

**FOOD SAFETY PRACTICES AND QUALITY ASSURANCE MECHANISMS AT SELECTED
OLD AGE HOMES IN MANGAUNG AND LEJWELEPUTSA, FREE STATE**

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by

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DECLARATION OF INDEPENDENT WORK

I, the undersigned, affirm that the research project submitted to the Central University of Technology, Free State, for the degree of Doctor of Philosophy in Environmental Health is an original and independent work conducted by me. This work complies with the code of academic integrity, as well as other relevant policies, procedures, rules and regulations of the Central University of Technology, Free State and has not been submitted before to any institution by me or any other person for the attainment of a qualification.

Tshegofatso Nhabe

I certify that the above statement is correct.

Professor Ntsoaki J. Malebo (Supervisor)

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SUMMARY

Older people often experience changes in their bodies that weaken their immune systems, making them more vulnerable to foodborne illnesses. Maintaining hygiene at old age homes in areas where food is prepared and served is very important to prevent potential foodborne illnesses. Food handlers and kitchen staff play a key role in preventing contamination by washing their hands regularly, cleaning utensils and surfaces properly and following safe food handling procedures from the time food is received to when it is served. As the global elderly population grows and more people live in old age homes, addressing their specific food safety needs is becoming increasingly important. In South Africa, food safety is regulated by laws such as the Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972 and the Regulations Governing General Hygiene Requirements for Food Premises (R638 of 2018). These regulations set standards to keep kitchens clean and food safe, reducing the risk of foodborne illnesses and protecting the health of elderly residents.

This study assessed quality assurance mechanisms and food safety practices and measured the level of microbial contamination on food preparation surfaces in old age home kitchens. It found contamination levels that exceeded the legal limit of 100 colony-forming units (CFU) per square centimetre (cm²). For practical reasons, the study used a threshold of 300 CFU/cm² to act as an early warning system for detecting hygiene problems. Microorganisms were then identified using the MALDI-TOF MS method. To understand the behaviour of food handlers and what influenced their practices, the study used three models: social cognitive theory (SCT), the social ecological model (SEM) and the knowledge, attitude and practice (KAP) model. These models help to explain how knowledge, attitudes and environmental factors influence food safety practices. The study showed that most old age homes made a strong effort to follow food safety guidelines and ensure quality at the facility level. Food handlers in the study believed strongly in the importance of hygiene and worked hard to meet industry standards and provide a safe environment for residents. They displayed positive attitudes towards hygiene and carefully followed the instructions set by the regulations. Their commitment was influenced by the need to comply with the law, meet accreditation standards and maintain a good reputation. However, while many practices were done well, some areas, such as personal hygiene practices, cooking temperatures, the cleanliness of refrigerators and freezers, waste storage and pest control, required improvement. The findings show how different factors influence food safety practices and provide valuable information for improving food safety management in old age home kitchens.

TABLE OF CONTENTS

Declaration of Independent Work	ii
Acknowledgements	iii
Summary	iv
List of Figures	ix
List of Tables.....	x
List of Abbreviations and Acronyms.....	xi
Chapter 1 Background.....	1
1.1 Introduction	2
1.2 Foodborne Illnesses.....	7
1.3 Key Studies in Sub-Saharan Africa	7
1.4 Food Quality Assurance Mechanisms in Old Age Homes	10
1.5 Role Players in Ensuring Food Safety.....	11
1.6 Problem Statement	14
1.7 Aim	15
1.8 Objectives.....	15
1.9 Research Questions	16
1.10 Layout of the Dissertation	16
References.....	18
Chapter 2 Literature Review.....	29
2.1 Introduction	30
2.2 Food Safety	30
2.2.1 Food preparation	31
2.2.2 Human behaviour and cultures	33
2.3 Mode of Transmission.....	36
2.4 Microbiological and Other Hazards	37
2.5 Regulatory Processes.....	42
2.5.1 Regulatory standards in South Africa	42
2.5.2 South African food safety regulations.....	42
2.5.3 Gaps in the regulatory framework	45
2.5.4 Understanding the regulatory processes.....	46
2.6 Quality in Food.....	47
2.7 Control and Preventive Measures	48
2.8 Conclusion	48
References.....	50

Chapter 3 Quantifying and Identifying Microorganisms Present on Food Preparation

Surfaces Within the Kitchens of Old Age Homes	62
3.1 Abstract	63
3.2 Introduction	63
3.3 Materials and Methods.....	66
3.3.1 Sampling site	66
3.3.2 Sample collection.....	66
3.3.3 Study design	67
3.3.4 Analysis of data	68
3.3.5 Microbial identification using MALDI-TOF MS/fingerprinting.....	69
3.4 Results and Discussion.....	70
3.4.1 Microbiological Results	70
3.4.2 MALDI-TOF MS microbial fingerprinting.....	75
3.5 Conclusion	80
References.....	81

Chapter 4 Evaluating Food Safety Practices and Quality Assurance Mechanisms in

Old Age Homes	88
4.1 Abstract	89
4.2 Introduction	89
4.3 Materials and Methods.....	89
4.3.1 Study area	90
4.3.2 Data collection	90
4.4 Data Analysis.....	91
4.5 Results and Discussion.....	91
4.5.1 Questionnaire	91
4.5.2 Analysis of sanitation and hygiene infrastructure in old age homes based on questionnaire responses	93
4.5.3 Integrated safety and hygiene procedures	97
4.5.4 Comprehensive temperature management – delivery, storage and post-cooking	99
4.5.5 Preventing contamination through adequate food separation and display practices	106
4.5.6 Facility infrastructure and maintenance standards	108
4.5.7 Qualitative analysis based on questionnaire results	109
4.5.8 Food safety checklist	119
4.6 Conclusion	120
References.....	121

Chapter 5 Framework to Reduce Surface Contamination and Increase Food Safety

Knowledge in Old Age Homes	129
5.1 Abstract	130
5.2 Introduction	130
5.2.1 Rationale for development	130
5.2.2 Social cognitive theory	132
5.2.3 Social ecological model	132
5.2.4 Knowledge, attitudes and practices model	134
5.2.5 Relation between theory and models	138
5.3 Engagement and Motivation	140
5.4 Food Safety Framework.....	140
5.5 Framework Incorporation	142
5.6 Food Safety Control Measures	143
5.7 Applicability in Various Settings	146
5.8 Conclusion	148
References	148
Chapter 6 Conclusions and Recommendations	153
6.1 Introduction	154
6.2 Chapter 3	154
6.2.1 Microbial quantification	154
6.2.2 Identification using MALDI-TOF MS	154
6.3 Chapter 4	156
6.3.1 Summary of questionnaire results	157
6.3.2 Summary of the food safety checklist	157
6.4 Norms and Standards Applicable to all Premises	158
6.5 Chapter 5	159
6.6 Recommendations	161
6.7 Study Limitations	163
6.8 Conclusion	164
References	164
Annexures	170
Annexure 1 Permission Letter for Study Participation	170
Annexure 2 Permission to Conduct Research	171
Annexure 3 Ethical Clearance (GHREC)	172
Annexure 4 Ethical Clearance (EBREC)	173
Annexure 5 Research Study Information and Consent Form	175
Annexure 6 Questionnaire	177

Annexure 7 Food Safety And Hygiene Checklist	186
Annexure 8 Turnitin Report	191

LIST OF FIGURES

Figure 1: Multidisciplinary nature of food safety.....	31
Figure 2: Microbiological threats to food safety	47
Figure 3: Visual representation of the Free State Province showing the Mangaung Metropolitan Municipality and Lejweleputswa District Municipality, where the selected old age homes for this study are located	66
Figure 4: MALDI-TOF MS machine	68
Figure 5: MALDI-TOF MS step procedure.....	69
Figure 6: Clean kitchen conditions in selected old age homes, based on microbial analysis: (a) Food preparatory surfaces and shelves where food is placed after preparation. (b) Handwash basins designated for dishes and food handlers' hands. (c) Food preparatory surfaces and stoves in a clean kitchen. (d) Clean utensils stored on stainless steel movable shelving after washing.	Error! Bookmark not defined.
Figure 7: Gender distribution of old age home food handlers	91
Figure 8: Percentage of responses for hygiene and food safety practices.....	93
Figure 9: Handwash basin, stainless steel dishwashing area for utensils and cutlery, and a cooking stove located within the kitchen space, illustrating key components essential for maintaining hygiene and food safety compliancef	94
Figure 10: Plastic washbasins located in food preparation areas of old age homes, alongside stored items such as pots, liquid soap, sterile plastic wrap, and bread buns; highlighting potential cross-contamination risks due to inadequate separation of food and non-food items.....	95
Figure 11: Microwave in a kitchen for reheating food	106
Figure 12: Social cognitive theory	132
Figure 13: Social ecological model.....	134
Figure 14: Knowledge, attitudes and practices model	135
Figure 15: Schematic representation of a food safety framework	145

LIST OF TABLES

Table 1: Characteristics of microorganisms or toxins commonly responsible for major foodborne illnesses	4
Table 2: Risk factors for foodborne illnesses	7
Table 3: Major bacteria and their risks	38
Table 4: Major viruses and their risk.....	39
Table 5: Major parasites and their risks.....	39
Table 6: Common sources of physical contaminants in foods	42
Table 7: Standards and requirements for facilities in food premises in South Africa.....	43
Table 8: Section 24(1)(a) of the Standards Act.....	44
Table 9: MALDI-TOF MS identified microorganisms	75
Table 10: Sources of bacterial species on kitchen surfaces, their common sources, implications and symptoms	78
Table 11: Quantitative analysis of food safety and hygiene practices.....	92
Table 12: Compliance levels across key food safety domains.....	119

LIST OF ABBREVIATIONS AND ACRONYMS

AGE	Acute Gastroenteritis
AIDS	Acquired Immunodeficiency Syndrome
ATP	Adenosine Triphosphate
BCCDC	British Columbia Centre for Disease Control
BCE	Before Common Era
BS EN	British Standard European Norm
BSC/DDID FSMA	Board of Scientific Counsellors, Deputy Director of Infectious Diseases for Food Safety Modernisation Act
BSI	British Standards Institution
BTS	Bacterial Test Standard
CCP	Critical Control Point
CDC	Centre for Disease Control
CFR	Case Fatality Rate
CFU	Colony Forming Unit
CoA	Certificate of Acceptability
DAFF	Department of Agriculture, Forestry and Fisheries
DFWED	Division of Foodborne, Waterborne and Environmental Diseases
DoH	Department of Health
EBREC	Environment and Bio-Safety Research Ethics Committee
ECDC	European Centre for Disease Prevention and Control
EHP	Environmental Health Practitioner
FAO	Food and Agriculture Organization
FBD	Foodborne Diseases
FDC	Foodstuffs, Cosmetics and Disinfectants
FIFO	First In, First Out
FSF	Food Safety Framework
FSMS	Food Safety Management Systems
GHP	Good Hygiene Practices
GHREC	General/Human Research Ethics Committee
GMP	Good Manufacturing Practices
HACCP	Hazard Analysis Critical Control Points
HCCA	α -Cyano-4-Hydroxycinnamic Acid
HIV	Human Immunodeficiency Virus
HR	Human Resource
ID	Identity

