Cudjoe et al (2022) who found that raw meat and other food stuffs were left unprotected in butcheries and by customers leaving food exposed to flies. However, Kanu & Turay (2024c) in Seirra Leone observed that food was covered and surroundings clean thereby covering food safety. On the same,(Iwu et al. (2017) in

Nigeria), also reported that food was protected from flies and rodents both for prepared food (62.5%) and stored food (59.5%). However. the small but significant *phi* coefficient shows these behavioural differences are linked to outlet type(Kunene, 2016), probably because formal outlets have better infrastructure (screens, counters) and regulatory pressure.

To ensure contamination prevention, food covering practice should be emphasized and strengthened(Kanu & Turay, 2024c), improvement on personal-hygiene-related attitudes support better food handling practices(Kanu & Turay, 2024b), and promote food safety education for vendors, awareness campaigns, and food safety regulations with surveillance(Kanu & Turay, 2024c).

Table 17: Food Preparation Area Cleaning Frequency by Food Outlet Category

		Category				Total	
		Formal		Informal			
		N	%	N	%	N	%
Cleaning frequency of food preparation area	**After every use = 3**	103	48.8	14	37.8	117	47.2
	Once daily =2	73	34.6	11	29.7	84	33.9
	Several times a week = 1	32	15.2	7	18.9	39	15.7
	Weekly = 0	3	1.4	5	13.5	8	3.2
Total		211	100	37	100	248	100

Informal food outlets reportedly cleaned preparation areas more frequently than formal ones. Formal outlets show significant lapses for instance cleaning only weekly. Overall, after every use was most common then daily, several times and weekly least. A chi-square test showed a statistically significant association between outlet category and cleaning frequency, χ^2 (3, N=248) =15.57, p=.001, with a moderate effect size (Cramér's V = 0.25). Contrary to expectations, informal outlets cleaned more frequently than formal ones despite their higher vermin prevalence and presence.

Nyoni & Wellington Garikai (2019) found that food slightly over half (55%) of street vendors prepared food more than twice on the same area, while 45% washed the surface before use. Iwu et al. (2017) in Nigeria reported similar finding: about half of the respondents rinsed plates with water once after use, indicating that cleaning practices were present but inconsistent. However, it was noted that the absence of handwashing facilities could cause lapses in consistent cleaning. In Masvingo, it was observed that attitude influences cleaning practice, making them inconsistent(Ncube, 2020). However, Halim-Lim et al. (2023) stressed that, government must enforce regulations, and provide educate to maintain compliance.

The results collectively highlight the importance of regular inspections and monitoring for compliancy consistency, standardised hygiene protocols through short subsidised trainings on basic HACCP for informal outlets while advocate ISO Certification on formal outlets. Future studies could strengthen sampling systems to routinely monitor microbial contamination and determine if suspected FBD will be linked to cleanliness.

Table 18: Food Waste Disposal Methods Being Done by Food Outlet Category

		Category				Total	
		Formal		Informal			
		N	%	N	%	N	%
Food waste disposal method	**Covered bin**	83	39.3	13	35.1	96	38.7
	Open bin	79	37.4	18	48.6	97	39.1
	Thrown outside	3	1.4	2	5.4	5	2.0
	Collected by Council	46	21.8	4	10.8	50	20.2
Total		211	100	37	100	248	100

Food waste disposal methods between formal and informal food outlets revealed similar practices. Covered bins were used almost equally the same while overall disposal means were at 39.3% (96) for open bins and collected by council was high in formal 21.8% (46) than informal at 35.1% (13). Food waste thrown outside was rare. A Chi- square test found no statistically significant association between outlet category and waste disposal method, $\chi^2(3, N = 248) = 5.518, p = .138$. Both groups predominantly relied on bins, although informal outlets used bins more often.