ISO	International Organization for Standardization
KAP	Knowledge, Attitude and Practice
KPA	Key Performance Areas
MALDI -TOF MS	Matrix-Assisted Laser Desorption Ionization-Time of Flight Mass Spectrometry
MSA	Mannitol Salt Agar
MSP	Micro Scout Plate
MT	MALDI-TOF
NA	Nutrient Agar
NCEZID	National Centre for Emerging and Zoonotic Infectious Diseases
NICD	National Institute for Communicable Diseases
NMC	Notifiable Medical Conditions
NRCS	National Regulator for Compulsory Specifications
NSNP	National School Nutrition Programme
NTS	Non-Typhoidal Serotypes
PCA	Plate Count Agar
pH	Potential of Hydrogen
PPE	Personal Protective Equipment
PRP	Prerequisite Programmes
QA	Quality Assurance
SAARNSF	South African Antimicrobial Resistance National Strategy Framework
SABS	South African Bureau of Standards
SAFCA	South African Food Control Agency
SANS	South African National Standards
SCM	Social Cognitive Model
SCT	Social Cognitive Theory
SEM	Social Ecological Model
SOP	Standard Operating Procedures
SPSS	Statistical Package for the Social Sciences
ST6	Sequence Type 6
TCC	Total Coliform Count
TNTC	Too Numerous to Count
TVC	Total Viable Count
UNESCWA	United Nations Economic and Social Commission for Western Asia
V	Version
WC	Water Closet
WHO	World Health Organization

CHAPTER 1

BACKGROUND

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1.1 Introduction

As people age, there is an increasing likelihood that they will have to move into an old age home setting. The primary catalysts for losing independence and having to move into an old age home are often the following: losing a lifelong partner, having a serious health condition, which often stems from a geriatric syndrome, sustaining a bone fracture, experiencing the onset of dementia and not having anyone to provide care for them at home. Globally, there are about 125 million oldest-old adults (between the ages of 80 and 99 years) and 914 million old adults (between the ages of 60 and 79 years); this calculation is anticipated to triple in number by 2050 (World Health Organization, 2024). Old age homes are typically designed as cluster communities that should be protected against infections. In the event of an infection occurring at the institution, the expectation is that it will be managed effectively on the premises (Holland *et al.*, 2020). However, information regarding the specific control measures used to ensure the safety of residents against microorganisms in these homes is limited (Chawla *et al.*, 2023). This gap presents an opportunity to introduce the concept of quality assurance (QA) in the context of these cluster homes. QA is a vital framework for ensuring that adequate control measures are in place to manage risks associated with food safety in old age homes. According to Okpala and Korzeniowska (2021), these measures include regular inspections, comprehensive staff training, and strict sanitation protocols, all of which are important for maintaining high standards of hygiene, monitoring infection control practices, and ensuring compliance with health and safety regulations. Mphanga *et al.* (2024) states that, by implementing strong QA systems, facilities can proactively address potential food safety risks through routine audits and continuous monitoring, allowing them to detect and correct issues before they escalate into outbreaks.

The Cooperative Governance Traditional Affairs (2025) supports that this proactive approach not only minimises the spread of infections but also promotes the overall health and well-being of elderly residents, who are particularly vulnerable to foodborne illnesses. In contrast, the study by Shott *et al.* (2018) states that the absence of a well-defined QA mechanism can result in delayed responses to emerging risks, increasing the likelihood of outbreaks and subsequent hospitalisations. Therefore, a comprehensive and well-maintained QA system is not just a regulatory necessity but a critical component in protecting residents and ensuring the delivery of quality care within old age homes as supported by Odilichukwu *et al.* (2021). Moreover, these facilities run the risk of being influenced by long-established food safety beliefs and practices among food handlers, which can contribute to the acquisition of foodborne illnesses (Holland *et al.*, 2020). Vulnerable populations, particularly young children and adults over the age of 50, experience severe foodborne illnesses at higher rates than the general population.

Age-related physiological changes, including reduced immunity and other effects of the ageing process, further elevate the risk of infection among elderly individuals (National Institute on Ageing, 2018). Furthermore, research indicates that adults over the age of 50 are hospitalised and die from foodborne illnesses at notably higher rates than other age groups (Holland *et al.*, 2020; Thaivalappil *et al.*, 2020). In many countries, elderly persons who are unable to care for themselves live in old age homes where they receive assistance with meals, daily living and health care (Miller *et al.*, 2021). Food preparation areas in old age homes are considered important to the health and well-being of the elderly population housed there. Thus, correct food preparation practices in old age homes may reduce the risk of foodborne diseases in these residents when compared with elderly persons living in the community, who may have less exposure to safe food preparation practices (Miller *et al.*, 2021). The association between the consumption of food and human diseases was recognised very early. In 460 before common era (BCE), Hippocrates reported that there was a strong connection between food consumed and human illnesses (Azanaw *et al.*, 2019; Hutt, 1984). Foodborne pathogens (e.g., viruses, bacteria and parasites) are biological agents that can cause a foodborne illness event.

A foodborne disease outbreak is, therefore, defined as the occurrence of two or more cases of similar illnesses resulting from the ingestion of a common food (Food Standards Agency, 2020). As such, foodborne illnesses manifest when a pathogen is ingested with meals and establishes itself (and usually multiplies) in the human host or when a toxigenic pathogen establishes itself in a food product and produces a toxin, which is then ingested by the human host (WHO, 2019). Foodborne illnesses are generally classified into (a) foodborne infection and (b) foodborne intoxication (WHO, 2019). Foodborne illnesses are caused by a variety of bacteria, parasites and viruses; leading causes include infections with (i) non-typhoidal *Salmonella* (approx. 59 000 deaths), (ii) *Salmonella typhi* (approx. 52 000 deaths), (iii) Enteropathogenic *Escherichia coli* (approx. 37 000 deaths) and (iv) Norovirus (approx. 35 000 deaths) (Hoelzer *et al.*, 2018; WHO, 2015). Typical foodborne illness symptoms include nausea, vomiting and diarrhoea (FSA, 2020). More than 250 different sources of foodborne diseases have been identified (Harrison and DiCaprio, 2018; Odeyemi and Bamidele, 2016). These diseases can arise from a variety of sources. According to Elbehiry *et al.* (2023), bacterial pathogens such as *Salmonella*, *Escherichia coli* and *Listeria* are commonly found in raw meats, unwashed vegetables and unpasteurised dairy. Adding to this, Olaimat *et al.* (2024) explain that viruses such as Norovirus and Hepatitis A are spread through contaminated food or water, with Norovirus often associated with shellfish and Hepatitis A linked to poor sanitation.

Marín-García *et al.* (2022) point out that parasites such as *Giardia* and *Toxoplasma* can taint water and undercooked meat. Additionally, chemical contaminants such as pesticides on fruits and vegetables, along with issues from improper food handling, such as cross-contamination and incorrect storage, add another layer of risk. Studies by Beshearse *et al.* (2021), Iannetti *et al.* (2021) and Kearney (2018) have also investigated the prevalence of infections caused by agents transmitted through contaminated food or water, specifically comparing elderly individuals residing in old age homes with those living independently in the community. Table 1 presents information on the approximate time it takes for symptoms to appear after contaminated food has been consumed, the main symptoms experienced, the primary microorganisms or toxins responsible for causing the major foodborne illnesses and their source.

Table 1: Characteristics of microorganisms or toxins commonly responsible for major foodborne illnesses

Approximate onset time to symptoms	Predominant symptoms	Associated organism or toxin	Source
1-7 h (mean 2-4 h)	Nausea, vomiting, retching, diarrhoea, abdominal pain, prostration	<i>Staphylococcus aureus</i> and its enterotoxins	Contaminated food, especially dairy, cream-filled pastries and meats
8-16 h (2-4 h if emesis predominant)	Vomiting or diarrhoea, depending on whether diarrheic or emetic toxin present; abdominal cramps; nausea	<i>Bacillus cereus</i> (emetic toxin)	Fried rice and other starchy foods
12-48 h	Nausea, vomiting, watery non-bloody diarrhoea, dehydration	Norovirus	Contaminated shellfish, fruits and vegetables
2-36 h (mean 6-12 h)	Abdominal cramps, diarrhoea, putrefactive diarrhoea (<i>Cl. perfringens</i>), sometimes nausea and vomiting	<i>Clostridium perfringens</i>	Improperly stored or reheated meats, poultry and gravies
6-96 h (usually 1-3 days)	Fever, abdominal cramps, diarrhoea, vomiting, headache	<i>Salmonella</i> spp., <i>Shigella</i> spp., <i>Escherichia coli</i>	Contaminated poultry, eggs, dairy products and produce

Approximate onset time to symptoms	Predominant symptoms	Associated organism or toxin	Source
6 h to 5 days	Abdominal cramps, diarrhoea, vomiting, fever, malaise, nausea, headache, dehydration	<i>Vibrio cholerae</i> (O1 and non-O1), <i>Vibrio parahaemolyticus</i>	Contaminated water and undercooked seafood
1-10 (median 3-4 days)	Diarrhoea (often bloody), abdominal pain, nausea, vomiting, malaise, fever (uncommon with <i>E. coli</i> O157:H7)	Enterohemorrhagic <i>Escherichia coli</i> , <i>Campylobacter</i> spp.	Undercooked beef (<i>E. coli</i>), contaminated poultry (<i>Campylobacter</i>)
3-5 days	Fever, vomiting, watery non-inflammatory diarrhoea	Rotavirus, Astrovirus, enteric Adenovirus	Contaminated water and food, person-to-person contact
3-7 days	Fever, diarrhoea, abdominal pain	<i>Yersinia enterocolitica</i>	Contaminated pork, unpasteurised milk and untreated water
1 to several weeks	Abdominal pain, diarrhoea, constipation, headache, drowsiness, ulcers, variable - often asymptomatic	<i>Entamoeba histolytica</i>	Contaminated water or food, especially in areas with poor sanitation
3-6 months	Nervousness, insomnia, hunger pains, anorexia, weight loss, abdominal pain, sometimes gastroenteritis	<i>Taenia saginata</i> , <i>Taenia solium</i>	Undercooked beef (<i>Taenia saginata</i>), pork (<i>Taenia solium</i>)
2 h to 6 days (usually 12-36 h)	Vertigo, double or blurred vision, loss or light reflex, difficulty in swallowing, dry mouth, weakness, respiratory paralysis	<i>Clostridium botulinum</i> and its neurotoxins	Improperly canned or preserved foods

Approximate onset time to symptoms	Predominant symptoms	Associated organism or toxin	Source
4-28 days	Gastroenteritis, fever, oedema around eyes, perspiration, muscular pain, chills, prostration, laboured breathing	<i>Trichinella spiralis</i>	Undercooked or raw pork and wild game meats
7-28 days	Malaise, headache, fever, fever, cough, nausea, vomiting, constipation, abdominal pain, chills, rose spots, bloody stools	<i>Salmonella typhimurium</i>	Contaminated food and water
10-13 days	Fever, headache, myalgia, rash	<i>Toxoplasma gondii</i>	Undercooked or raw meat, especially pork and lamb; contaminated water
Varying periods	Fever, chills, headache, arthralgia, prostration, malaise, swollen lymph nodes and other specific symptoms of disease in question	<i>Listeria monocytogenes</i> , <i>Campylobacter jejuni</i>	Contaminated dairy products (<i>Listeria</i>), undercooked poultry (<i>Campylobacter</i>)

FDA, 2012

Given this context, the primary purpose of this study was to investigate common food safety practices and QA methods, as well as to evaluate the cleanliness of food preparation surfaces in selected old age homes in the Mangaung metropolitan and Lejweleputswa district municipalities in the Free State. The Free State Province was chosen due to the researcher's personal connection to the region and the critical need for improved food safety practices. With old age homes in the area being inspected only twice a year and a troubling history of foodborne illness cases, there is pressing concern about the adequacy of current standards. Despite advances made in the field of food safety to control the spread of foodborne illness, various studies conducted in Africa demonstrate inadequacies in ensuring food safety and this results in foodborne illnesses.

1.2 Foodborne Illnesses

Food safety, from the food supply chain to final preparation and consumption, is an ongoing challenge (WHO, 2019). Ensuring proper food safety and sanitation practices is crucial for safeguarding consumer health (UN ESCWA, 2019; Quinlan, 2013). This is especially important in old age homes, where the risk of foodborne illnesses is heightened due to the vulnerability of the elderly residents. In old age homes, maintaining the cleanliness of preparation surfaces, such as countertops, basins and holding shelves, is essential. These surfaces can harbour harmful bacteria if not properly cleaned and sanitised, posing increased risks to residents with compromised immune systems or underlying health conditions (Osaili *et al.*, 2017). The consequences of foodborne diseases in old age homes can be severe and life-threatening, leading to serious health issues, increased hospitalisation costs and even fatalities. According to the WHO (2019), foodborne illnesses are responsible for approximately 2.2 million deaths around the world each year. These numbers highlight the impact that these diseases have on individuals and communities, which emphasises the urgent need for effective food safety measures and improved access to clean water and sanitation to prevent such tragedies. As in other countries, foodborne diseases characterised by acute gastrointestinal diseases are the most significant food safety problem as well as the most distressing food-related threat to public health. Table 2 outlines the risk factors for foodborne illnesses.

Table 2: Risk factors for foodborne illnesses

a) Immune system function decreases with age, making it harder for the body to fight infections.
b) Chronic diseases and ailments such as malnutrition and immobility, which occur at high rates in seniors, can increase their vulnerability to infections.
c) Changes in the digestive system of older adults reduce their production of stomach acid, which is important in defending the elderly against foodborne pathogens. The frequent use of antacids and antibiotics can further hamper acid production and disrupt beneficial bacteria in the gut that offer some protection from harmful foodborne contaminants. Older adults also typically exhibit slower digestion, giving pathogens an extended amount of time to colonise and infect the body.

CDC, 2012; CDC, 2014

1.3 Key Studies in Sub-Saharan Africa

Food safety and foodborne illnesses in Kenya

Kenya has experienced a few notable outbreaks of foodborne illnesses in recent years. In 2009, a gastroenteritis outbreak in Madera was linked to *Escherichia coli* (Ochi *et al.*, 2017). In 2014, the Regional Centre of the Centres for Disease Control and Prevention (CDC) in Kenya examined samples from nearly 57 outbreaks, revealing various illnesses associated with *Salmonella enterica*. Two years later, an *Escherichia coli* outbreak in Maru affected over 50 children, resulting in at least two deaths (Daily Nation, 2016). Following the overview of foodborne outbreaks in Kenya, it is important to examine the factors contributing to these issues. Research conducted in Kenya identified inadequate storage and handling practices as contributors to food contamination and outbreaks (Kariuki *et al.*, 2017). Boatemaa *et al.* (2019) emphasise that food safety challenges are exacerbated by poor storage conditions.

Additionally, studies indicate that inadequate hygiene practices in small and medium-scale slaughterhouses, such as the absence of gloves, soap, disposable towels for handwashing and insufficient equipment cleaning, are factors leading to contamination (Siluma *et al.*, 2023). These issues are further emphasised by the presence of pathogens such as *Campylobacter* spp., *Salmonella*, *Escherichia coli* and *Toxoplasma gondii* in poultry products, as identified in studies from Kenya (Arias-Granada *et al.*, 2021; Oliveira *et al.*, 2021). This highlights the pressing need for improved food handling and storage practices to mitigate the risk of outbreaks. Moreover, despite the frequency of these outbreaks, public awareness of foodborne diseases in Kenya remains low. Moreover, a study by Khalid *et al.* (2020) revealed gaps in government control and the enforcement of hygiene standards by poultry processors, particularly in Nairobi. Addressing these regulatory shortcomings is important for enhancing food safety and reducing the risk of future outbreaks. This information is relevant to the current study as it highlights the urgent need for improved hygiene practices and regulatory compliance among poultry processors, which directly impacts food safety outcomes. By identifying these deficiencies, the research aims to contribute to the development of more effective food safety strategies and policies, ultimately protecting public health and reducing the incidence of foodborne illnesses.

Food safety and foodborne illnesses in Senegal

According to a study by Arias-Granada *et al.* (2021), foodborne illnesses are prevalent in Senegal but are not consistently acknowledged unless they manifest as large-scale outbreaks. For example, in 2016, more than 30 individuals were hospitalised after consuming contaminated mayonnaise and liver from a street vendor in Guédiawaye, a city near the capital, Dakar (Leral Net, 2017). Similarly, Mwihi *et al.* (2018) reported a disease outbreak linked to the consumption of contaminated fish. These events, along with a rise in gastrointestinal infections during major religious celebrations, suggest a potential association

between foodborne illnesses and street food consumption (Manyi-Loh and Lues, 2023; Leone *et al.*, 2022). In another case, a milk product commonly consumed by children was found to be contaminated with *Salmonella* (Leone *et al.*, 2022). Further studies by Leone *et al.* (2022) and Augustin *et al.* (2020) investigated a range of pathogens and food products, including *Vibrio* spp. in seafood, *Salmonella* spp. and *Campylobacter* spp. in poultry, drug-resistant bacteria in chicken, and the microbial quality of raw milk. These findings highlight the widespread nature of foodborne pathogens and emphasise the need to improve food safety across various food sources. Qualitative studies involving focus groups with mothers revealed some awareness of the health risks associated with animal-sourced foods and the importance of hygienic practices such as thorough washing and proper cooking (Yemane and Tamene, 2022; Gautam and Curtis, 2021; Traoré *et al.*, 2018). However, studies by Arias-Granada *et al.* (2021) and Bauchet *et al.* (2021) indicated that fewer than one-third of smallholder farmers were aware of foodborne diseases and the contamination risks posed by aflatoxins and bacteria.

Food safety and foodborne illnesses in South Africa

Listeriosis outbreak in South Africa June 2017-April 2018

An outbreak of *Listeria monocytogenes* in 2017/2018, linked to a ready-to-eat processed meat product called “polony” resulted in approximately 1,000 fatalities (Chutel, 2018; WHO, 2018). A total of 937 laboratory-confirmed cases were identified, of which 50% (465 cases) were pregnancy-associated; notably, 87% (406 cases) of these involved neonates (Tchatchouang *et al.*, 2020). Among the total cases, 24% (229) occurred in individuals aged 15 to 49 years, excluding pregnant individuals. Among patients with known HIV status, 38% of pregnancy-associated cases (77 out of 204) and 46% of non-pregnant cases (97 out of 211) were HIV-positive. Out of 728 patients with known clinical outcomes, 27% (193) died as a result of the infection. Additionally, the study by Thomas *et al.* (2020) reported that sequences were obtained from clinical isolates of 609 patients, with 93% (567) identified as sequence type 6 (ST6). A case-control study revealed that individuals infected with ST6 were more likely to have consumed polony than those with non-ST6 infections (odds ratio 8.55; 95% confidence interval, 1.66 to 43.35). Smith *et al.* (2019) further confirmed that ST6 isolates were found in both polony and environmental samples, and that patient isolates clustered within the same core-genome multilocus sequence typing group, differing by no more than four alleles. These findings confirmed the outbreak source as polony produced at a single facility. A product recall from the implicated facility was followed by a sharp decline in *Listeria* ST6 infections.

Salmonella food poisoning outbreak in North-West Province, South Africa

According to He *et al.* (2023) and Motladiile *et al.* (2019), *Salmonella* outbreaks have been reported across various regions of South Africa. *Salmonella enterica*, which includes over 2500 typhoidal and non-typhoidal serotypes (NTSs), poses a global public health threat due to its transmission through contaminated food. NTSs are frequently associated with foodborne acute gastroenteritis (AGE), with contaminated meat, poultry, eggs, and dairy products accounting for over 95% of infections (Fleckenstein *et al.*, 2021). In one outbreak reported by Motladiile *et al.* (2019), 164 schoolchildren in the North West province developed symptoms of AGE after consuming meals from the National School Nutrition Programme (NSNP), including maize meal, beans, and vegetables. *Salmonella enterica* serovar Heidelberg was identified in 92% of the cases, which were linked to poorly stored and prepared samp. The illness typically lasted two days, with a case fatality rate of 0.6%.