The results from this study indicates that food waste disposal methods between formal and informal food outlets revealed similar practices. Covered bins were almost equally used and the overall disposal means were at 39.3% (96), open bins and collected by council was high in formal than in informal. Food waste thrown outside was rare. In their study, "Improper Waste Handling and Proliferation of Insects and Rodents in Urban" , G. Dimkpa et al (2025) found that open bins were oftenly used than covered bins, and plastic bag were flet on the floor. They expressed concern that poorly managed waste can attract vermin thereby promoting chances of food contamination and foodborne infections. Another similar corresponding finding (Gospel Chimenma Dimkpa et al., 2025b; Kanu & Turay, 2024b) was reliance on basic bin containment by some outlets which attracts vermin because waste is accessible and said formal outlets use council collection more (21.8%) and have lower infestation rates, but heavy use of open bins (37.4%) reduces that advantage.

Kanu & Turay (2024b) in Sierra Leone also confirmed that statistical tests showed no strong association between outlet type and sanitation practices, indicating broad weaknesses across both categories. Fears are that, poor waste handling leads to vermin harbourage(Arasada, 2022) leading to proliferation and disease risk like E. coli from rotting waste(Buzan et al., 2017; Dimkpa et al., 2025). Gospel Chimenma Dimkpa et al (2025b) proposed that poor waste management can be corrected through municipal systems strengthening, through partnerships, and educating clients on appropriate waste management. They recommended using covered, rodent-proof bins; increasing scheduled collections; offer waste-minimization and disposal training; consider subsidies for secure bins at informal outlets. This study proposes adoption of the same recommendation by the Mutare City. It also advices for future audits that link food waste disposal methods to infestation levels so as to measure the impact on food safety.

Table 19: Vermin Control Methods Category of Food Outlet Category

	Formal		Informal		Total	
	N	%	N	%	N	%
Use traps	39	18.5	6	16.2	45	18.1
Use pesticides	77	36.5	18	48.6	95	38.3
Call Pest Control Services	24	11.4	2	5.4	26	10.5
Use traps and pesticides	34	16.1	3	8.1	37	14.9
Do nothing	37	17.5	8	21.6	45	18.1
Total	211	100	37	100	248	100

Common practice was pesticides usage by both groups followed by traps and pesticides combined, then pest control services and doing nothing lastly. Formal outlets mostly used pesticides while other means followed. Informal outlets relied much on pesticides and less on pest control services, while some were inactive (did nothing). No statistically significant association between outlet category and vermin control methods, by Chi-square, ($\chi^2 = 3.264$, df $= 4$, $p = 0.515$), Phi = 0.115 and, $V = 0.115$. The weak association (φ = 0.115) probably indicate broad shortcomings in integrated pest management (IPM) across all outlets.

This matches other regional studies showing chemical control is preferred(Chrispine & Awiti, 2019a). Oh et al 2022), debated on the use of ecologically friendly methods but failed to elaborate on their finding on the prevalence use of the pesticides. Whereas, Awoniyi et al (2024a) warns of public-health risks which can arise from both vermin and pesticide misuse, and (bin Mohamad Saber(2025) cautions on the lack of routine medical checks for handlers and the pesticide/inaction pattern in informal outlets which worsen vulnerability.

From the findings the researcher proposes adoption of IPM, improvement on sanitation and waste management to deprive vermin of nutrition (as also reported by Awoniyi et al., 2024a), and strengthen professional pest control services (Oh et al., 2022). The recommendations are not limited to these measures and should include food sampling and monitoring for pesticides residue(Bellia et al., 2016b).

Table 20: Category of Food Outlet by Receipt of Formal Food Safety Training

		Formal food safety training				Total	
		Yes		No			
		N	%	N	%	N	%
Category of food outlet	**Formal**	65	87.8	146	83.9	211	85.1
	Informal	9	12.2	28	16.1	37	14.9
Total		74	100	174	100	248	100