Motladiile *et al.* (2019) emphasize that understanding the source and causative agent of an outbreak is critical, requiring epidemiological, environmental, and microbiological investigations. Effective control measures include strict hygiene practices in food handling and preparation, regular inspections, and adherence to food safety regulations. Public education campaigns on safe food handling can empower communities to make informed choices (Putri and Susanna, 2021), while investments in rapid detection technologies enable early intervention. Coordinated efforts among government agencies, the food industry, and healthcare providers are essential for managing outbreaks and protecting public health (Baba and Esfandiari, 2023). Despite initiatives like the NSNP aimed at reducing hunger and improving learning (Mulaudzi *et al.*, 2023), foodborne disease outbreaks persist in provinces such as the Eastern Cape, KwaZulu-Natal, and Limpopo. Poor hygiene practices in school environments is an issue observed globally and continue to contribute to these outbreaks, with transmission often occurring in enclosed spaces and symptoms lasting three to five days (Bisholo *et al.*, 2018).

Staphylococcus aureus in Nkonkobe Municipality, South Africa

Adegoke and Okoh (2014) conducted a study in Nkonkobe Municipality, South Africa, examining 150 farm animals, including chickens, to investigate the presence of *Staphylococcus aureus*. They identified 120 *Staphylococcus* isolates, all resistant to various antimicrobial agents, which the authors attributed to the animals' bacterial flora being exposed to antibiotics. This trend, also supported by Barbosa and Levy (2000), highlights the growing risk of antimicrobial resistance (AMR) in food-producing animals. To address this, the South African Antimicrobial Resistance National Strategy Framework (SAARNSF) recommends

stricter control of antibiotic use in agriculture (RSA DAFF, 2017). Enforcing regulations that restrict antibiotic use to therapeutic purposes under veterinary supervision, along with robust surveillance systems to monitor misuse, is crucial. Toghroli *et al.* (2024) further emphasise the need for farmer and veterinarian education on responsible antibiotic practices, while Nardulli *et al.* (2023) advocate for multi-stakeholder collaboration including government, health professionals, and pharmaceutical companies to promote sustainable antibiotic stewardship.

The presence of *Staphylococcus aureus* in ready-to-eat chicken meat, as observed in the Tshwane metropolitan area by Mekhloufi *et al.* (2021), reinforces these concerns. Their study estimated a 1.3% probability of food poisoning from *Staphylococcal enterotoxins*, emphasizing the public health risks linked to contaminated meat. Similar findings from Madoroba *et al.* (2021) and Thwala *et al.* (2021) confirm the widespread prevalence of pathogenic bacteria in South African poultry products. Poor food hygiene practices, if not addressed, may facilitate cross-contamination. Todd (2020) and García-Díez *et al.* (2023) link the rise in foodborne illnesses to inadequate agricultural practices and substandard hygiene during processing, such as improper evisceration during slaughter. Strengthening surveillance, education, and regulatory measures as outlined by the Council to Improve Foodborne Outbreak Response (2020) and White *et al.* (2022) can improve early detection and prevention of outbreaks. Developing countries can benefit from international knowledge exchange and capacity-building to enhance food safety systems and reduce the burden of foodborne diseases.

1.4 Food Quality Assurance Mechanisms in Old Age Homes

Petrescu *et al.* (2019) explain that food quality is defined by attributes that meet established standards set by both consumers and regulatory bodies. Consumers typically evaluate food based on physical and chemical properties such as size, shape, colour, consistency, texture, and taste. In contrast, regulatory bodies establish benchmarks to ensure food safety and quality, offering objective criteria that guide consumer expectations (Villamiel and Mendez-Albinana, 2022). These standards are crucial for maintaining consistency and safety in food production, regardless of individual preferences. Petrescu *et al.* (2019) further emphasise that maintaining consistent food quality is essential to meet consumer expectations. Therefore, establishing clear standards and implementing control systems are necessary to ensure that food quality aligns with these criteria (Okpala and Korzeniowska, 2021). In the context of old age homes, maintaining food quality is particularly important due to the vulnerability of the residents. To support this, the South African Department of Health (RSA DoH, 2018a) developed guidelines for environmental health practitioners (EHPs) to evaluate food premises based on Hazard Analysis Critical Control Point (HACCP) principles. This system identifies potential hazards at any stage of food production, processing, or preparation, assesses the

associated risks, and determines where control measures should be applied. Each food service establishment, including old age homes, is expected to implement HACCP steps to ensure food remains safe and of high quality for consumption.

1.5 Role Players in Ensuring Food Safety

Role of food handlers

Making sure food is safe involves various individuals; those who handle it, make rules about it and consume it. Each of them plays a crucial role in maintaining the safety and quality of food. Food handlers are the gatekeepers of food safety, serving as the last line of defence against foodborne illnesses. Their responsibilities include reducing, eliminating, preventing, and protecting food from contamination. Unfortunately, many begin their roles without proper medical check-ups and often lack essential experience or training in food safety (Insfran-Rivarola *et al.*, 2020). A study by Dagnew *et al.* (2012) revealed that out of 200 food handlers, only six were certified to handle food. While most washed their hands after using the toilet, fewer used soap and water, and even fewer washed their hands after touching their nose. Tappes *et al.* (2020) assert that unsafe food handling practices at any stage of the food chain can make food hazardous to health. Their study emphasises that the health status of food handlers, along with their adherence to good food hygiene behaviours and practices, is crucial for maintaining food safety at any food premises.

Tappes *et al.* (2020) further highlighted that the main sources of contamination by food handlers must be addressed to prevent or eliminate foodborne illnesses. They proposed the adoption of standardised operational procedures, including easily understandable flowcharts monitored by safety and occupational health professionals or EHPs during inspections in the South African context. Additionally, their study emphasised the need for training sessions for food handlers, covering topics such as the correct use of personal protective equipment (PPE). Yemane and Tamene (2022) note that between 10% to 20% of foodborne outbreaks are caused by food handler contamination, and foodborne illnesses are estimated to be the most common illness in Africa and Southeast Asia. Several outbreaks have been directly linked to food handlers (Ehuwa *et al.*, 2021; Sufen *et al.*, 2015). Contributing factors include limited food safety knowledge, poor personal hygiene, and inadequate sanitation in food preparation and service facilities (Ahmed *et al.*, 2017; Ifeadike *et al.*, 2014; McIntyre *et al.*, 2013).

Old age home kitchen managers

Old age home kitchen managers are responsible for overseeing all aspects of food handling, preparation, and service within the facility. They play a critical role in implementing and

enforcing hygiene and safety practices among food handlers, including proper handwashing, sanitation of utensils and surfaces, and safe food storage protocols. Kitchen managers must provide ongoing training and supervision to food handlers to ensure compliance with food safety regulations and standards (Al Banna *et al.*, 2022; RSA DoH, 2003). Additionally, they should conduct regular inspections of food premises to identify and rectify any potentially hazardous hygiene practices. When kitchen managers fail to inspect their food premises and adhere to regulatory standards, the consequences can be severe. Neglecting to enforce food safety measures may result in foodborne illness outbreaks among vulnerable elderly residents, with potentially serious health outcomes, including fatalities. Furthermore, non-compliance with the regulatory standards outlined in the Regulations Governing General Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018), may lead to legal fines, institutional closure, and significant damage to the institution's reputation (RSA DoH, 2018b). Therefore, the role of the kitchen manager in ensuring strict adherence to food safety regulations cannot be over-emphasised.

Environmental health practitioners

To ensure food quality and safety, the government is expected to provide education on food legislation to food handlers, managers, and owners of food premises through Environmental Health Practitioners (EHPs). In South Africa, EHPs play a key role in educating food handlers about food safety and hygiene while ensuring compliance with legislation. This includes standards for food premises, food containers, storage and temperature control, cooking temperatures, protective clothing, food transport, and responsibilities of both managers and food handlers (RSA DoH, 2013). National legislation mandates EHPs to offer training in food hygiene and safety, provide advice and guidance on best practices, and conduct regular compliance surveillance. Corrective actions taken during inspections reduce food poisoning and protect consumers from foodborne illnesses by identifying risks such as cross-contamination, improper storage, and inadequate cooking. Augustin *et al.* (2020) highlight how inspections can address these risks, which, if overlooked, may lead to widespread illnesses, hospitalisations, and fatalities. In old age homes, EHPs typically inspect facilities twice a year in accordance with the National Health Act 61 of 2003 (RSA DoH, 2003). However, this schedule may contribute to lapses in safe practices, such as poor storage, handling, cleaning, and cooking posing serious health risks. Given the rising incidence of foodborne outbreaks and their impact on vulnerable populations, more frequent inspections in old age homes are necessary. The absence of consistent oversight by EHPs can have far-reaching public health and economic consequences, including medical costs, loss of productivity, and reputational damage to facilities. Increasing inspection frequency could help maintain food safety

standards, while unannounced inspections may further discourage non-compliance and promote adherence to hygienic practices. Failure to inspect regularly can lead to neglect of sanitation standards and increase the risk of foodborne illnesses, particularly among older adults, who are already vulnerable (Makhunga *et al.*, 2023). Using food safety checklists to evaluate handler practices is critical to maintaining standards. Studies in similar settings by Barnes *et al.* (2022), Putri and Susanna (2021), and Tappes *et al.* (2020) highlights the importance of frequent inspections in strengthening food safety protocols and protecting elderly residents' health.

Legislation

In South Africa, various laws are important for improving food QA, especially in old age homes. These laws set rules for hygiene in food premises, transporting food, and related areas. Key legislation includes the FDC Act 54 of 1972 (RSA DoH, 1972), which covers the Regulations Governing General Hygiene Requirements for Food Premises and the Transport of Food (R638 of 2018) (RSA DoH, 2018b). Other important laws are the Agricultural Product Standards Act 119 of 1990 (RSA, 1990), the Regulations Relating to Milk and Dairy Products 1555 of 1997 (RSA, 1997), and the Meat Safety Act 40 of 2000 (RSA, 2000). Specifically, the Department of Health (DoH), through the FDC Act 54 of 1972, established regulations that control food imports and the manufacturing and sale of food (RSA DoH, 1972), ensuring that only safe and quality food products are available in the market, directly benefiting vulnerable populations in old age homes.

Regulation (R) 638, which governs Hygiene Requirements for Food Premises and the Transport of Food, provides a framework for local and district municipalities to implement consistent hygiene practices in food handling and preparation (RSA DoH, 2018b). EHPs are qualified to assist with food control issues, oversee food transport, and apply and issue certificates of acceptability (CoAs) for food establishments as dictated by R638 of 2018 (RSA DoH, 2018b). These CoAs certify that facilities meet required hygiene standards, assuring the quality and safety of food served to residents in old age homes. By implementing these legislative frameworks, old age homes can ensure that food safety practices are consistently monitored and improved. Regular inspections by EHPs identify risks and hazards related to food handling, mitigating foodborne illnesses, while ongoing education and training for food handlers reinforce hygiene and safety. Thus, these laws collectively enhance food QA mechanisms in old age homes and protect the health and well-being of their residents, fostering a safer, more hygienic food environment.

1.6 Problem Statement

Pathogenic bacteria can spread through direct contact with contaminated surfaces or indirectly via improperly prepared food, person-to-person contact, or airborne and waterborne particles. Studies show that bacteria such as *Salmonella*, *Staphylococcus aureus*, and *Escherichia coli* can survive on hands, sponges, utensils, and even money for hours or days after initial contact (Novak Babič *et al.*, 2020). Research has also documented bacterial survival and transfer between hands, food, and food contact surfaces (Katzenberger *et al.*, 2021). Cross-contamination from raw foods to ready-to-eat foods, facilitated by hands, cleaning cloths, or surfaces, has contributed to foodborne outbreaks, especially when foods are not cooked further. While kitchen surfaces are essential for food preparation (Lange, 2017), their role in spreading harmful bacteria within old age homes is not well documented. Cleaning may remove visible food particles, but bacteria can remain on surfaces, posing a contamination risk. Large transfers of bacteria from preparation surfaces to food increase the likelihood of foodborne illnesses, a global concern due to the significant sickness and mortality associated with these illnesses (Petrescu *et al.*, 2019; Osaili *et al.*, 2017).

The absence of strong food quality assurance (QA) processes exacerbates these risks. Most studies focus on contamination itself but overlook whether old age homes have adequate control measures to prevent bacterial spread. Factors such as food handlers' practices, poor surface hygiene, inadequate management, and insufficient inspections by EHPs further increase vulnerability. Although old age homes are smaller than extensive healthcare facilities, they must maintain high food quality standards because their residents are particularly susceptible to foodborne illnesses. Studying contamination alone is insufficient; the effectiveness of existing prevention systems must also be evaluated. Measuring bacterial spread risk at each food preparation stage can enhance risk management. Additionally, improving training, monitoring, and inspections will strengthen food safety and protect elderly residents. This study underscores the urgent need to assess and improve food QA mechanisms in old age homes to safeguard this vulnerable population from foodborne diseases.

1.7 Aim

To investigate common food safety practices and QA mechanisms related to food safety issues in old age homes.

1.8 Objectives

Three objectives were identified:

- Quantify and identify the distribution of microorganisms on food preparation surfaces in old age home kitchens.
- Assess the implementation of food safety practices and QA mechanisms of food handlers and managers at old age homes by using a questionnaire and a food safety checklist.
- Assess the food safety and QA knowledge and practices of food handlers and their managers at old age homes using a questionnaire and focus group sessions.

1.9 Research Questions

- What is the quantity and distribution of microorganisms on food preparation surfaces in old age home kitchens?
- What food safety practices and quality assurance (QA) mechanisms are implemented by food handlers and managers in old age homes?
- What are the levels of food safety and QA knowledge and practices among food handlers and their managers in old age homes?

1.10 Layout of the Dissertation

This study has six chapters, which are arranged as follows:

Chapter 1: This chapter is the introduction to the study; it provides an overview of the study and provides background material. This section also outlines the problem statement, the purpose of the study, the research aim, objectives and questions and explains the layout of the dissertation.

Chapter 2: This chapter provides an overview of current and existing literature on foodborne diseases. It deals with barriers to food safety implementation and compliance with the help of the involvement of EHPs. It describes food safety knowledge, why foodborne illness outbreaks should be investigated, QA mechanisms in old age homes, the role of the food handler, food safety practices, quality of food, mode of transmission, cross-contamination, control and preventive measures.

Chapter 3: The third chapter focuses on quantifying and identifying the distribution of microorganisms present on food preparation surfaces in the kitchens of old age homes, providing valuable insights into potential microbial risks and recommending improved hygiene practices in such environments.

Chapter 4: This chapter outlines the methodology for evaluating the efficacy of food safety practices and QA mechanisms among food handlers and managers in old age homes, employing a comprehensive approach that includes the use of a questionnaire and a food safety checklist for thorough assessment.

Chapter 5: The fifth chapter describes the development of a framework to reduce surface contamination and enhance the food safety knowledge of food handlers in old age home kitchens.

Chapter 6: In the concluding chapter, the focus is on summarising key discussions, presenting overall conclusions and offering practical recommendations, with a specific emphasis on implementation strategies for improvements.

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CHAPTER 2

LITERATURE REVIEW

Food Safety Practices and Quality Assurance Mechanisms at Old Age Homes in Mangaung
and Lejweleputswa

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2.1 Introduction

Food safety challenges in Africa often receive less policy attention compared to other pressing public health issues such as food security, malaria, human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), and tuberculosis (TB) (FAO, 2023). This insufficient policy focus results in many minor outbreaks and occasional cases of foodborne illnesses, including those involving food fraud, being missed and underreported (Sibanda *et al.*, 2023; Everstine, 2019). These issues are especially pronounced in less developed regions where access to clean water, proper sanitation, and stringent food safety regulations is limited. In such environments, improper food handling and storage practices are common, facilitating the spread of foodborne pathogens (Grace, 2023). Socioeconomic factors such as poverty, malnutrition, and inadequate healthcare further exacerbate the impact of foodborne illnesses by reducing the affected populations' ability to combat infections. Overcrowded living conditions and poor infrastructure also contribute to the rapid spread of disease outbreaks (Faour-Klingbeil and Todd, 2019). This context is particularly relevant for old age homes, where residents are vulnerable due to age and often compromised immune systems.

In South Africa, the food safety and control system play a role in protecting public health, including in old age homes. However, recent incidents such as the Listeriosis outbreak have exposed significant gaps in the system's implementation, underscoring the urgent need for improvement (Grace, 2023; Mbonane and Naicker, 2020). These outbreaks illustrate how environmental, social, and economic factors combine to increase the risks and severity of foodborne diseases, especially for vulnerable populations like the elderly. Globally, the Food and Agriculture Organization (FAO) estimates that contaminated food causes approximately 600 million illnesses and 420,000 deaths annually (FAO, 2023). Foodborne diseases are commonly linked to consuming contaminated food or water tainted with viruses, bacteria, and parasites (Dewey-Mattia *et al.*, 2018). While developed countries tend to have better outbreak reporting systems, underreporting remains a significant challenge in developing nations where food safety is less prioritized (Mbonane and Naicker, 2020; CDC, 2016). Within old age homes, food safety challenges are compounded by inadequate facilities, insufficient staff training, and potential non-compliance with regulations, further heightening the risk of foodborne illness (Grace, 2023). Addressing these issues requires coordinated efforts to improve food safety practices, strengthen regulatory frameworks, and equip old age homes to effectively prevent and manage foodborne disease outbreaks.

2.2 Food Safety

Food safety is the practice of producing, handling, storing and preparing food in a manner that prevents contamination, infections or diseases and retains enough nutrients for a healthy diet (Ramful, 2017). Moreover, food safety can also be defined as the assurance that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use (Ramful, 2017). Ensuring food safety involves various factors, as depicted in Figure 1.



Figure 1: Multidisciplinary nature of food safety

While documented food management systems such as HACCP outline correct procedures, the actual behaviour of food handlers is often more strongly influenced by the organisational culture surrounding food safety and day-to-day food handling practices. Food safety involves protecting the food supply chain from the introduction, growth, or survival of hazardous microbial and chemical agents. Unsafe food containing harmful bacteria, viruses, parasites, or chemical substances is responsible for over 600 diseases, ranging from diarrhoea to cancers (Lee and Yoon, 2021; Todd, 2020; Ramful, 2017). Kramer *et al.* (2023) emphasise that food safety culture and standards within an organisation are shaped by multiple factors, such as the availability of facilities (e.g., handwash stations) and the time allocated to implement safety practices, as illustrated in Figure 1. Improving these elements collectively enhances the overall food safety system.

A high incidence of foodborne illnesses in food service environments is linked to numerous interconnected factors that affect food quality and safety. These include poor food handling and preparation, unsafe human practices and organisational cultures, ineffective management

practices, weak regulatory oversight, and the presence of biological, chemical, and physical hazards (Todd, 2020; Harrison and DiCaprio, 2018; Baluka *et al.*, 2015; WHO, 2015), as shown in Figure 1. Todd (2020) and Shonhiwa *et al.* (2019) highlight the critical role of regulatory authorities in preventing outbreaks. In South Africa, key bodies such as the Department of Health (DoH), National Regulator for Compulsory Specifications (NRCS), South African Bureau of Standards (SABS), South African Food Control Agency (SAFCA), and the Department of Agriculture, Forestry and Fisheries (DAFF) are tasked with enforcing food safety laws, conducting inspections, and ensuring hygiene compliance (Boatemaa *et al.*, 2019). However, when these functions are inadequately performed due to infrequent inspections or weak supervision; food safety practices can deteriorate, raising the risk of outbreaks. As Baluka *et al.* (2015) argue, effective enforcement and monitoring are essential to mitigating the risks associated with foodborne illnesses. The following sections offer a detailed discussion of these contributing factors.

2.2.1 Food preparation

Cross-contamination in food occurs when microorganisms are transferred from one surface to another, contributing significantly to food safety hazards and the occurrence of foodborne illness outbreaks during various phases of food preparation (Augustin *et al.*, 2020). While many cases of foodborne illnesses are linked to insufficient cooking, temperature mishandling, and cross-contamination between raw and cooked foods, it is equally important to recognise that food contact surfaces pose a substantial risk (Augustin *et al.*, 2020). Microorganisms can easily spread throughout a kitchen, and the risk of cross-contamination exists at every stage of food handling. When raw food items come into contact with surfaces, equipment, utensils, or the unclean hands of food handlers, microorganisms can be transferred, leading to contamination (Ohman *et al.*, 2023). Commonly used food contact materials such as plastic, stainless steel, glass, and wood are vulnerable to microbial contamination, with some surfaces even allowing for biofilm formation, which further increases the risk (Carrascosa *et al.*, 2021). This contamination is influenced by several specific factors that are discussed in the following section.