Of the 248 food outlets surveyed, 74 (29.8%) reported to have received formal food safety training, whereas 174 (70.2%) did not. Formal outlets 211(85.1%) of the total accounted for 65 (87.8%) of those trained and 146 (83.9%) of those untrained, while informal outlets 37(14.9%) of total comprised, 9 (12.2%) were trained and 28 (16.1%) untrained. Formal outlets showed a slightly higher training receipt rate (30.8%) compared to informal outlets (24.3%). However, frequencies were closely aligned and no statistically significant difference, χ^2 (df = 1, N = 248) ≈ 0.45, p > .05, (indicated a homogeneity across categories rather than a marked disparity).This finding was also reported in several studies that identified knowledge and practice gaps despite measurable differences in vermin levels (Halim-Lim et al.,2023; Iwu et al., 2017; Ncube et al.,2020; Sheehama & Singh,2025a). Addressing it may require mandatory recruitment of food handlers regardless of food outlet category, subsidised short course trainings and maintenance of a database to monitor practices. These measures would promote food safety practices, as also suggested by various authors (Iwu et al.,2017; Musarapasi et al.,2023; Ncube et al.,2020).

Table 21: Food outlets cleanliness observations by food Outlet Category

	Category of food outlet				Total	
	Formal		Informal			
	N	%	N	%	N	%
Very clean	54	25.6	8	21.6	62	25.0
Moderately clean	113	53.6	15	40.5	128	51.6
Poorly maintained	44	20.9	14	37.8	58	23.4
Total	211	100	37	100	248	100

The majority of the outlets were moderately clean with formal showing vey very higher clean than informal, moderately clean and very poorly maintained least. However, informal ones had lower moderate cleanliness and higher poor maintenance despite similar very clean 21.6% (8). A Chi-square indicated an association between outlet category and interviewer related – rated cleanliness, $\chi^2(2, N = 248) = 5.115, p = .078$. Because the p-value is slightly above the conventional .05 threshold, this should be interpreted as a weak or borderline association rather than a strong one. The effect size was small (Cramer's V was .144). A study by (Dimkpa et al., 2025; Kanu & Turay, 2024b), however sated that perceived poor cleanliness increases risk of contamination and diseases, therefore standardized observer audits can be employed to measure cleanliness reliably.

Table 22: Vermin Proofing Methods/Presence and Use by Food Outlet Category

						Total	
		Available and used		None available			
		N	%	N	%	N	%
Category of food outlet	**Formal**	98	89.1	113	81.9	211	85.1
	Informal	12	10.9	25	18.1	37	14.9
Total		110	100	138	100	248	100

Generally, both categories had vermin proofing available and in use although formal outlets were predominant on those proofing methods than informal outlets. Conversely, 138 outlets (55.6%) had none available. A slightly 10% variance was observed between outlets which had and used vermin proofing methods and no statistically significant association between outlets category and vermin – proof availability/use ($\chi^2 = 2.505, \text{df} = 1, p = 0.114$). Although formal outlets showed a higher adoption rate, the relationship was weak (Cramer's V = 1.00).

In other studies vermin proofing gap was noted as widespread gap across both formal and informal outlets(Bellia et al., 2016a; Eisen et al., 2018; Gospel Chimenma Dimkpa et al., 2025a; Oh et al., 2022).However, mixed responses were reported on some who could accept nor deny vermin proofing as a gap(bin Mohamad Saber, 2025), so vermin problems are not just an informal-sector issue but a sector-wide shortfall in building integrity and environmental health investment (Oh et al., 2022). It was therefore recommended that municipal authorities prioritise vermin control and promote standards adaptable to different outlet types (Oh et al., 2022), since this strengthens the relationship between food safety, and sanitation practices and customer satisfaction (bin Mohamad Saber, 2025)

CHALLENGES FACED IN VERMIN CONTROL

Table 24: Challenges faced in Vermin Control by Category of Food Outlet

		Category				Total	
		Formal		Informal			
		N	%	N	%	N	%
Challenges faced in vermin control	**Lack of training**	45	21.3	7	18.9	52	21.0
	Activity is expensive	22	10.4	3	8.1%	25	10.1
	Lack of spraying/fumigation equipment	27	12.8	2	5.4	29	11.7
	lack of knowledge on chemicals to use	15	7.1	1	2.7	16	6.5
	Fear for food poisoning	14	6.6	6	16.2	20	8.1
	Doubt chemicals on sale's efficacy	17	8.1	5	13.5	22	8.9
	Reinfestations from disused and defunct infrastructure and equipment	16	7.6	2	5.4	18	7.3
	Illegal waste dump sites	13	6.2	1	2.7	14	5.6
	Lack of time for vermin control	7	3.3	3	8.1	10	4.0
	Pest control not prioritised by council	35	16.6	7	18.9	42	16.9
Total		211	100	37	100	248	100