Food handling, inadequate cooking and temperature control

In the context of extensive food preparation, multiple individuals are typically involved in the handling process, which increases the risk of food contamination due to mishandling, inadequate cooking, or improper storage and reheating (Illés *et al.*, 2021). Whether intentional or unintentional, the introduction of contaminants during large-scale food production can pose serious health risks (Illés *et al.*, 2021). For example, improper storage conditions that promote

bacterial growth may occur when items requiring refrigeration or freezing are not maintained at appropriate temperatures. This risk is further exacerbated by incorrect temperature settings or refrigeration malfunctions (Illés *et al.*, 2021). Kitchen surfaces also present a significant risk for microbial contamination, including the formation of biofilms. The extent of contamination on these surfaces is influenced by factors such as surface texture (smooth, rough, porous, or uneven) and condition (e.g., before or after cleaning, new or old, dry or wet) (Carrascosa *et al.*, 2021). Surface contamination is a major public health concern, as several disease outbreaks have been linked to improperly cleaned surfaces. For instance, Evans *et al.* (2021) report that inadequately cleaned equipment contributed to *Escherichia coli* contamination in meat. Similarly, Tegegne *et al.* (2024) identified equipment-related contamination in poultry slaughterhouses, where poultry meat was affected by contact with equipment used for broiler herds.

Food handlers' personal hygiene

Bintsis (2017) noted that people typically carry microorganisms associated with foodborne illness outbreaks on various parts of their bodies, such as their noses, mouths, skin, and intestines. Everyone plays a role in preventing and controlling illness, and both personal and kitchen hygiene can significantly help protect against harmful microorganisms (Moloi *et al.*, 2021). Since hands commonly carry bacteria, unwashed hands of food handlers can harbour a considerable number of microorganisms, including potentially harmful strains such as *Staphylococcus aureus*, *Escherichia coli*, *Shigella spp.*, and *Pseudomonas spp.* (Moloi *et al.*, 2021). The lack of proper personal hygiene often serves as a primary source of food contamination and foodborne diseases, suggesting that food may be prepared or handled in an unsafe manner (Tappes, 2020). For instance, food handlers who neglect sanitary practices, such as failing to wash their hands when transitioning between handling raw and ready-to-eat foods or after using the restroom can introduce pathogenic microorganisms to the food they prepare (Mkhungo *et al.*, 2018). Additionally, food handled by sick workers may become contaminated through unclean hands, sneezing, or coughing (Mkhungo *et al.*, 2018). Ensuring high standards of personal hygiene and safe food handling practices is foundational to preventing the transmission of pathogens from food handlers to consumers (Mkhungo *et al.*, 2018). Furthermore, food handlers must possess the necessary skills and knowledge to effectively apply hygiene principles in any food preparation setting.

Food handlers' knowledge and training

Numerous investigations have been carried out in various countries to evaluate the food safety knowledge of individuals responsible for handling food. These studies have focused on

aspects such as handwashing, temperature control, preventing cross-contamination, proper food storage, and the quality of microorganisms present in food (Dora-Liyana *et al.*, 2018; Lorenzo *et al.*, 2028; Saddiky *et al.*, 2024). Research has also shown that training positively influences food safety knowledge, with regular refresher courses deemed essential as knowledge tends to decline over time (Jianu and Chriş, 2012). In a broader context, food handler training is widely regarded as a critical strategy for improving food safety behaviours and practices, offering lasting benefits to the food industry (McFarland *et al.*, 2019). Observational studies by Barnabas *et al.* (2024), Fekadu *et al.* (2024), and Putri and Susanna (2021) have identified unsafe food preparation practices among food handlers, highlighting the urgent need for improvement to reduce foodborne illnesses. The effectiveness of food hygiene training is typically assessed by examining changes in food handlers' knowledge and their implementation of safe practices (Putri and Susanna, 2021). Demonstrating behaviours and providing hands-on training are effective methods for enhancing understanding. Additionally, continuous training programmes help manage organisational changes by improving employees' comprehension and adaptability (Da Vitória *et al.*, 2021). Although the fundamental principles of food safety have remained consistent for decades, presenting them in an engaging manner is crucial for retaining employees' attention (Baba and Esfandiari, 2023). Nkhebenyane and Lues (2020) emphasize that improper food handling continues to be a key contributor to foodborne illness outbreaks. In response, the food service sector in South Africa is governed by Regulations R638 of 2018, which highlight the responsibilities of health authorities to monitor food handlers' health and ensure the implementation of proper training (RSA DoH, 2018b).

Despite regulatory frameworks, the responsibility placed on food handlers is increasing due to the potential for local contamination to escalate into international public health crises (Fung *et al.*, 2018). Although foodborne illness cases in South Africa are often underreported and literature on these events remains limited, serious outbreaks have occurred globally over the past decade, exacerbated by international trade (Motladiile *et al.*, 2019). A prominent example is the *Listeria monocytogenes* outbreak from 1 January 2017 to 17 July 2018 in South Africa, traced to ready-to-eat processed meat products from the Enterprise Foods Polokwane facility, resulting in 1 060 laboratory-confirmed cases (WHO, 2018). Another incident occurred in Mokopane, Limpopo Province, where approximately 42 health officials attending a workshop experienced severe diarrhoea after consuming contaminated food at a lodge and required hospitalisation for food poisoning (News24, 2014). Similarly, the South African Communicable Diseases Surveillance Bulletin (2010) reported an outbreak at a funeral in Tshivhilwe Village, Vhembe District, where 193 out of 400 attendees (48%) fell ill with symptoms such as diarrhoea, fever, joint pain, headache, and vomiting. Three individuals required hospitalisation,

though no fatalities were reported (Limpopo Provincial Department of Health, 2018). These incidents underscore the persistent risks associated with inadequate food handling and the pressing need for effective training and oversight within food service environments.

2.2.2 Human behaviour and cultures

Ali and Immanuel (2017) observed that approximately 10% to 20% of foodborne illness outbreaks result from contamination due to improper food handling. This highlights a significant concern, as poor food handling practices can severely impact human health, as detailed by Meleko *et al.* (2015) and Manes *et al.* (2013). Understanding these practices requires examining how cultural and behavioural factors, as explained by social models such as the Social Cognitive Theory (SCT) and Social Ecological Model (SEM), influence food safety behaviours. In old age homes, inadequate hygiene practices can transform these facilities into hotspots for infectious diseases. Many residents are immunocompromised, making them particularly vulnerable to infections caused by improper food handling and sanitation (Prüss-Ustün *et al.*, 2016; Woh *et al.*, 2016; Scallan *et al.*, 2015). Studies report that poor management in these facilities contributes to elderly deaths from infections acquired within the homes (Owusu-Kwarteng *et al.*, 2020; Miller *et al.*, 2021).

The SCT provides insight into how food safety behaviours develop and persist, emphasising that individuals often adopt behaviours by observing and imitating others, particularly when those behaviours are seen as beneficial or rewarded. In old age homes, if food handlers observe poor hygiene practices being normalised or inadequately addressed by supervisors, they may be more likely to replicate these behaviours (Zenbaba *et al.*, 2022). Additionally, the SCT highlights the importance of self-efficacy; an individual's belief in their ability to implement required food safety practices. When food handlers lack confidence or perceive their efforts as ineffective, they are less likely to follow protocols (Lee *et al.*, 2017). The SEM adds a broader perspective by illustrating how multiple levels; individual, interpersonal, organisational, community, and societal shape food safety behaviour (Caperon *et al.*, 2022). For example, hygiene practices in old age homes are shaped by peer behaviours, institutional policies, community norms, and national food safety regulations. Cultural norms and weak organisational practices can hinder the implementation of food safety measures, particularly where there is resistance to stringent protocols. The study by Ziso *et al.* (2022) indicate that insights from the SCT and SEM reveal the complexity of improving food safety practices. Effective interventions must target behavioural and cultural factors at multiple levels to enhance hygiene standards and reduce foodborne illness in old age homes (Insfran-Rivarola *et al.*, 2020). This understanding underscores the need to go beyond individual behaviour change. Broader social and environmental contexts must also be addressed, where EHPs

play a pivotal role. These professionals are responsible for enforcing food safety standards and regulations, ensuring consistent application across various settings (Awuchi, 2023; Mihafu *et al.*, 2020). Without diligent enforcement, there is a risk that individuals or facilities may neglect best practices, undermining hygiene efforts. Integrating insights from the SCT and SEM with strong regulatory oversight enables EHPs to support facilities more effectively, ultimately reducing foodborne illnesses and protecting public health.

Liggans and Kim (2024) emphasise the importance of improving food safety culture and behaviour. When staff understand the significance of food safety and commit to best practices, the overall safety of food improves. Conversely, poor practices such as inadequate handwashing, improper temperature control, and cross-contamination often stem from a deficient food safety culture. This underscores the need for a systematic approach to instilling strong food safety values. The General Hygiene Requirements for Food Premises, Transport of Food and Related Matters (R638 of 2018) mandate comprehensive training, proper hygiene infrastructure (e.g., accessible handwashing stations), and an environment that prioritises food safety (RSA DoH, 2018b). Behavioural change is essential: food handlers must understand the consequences of negligence and feel empowered to take responsibility for hygiene practices. Regular internal feedback from supervisors and external monitoring by EHPs, coupled with a culture of continuous improvement, supports high food safety standards. While poor hygienic practices contribute to foodborne illness, the foundation lies in food safety culture and behaviour. Strengthening these through education, adequate facilities, and committed leadership can reduce contamination risks and improve public health outcomes (Joomun *et al.*, 2024).

2.3 Mode of Transmission

Food preparation in small establishments catering to large groups, such as old age homes, is often linked to increased microbiological contamination due to prolonged storage of food at room temperature (Rohith, 2021; Bintsis, 2017). Cross-contamination can occur when the same knife, cutting board or surface is used for different foods without proper washing using soap and warm water (Madlala, 2022; Shumaker *et al.*, 2022). Common contributing factors include inadequate sanitation, poor hand hygiene, and improper cleaning of food-contact surfaces. For instance, bacteria can transfer from unclean surfaces to ready-to-eat foods, especially when surfaces are not sanitised and wiped with a clean, warm cloth (Madlala, 2022; Mkhungo *et al.*, 2018; Baluka *et al.*, 2015). According to the WHO, foodborne pathogen transmission remains a critical concern in developing countries due to poor food hygiene (Fasanmi *et al.*, 2018). Undercooking food, leaving it out too long, or storing it at incorrect

temperatures (outside the 0-5°C range) supports bacterial growth. Refrigerators should maintain temperatures at 4°C or 5°C to preserve food safety.

Poor personal hygiene, including unwashed hands, unclean clothing, and loose hair, is another source of contamination, as hair or dirt can fall into food during preparation (Meleko *et al.*, 2015; WHO, 2015). Educating food handlers on hygiene can significantly reduce the risk of foodborne illnesses. Regular cleaning of kitchen surfaces, utensils, and hands especially with clean cloths and antibacterial agents minimises microbial presence. However, using contaminated damp cloths may spread bacteria instead (Madlala, 2022). Effective surface hygiene requires a three-step process: cleaning, sanitising and sterilising. Some pathogens, such as *Salmonella*, *Escherichia coli* and *Bacillus cereus*, may resist certain disinfectants, making additional methods like heat treatment essential. Cloths should be boiled or washed in a dishwasher above 60°C with detergents to reduce bacterial contamination (Mendoza *et al.*, 2022).

2.4 Microbiological and Other Hazards

Microorganisms pose a significant challenge to the food industry, and most food processes are designed with microbial quality in mind (Carrascosa *et al.*, 2021). Microbiological food safety has received increased attention on both national and international platforms (Acuff *et al.*, 2023; Carrascosa *et al.*, 2021). Given the heightened vulnerability of both the very young and the elderly to foodborne illnesses, prioritising food safety is essential for minimising cases and preventing severe outcomes (Njoagwuani *et al.*, 2023; Yemane and Tamene, 2022; Carstens *et al.*, 2019; Lange, 2017). Several hazards including biological, chemical, and physical can contribute to foodborne illnesses, with biological hazards being among the most concerning. These are introduced into food primarily through contact with soil, contaminated water, sewage, air, persons, animals (birds and pests), and equipment (Alegbeleye *et al.*, 2018). Bacteria grow best in neutral to slightly acidic food and have varying requirements for pH, temperature, and oxygen (Msimbira and Smith, 2020). Their growth is most rapid between 4°C and 60°C, while lower or higher temperatures inhibit multiplication. Some bacteria require oxygen (aerobic), others do not (anaerobic), and some can grow in both conditions (facultative). When food and water are available, bacteria thrive (Ahansaz *et al.*, 2023; Lorenzo *et al.*, 2018). Other harmful microorganisms include viruses, helminths, protozoa, and algae (Chlebicz and Slizewska, 2018). Table 1 (Chapter 1) outlines the characteristics of microorganisms or toxins commonly responsible for major foodborne illnesses, with *Salmonella*, *Campylobacter*, *Clostridium*, *Escherichia coli*, *Staphylococcus*, and *Listeria* being the most common.

People can become ill by consuming food or water contaminated with harmful bacteria or their toxins. These illnesses fall into three categories: infections, intoxications, and toxic infections. Infections result when live viruses or enteropathogenic bacteria are ingested and multiply in the digestive tract, as seen in Salmonellosis and Hepatitis A (Lamichhane *et al.*, 2024). Intoxications occur when preformed toxins produced by bacteria or moulds are present in food; viable cells are not required for illness to occur; *Staphylococcus aureus* food poisoning is a typical example (Abril *et al.*, 2020). Toxic infections involve the ingestion of large numbers of viable pathogenic bacteria; upon sporulation or death, these bacteria release toxins that cause illnesses and *Clostridium perfringens* gastroenteritis exemplifies this category (Petrova *et al.*, 2022). Table 3 provides an overview of major bacteria associated with foodborne illnesses, categorising them according to their respective contamination risks.

Table 3: Major bacteria and their risks

Major bacteria	Risk contamination
<i>Clostridium botulinum</i>	Intoxication, even death
<i>Listeria monocytogenes</i>	Infection
<i>Salmonella</i> spp. (<i>typhimurium</i>, <i>enteritidis</i>)	Infection
Enterohaemorrhagic <i>Escherichia coli</i>	Infection
<i>Campylobacter jejuni</i>	Infection
<i>Yersinia enterocolitica</i>	Infection
<i>Bacillus anthracis</i>	Infection
<i>Bacillus cereus</i>	Intoxication
<i>Staphylococcus aureus</i>	Intoxication
<i>Clostridium perfringens</i>	Infection
<i>Vibrio</i> spp. (<i>vulnificus</i>, <i>parahaemolyticus</i>)	Infection
<i>Brucella abortus</i>, <i>Brucella suis</i>	Infection
<i>Shigella</i> spp. (<i>dysenteriae</i>)	Infection

According to Tiwari and Nagalli (2023), among these bacteria, *Clostridium botulinum* poses an exceptionally severe risk, as its presence in food can lead to intoxication with potentially fatal outcomes. Similarly, *Listeria monocytogenes* is a significant concern due to its ability to cause infection, underscoring the need for vigilance in food safety practices to prevent its transmission. Additionally, *Salmonella* spp. (including *typhimurium* and *enteritidis* strains), enterohaemorrhagic *Escherichia coli*, *Campylobacter jejuni*, *Yersinia enterocolitica*, and *Shigella* spp. are all associated with infection, illustrating the broad spectrum of bacterial pathogens capable of contaminating food and causing illness upon consumption.

The inclusion of *Bacillus anthracis* and *Brucella abortus* or *suis* in Table 3 further reflects the diversity of bacterial threats to food safety, as these pathogens can cause infection when ingested (Jessberger *et al.*, 2020). *Bacillus cereus* and *Staphylococcus aureus* are highlighted for their potential to cause intoxication, indicating the presence of harmful toxins in contaminated food. Moreover, *Clostridium perfringens* and certain *Vibrio* species (*vulnificus* and *parahaemolyticus*) are recognised as infectious agents, adding to the complexity of foodborne illness risks associated with bacterial contamination. In general, Table 3 illustrates that bacterial contamination in food involves various bacteria capable of causing illness in different ways. Understanding the risks associated with each bacterium equips EHPs, food handlers, and the food industry to implement targeted measures to reduce contamination and protect public health. Table 4 complements this by providing an overview of major foodborne viruses and their associated risks.

Table 4: Major viruses and their risk

Major viruses	Risk contamination
Hepatitis A virus	Fever, abdominal discomfort
Norwalk virus	Nausea, vomiting, diarrhoea, abdominal pain (gastroenteritis), headache, low-grade fever
Rotavirus	Vomiting, watery diarrhoea, fever, abdominal pain

Hepatitis A virus can cause fever and abdominal pain when people consume food contaminated with high levels of the virus. Norovirus, also known as the Norwalk virus, induces symptoms such as nausea, vomiting, diarrhoea, abdominal pain, headache, and mild fever, and is a food safety concern due to its rapid onset of illness (Hellysaz *et al.*, 2023). Rotavirus is recognised for causing vomiting, watery diarrhoea, fever, and abdominal discomfort, particularly in children (LeClair and McConnell, 2023). According to Olaimat *et al.* (2024), viruses pose a major public health threat as they can rapidly spread through contaminated food and water, leading to outbreaks of illness. Food contamination can occur during handling or preparation, transmitting viruses to consumers. Symptoms range from mild discomfort to severe illness, especially in vulnerable groups such as children, the elderly, and individuals with weakened immune systems, including those with HIV/AIDS and cancer (Miller *et al.*, 2021). Therefore, minimising viral risks in food through safe handling, storage, and preparation practices is essential. Adherence to food safety regulations helps identify and resolve issues before they cause widespread illness, while educating and training food handlers is crucial to reducing viral infection incidence. Ultimately, proactive measures to protect public health and

ensure food safety are paramount. Table 5 outlines the major parasites and their associated risks of contamination in food.

Table 5: Major parasites and their risks

Major parasites	Risk contamination
<i>Giardia lamblia</i>	Diarrhoea, abdominal cramps, fatigue, nausea, flatulence (intestinal gas), weight loss
<i>Entamoeba histolytica</i>	Dysentery (severe, bloody diarrhoea)
<i>Ascaris lumbricoides</i>	Intestinal, lung infection
<i>Diphyllobothrium latum</i>	Attaches to intestinal wall
<i>Cryptosporidia</i>	Respiratory, gastrointestinal illness
<i>Trichinella spiralis</i>	Intestinal wall, enter the blood (to feed on it) and lymphatic system
<i>Toxoplasma gondii</i>	Neurological disorders, particularly schizophrenia, bipolar disorder
<i>Taenia solium</i>	Attaches to intestinal wall
<i>Anisakis</i> spp.	Anisakiasis

Belkessa *et al.* (2021) state that *Giardia lamblia*, for instance, poses a risk of causing diarrhoea, abdominal cramps, fatigue, nausea, flatulence and weight loss upon ingestion. While *Entamoeba histolytica* on the other hand, is linked to severe cases of dysentery characterised by bloody diarrhoea. *Ascaris lumbricoides* can lead to infections in both the intestines and lungs and *Diphyllobothrium latum* attaches itself to the intestinal wall upon ingestion. *Cryptosporidia* can cause respiratory and gastrointestinal illnesses. Liu *et al.* (2023) indicate that *Trichinella spiralis* is particularly concerning as it infiltrates the intestinal wall, enters the bloodstream and migrates to the lymphatic system, posing health risks. In addition to the parasites listed in Table 5, *Toxoplasma gondii* has been associated with neurological disorders and potential links to conditions such as schizophrenia and bipolar disorder. Similarly, *Taenia solium*, like *Diphyllobothrium latum*, attaches itself to the intestinal wall upon ingestion and contributes to gastrointestinal complications. Furthermore, *Anisakis* spp. can cause *Anisakiasis*, a condition resulting from the ingestion of larvae. Overall, these foodborne pathogens pose serious threats by spoiling food and causing illnesses, diseases and even death among consumers (Chlebicz and Slizewska, 2018).

Chemical hazards

According to the FAO (2023), chemical contamination can result from improper storage of pesticides, detergents, rodenticides, and sterilising agents, potentially causing leakage and spillage into agricultural products and processed foods (Gałęcki *et al.*, 2023; Lebelo *et al.*,

2021). Toxic chemicals stored in unmarked containers might also be mistakenly used as food ingredients or mixed with foods. For example, repurposing pesticide and detergent containers for food packaging without proper cleaning and sterilisation can introduce harmful chemicals, leading to foodborne illnesses. Food processing activities may further introduce harmful chemicals, which is why various legislative frameworks exist worldwide to manage substances such as fertilisers, pesticides, weed inhibitors, growth regulators used during production, and waxes applied after harvest (FAO, 2023; Thompson and Darwish, 2019). Chemical hazards linked to sanitation and domestic activities can also be present in kitchen environments. Arsenic contamination in drinking water, often from agricultural runoff and pesticide use, can cause long-term health issues like skin lesions and cancer. Lead contamination from old plumbing, lead-based paints, or contaminated soil and dust may lead to gastric cancer, while mercury-tainted grain has been associated with liver cancer (Khabo-Mmekoa *et al.*, 2022).