The lack of training was most frequently reported challenge in both formal and informal outlets. Other key challenges entail pest control not prioritized by council, lack of spraying equipment, activity being expensive, doubts about chemical efficacy, fear of food poisoning, and reinfestation from infrastructure. Informal outlets reported slightly higher fears of poisoning and doubts on efficacy. The distribution of challenges was not statistically significant, $\chi^2(9, N = 248) = 10.078, p = .344, \phi = .202$. However, Eisen et al (2018), reported that some methods were are labour intensive, inconsistent and lacked commitment in Western Nile when rodent eradication seemed evitable and sudden withdrawal was done. Whereas, (Bellia et al., 2016b; Oh et al., 2022) reported of scarcity of service and weak regulation. Hence, Wang & Cooper (2025) highlighted that if barriers are left unattended it could perpetuate vermin and pathogen infections (including cholera risk) where documentation and sanitation are poor

It is hereby proposed that, practical training focused on IPM should be offered, promote vermin proofing, and advocacy on safe pesticide use and, the strengthening and capacitation of council-led vermin control services. These combined can address root causes of vermin infestation and contamination.

6. CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

This study highlights vermin infestation as a widespread public health challenge affecting food outlets in Mutare City, with a statistically significant higher prevalence

observed in the informal sector. While both formal and informal outlets share similar demographic characteristics and levels of food safety knowledge, the informal sector is to a greater extend affected by frequent vermin sightings likely due to structural, sanitation and inconsistent waste management practices.

The analysis reveals a critical awareness behaviour gap although foodhandlers across both sectors recognise the health risks posed by vermin and disease transmission, this awareness dose not consistently translate into effective evidence based mitigation strategies. The widespread reliance on chemical(pesticides) control at the expense of Integrated Pest Management (IPM) practices, coupled with lack of formal training and insufficient vermin proofing infrastructure, highlights the system's shortcomings. Ultimately, the study confirms that vermin infestation is not merely an informal sector issue but a sector-wide failure in building integrity, regulatory oversight, and environmental health investment.

6.2 RECOMMENDATIONS

To address the disconnect between awareness and practice, and to mitigate the public health risks associated with vermin driven food contamination, the following recommendations are proposed;

The Health Promotion and Environmental Health Departments in the city should move beyond basic awareness campaigns and provide practical, subsidised, and recurring training focused on Integrated Pest Management (IPM) for food handlers in both formal and informal sectors. Training must explicitly link temperature control and proper hygiene to vermin-vector pathogen mitigation. Also, there is an urgent need for the Environmental Health Directorate to have standardised, routine audits that move beyond visual inspection to incorporate objective microbial sampling. The Town Planning Department must enforce building integrity standards, including mandatory vermin-proofing for all food outlets, and provide support for upgrading infrastructure in the informal sector.

The municipality's Health Services Department must strengthen waste management systems by increasing the frequency of refuse collection, ensuring the provision of rodent-proof bins, and eliminating illegal waste dump sites near food outlets thereby addressing the root causes of vermin harbourage.

On future policy-making, the Public Relations Department must actively co-opt the informal sector on planning rather than excluding it. This includes fostering public-private partnerships to improve sanitation provision and advocating for standardised, accessible pest control services that move away from sole reliance on pesticides toward ecologically friendly and sustainable methods.

Additionally, the Environmental Health and City Health Departments should collaborate and ensure routine medical checks for food handlers are routinely conducted, and documentation of pest control programs should be made a mandatory requirement by the Pest Control Section for all food business operating licenses.

6.3 FUTURE PERSPECTIVES

Future studies should transition towards data-driven vermin detection, such as the use of low-cost, automated smart traps, to provide precise validation of infestation levels.

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CONFLICT OF INTEREST

The researcher hereby declares no conflict of interest over the conduction of the research.

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