These concerns extend to how old age homes manage cleaning and maintenance. Improper use or rinsing of strong chemicals during handwashing, cleaning, or disinfecting can leave residues that contaminate food, posing health risks especially to vulnerable elderly residents (Disinfection101). To minimise this risk, chemicals should be stored in designated areas or below food contact surfaces to prevent dripping into food (Menini *et al.*, 2022). Understanding environmental pollutant sources is crucial, particularly for older individuals who are more vulnerable to their effects. Many problems related to environmental pollution and domestic hygiene arise from inadequate sanitation and poor housing conditions (Bazaanah and Mothapo, 2023). Proper handling and storage of chemicals are therefore vital for maintaining a safe environment for food preparation and consumption.

Physical hazards

Physical hazards in food production can arise from various sources, including metal, glass, plastic, wood, personal items, machinery and equipment (Onyeaka *et al.*, 2023). Examples of these hazards include pins, nails, broken bulbs or bottles, fragments, watches, jewellery, keys, stones and hair. Such items can cause health risks, such as choking, cuts and bruises to the mouth and gastrointestinal system (Onyeaka *et al.*, 2023). Unnatural physical hazards can be introduced at any stage of the production process. As detailed in Table 6, these hazards include plastic items, such as utensils and disposable gloves, stones and pebbles, glass from jars or broken thermometers, wood from pallets used to store food ingredients and metal objects, such as wire, staples and pins. Additionally, human-origin hazards such as hair and fingernails may result from inadequate food hygiene practices, such as not wearing hairnets and gloves (Gizaw, 2019). Addressing these physical hazards through legislation is important for maintaining food safety and preventing potential harm.

Table 6: Common sources of physical contaminants in foods

Sources	Contaminants
Field	Rocks/stones/sand, asphalt, metals/bullets, concrete particles, bones, wood fragments and thorns.
Processing	Glass, ceramic/chards, metal fragments, staples, blades, clips, needles, keys, screws, magnet fragments, washers, bolts, screening, plastics, grease/lubricants, rubber, insulation/seal materials, nail polish, jewellery, coins, pieces of gloves, finger cots, bandages, cigarette butts, gum, bones, pits, fruit stones, nut and animal shells, medications/tablets/capsules, wood, pens, pencils, rodents and insects.
Storage and distribution	Metal, plastic, wood fragments, insects and rodents.

2.5 Regulatory Processes

2.5.1 Regulatory standards in South Africa

Countries such as South Africa have established regulatory standards to ensure public health and safety, including the National Norms and Standards Relating to Environmental Health under the National Health Act 61 of 2003 (RSA DoH, 2003). These standards clearly define the roles and responsibilities of EHPs, such as conducting food safety inspections and enforcing control measures in all foodservice establishments. Investigating food premises and outbreaks of foodborne illnesses is essential to identify sources of contamination. This process enables the implementation of appropriate public health interventions and control protocols designed to prevent food contamination caused by unsafe practices, thereby ensuring quality assurance and protecting consumers. Regulations also play a key role in preventing and controlling the occurrence and spread of diseases in food environments by helping identify and manage contamination sources and outbreaks (Lange, 2017). By objectively analysing detailed data gathered during inspections, EHPs can determine the contamination source and causes, which helps to prevent similar events from occurring in the future.

EHPs and epidemiologists collaborate as part of the Outbreak Response Team, with EHPs conducting on-site inspections such as identifying a broken refrigerator at an old age home that fails to maintain proper chilling temperatures of -4°C and below, which are necessary for storing dairy or meat products safely (Stefanou *et al.*, 2023). These chilling temperatures slow bacterial growth, helping keep food safe for shorter periods, while freezing meat products can extend their shelf life by completely inhibiting bacterial growth. Meanwhile, epidemiologists

analyze illness patterns and trace outbreak sources within the community. Together, they identify hazards, control contamination, and implement effective public health measures to protect vulnerable populations, including the elderly. Inspections also provide valuable learning opportunities for environmental health staff and others in the Department of Health, allowing them to gain considerable field knowledge beyond formal training. This experience strengthens collaboration and communication among investigative team members and helps prepare them to prevent food contamination and illnesses before they occur. Additionally, political, public, or legal concerns may prompt regulatory actions or strengthen food safety measures. Widely used frameworks such as HACCP and Codex Alimentarius assist in identifying hazards, assessing risks, and determining critical control points in food production and processing. Despite these regulatory frameworks, which are key quality assurance mechanisms, foodborne illnesses and outbreaks continue to be reported, and food safety practices often remain below standard.

2.5.2 South African food safety regulations

The Regulations Governing General Hygiene Requirements for Food Premises, Transport of Food and Related Matters (R638 of 2018) outlines the standards and requirements for facilities in food premises; details are presented in Table 7.

Table 7: Standards and Requirements for Food Premises and On-site Facilities in South Africa

Regulation (R638 of 2018)	Requirement
5. Standards and requirements for food premises	
A food premises must be of such location, design, construction and finish and must be so equipped and maintained in the condition for which it was intended that it can be used at all times for the purpose for which it was designed, constructed and equipped without creating a health hazard and that	
(a) can be handled hygienically on the food premises and facilities thereon; and	
(b) can be protected effectively by the best available method against contamination or spoilage by poisonous or offensive gases, vapours, odours, smoke, soot deposits, dust, moisture, insects or other vectors or by any other physical, chemical (including unintended allergens) or biological contamination or pollution or by any other agent whatsoever.	
6. Standards and requirements for food premises	
Food contact surfaces	(1). The surface of a table, counter or working surface on which unwrapped food is handled and any equipment, utensil or basin or any other surface which comes into direct contact with food must be made of smooth, rust-proof, non-toxic and non-absorbent material that is free of open joints or seams but wooden chopping

Regulation (R638 of 2018)	Requirement
5. Standards and requirements for food premises	
	blocks, cutting boards and utensils are not prohibited if such items are kept in such a condition that dirt does not accumulate thereon or therein and are maintained as such. A surface referred to in sub-regulation (1) and crockery, cutlery, utensils, basins or any other such items or facilities must not be used for the handling of food if they are not clean or if they are chipped, split or cracked.
Hygiene of surfaces	(4). A surface referred to in sub-regulation (1) must be- (a) cleaned and washed before food comes into direct contact with it for the first time; and (b) cleaned and washed as and when necessary, during or immediately after the processing of food, so that contamination of the food that comes into contact with any such surface or item is prevented.
Summary: These regulations establish and enforce general hygiene requirements for surfaces in food preparation areas, ensuring a clean and safe environment for handling and preparing food. The guidelines outlined aim to maintain high standards of cleanliness to safeguard public health and prevent foodborne illnesses.	

RSA DoH, 2018

Another guideline is the South African National Standards (SANS) 10049: 2019). This guideline is important for the entire food process, from when the food is first produced to when it reaches the consumer. It outlines important practices for handling food to make sure it is safe for consumers (Table 8).

Table 8: Section 24(1)(a) of the Standards Act.

Standard no. and year	Title, scope and purport
SANS 10049: 2019 Ed. 5	Food safety management – requirements for prerequisite programmes (PRPs). Contains the requirements for the development, establishment, implementation, maintenance and continual improvement of prerequisite programmes (PRPs) for food safety management for all food handling organisations and activities.
Summary: The document outlines specific requirements and guidelines pertaining to the food industry and how they are intended to be applied.	

The SANS 10049:2019 standard aims to ensure that all food meets the safety requirements set by regulatory authorities and aligns with the expectations of customers regarding food safety and hygiene. This involves keeping levels of harmful substances, known as food safety hazards, consistently low and below concerning levels. These hazards can be biological (pathogens or pests), chemical (cleaning chemicals) or physical (glass or metal pieces). The goal is to prevent immediate harm upon consumption or potential long-term health issues caused by unsafe food handling practices.

2.5.3 Gaps in the regulatory framework

EHPs are responsible for enforcing compliance with food safety regulations through routine inspections (R638 of 2018). While they are not mandated to provide training, these inspections often include health education and awareness components aimed at promoting proper food safety practices. However, the limited number of inspections conducted at food service establishments may reduce opportunities to reinforce essential food safety principles among staff. According to Section 4 (Homes for the Aged) of the National Norms and Standards Relating to Environmental Health in terms of National Health Act 61 of 2003 (RSA DoH, 2003) the following norms are stated:

- Old age homes should be operated under a permit or registration authorising that activity by the relevant municipality.
- The premises should be operated under a valid health certificate issued by an EHP of the relevant municipality to the effect that the premises and general facilities comply with environmental health requirements.
- Building and facilities should be accessible and promote the health, safety and welfare of residents.
- Physical layout of the grounds and buildings should promote mobility, social interaction and areas of service delivery.

For Environmental Health Monitoring Standards, inspections must be conducted at least twice a year (not less than twice a year). The risk profile of the premises should also inform the frequency of inspections on the premises. With that said, the risk analysis of the premises should be conducted with a specific focus on the following areas:

- Food preparation areas (to include analysis of food risks)
- Water, sanitation and hygiene
- Waste management
- Care and protection of patients.

With routine inspections done twice a year for old age home facilities, these might not be sufficient to ensure that the QA mechanism is adequate. Not only are EHPs in the field not enough but support in terms of resources to implement these inspections is lacking, which makes it even more difficult to ensure compliance and conduct training for food handlers to maintain their food hygiene and safety knowledge. This is evident as foodborne outbreaks are still reported.

2.5.4 Understanding the regulatory processes

Understanding regulatory processes for food safety inspections is important for evaluating the effectiveness of measures designed to prevent foodborne outbreaks. Reports submitted to the National Institute for Communicable Diseases (NICD) in South Africa reveal that between March 2018 and August 2020, 337 foodborne outbreaks were reported through the notifiable medical condition (NMC) surveillance system. Of these, 129 outbreaks (38%) were investigated, resulting in 2 932 cases, including 319 hospital admissions and 20 deaths (Ramalwa *et al.*, 2020). This data highlights a concern within the regulatory framework: despite having systems in place for reporting outbreaks, there is a shortage of EHPs in some areas, which limits their ability to conduct routine food hygiene and safety inspections as required. In these specific areas, inspections are often carried out mainly in response to foodborne disease outbreaks rather than proactively on a scheduled basis; however, this reactive approach is not representative of practices across all regions. For instance, childcare centres are inspected at least once every quarter (no less than three times a year). In contrast, other facilities, including nursing homes, maternity homes, homes for the aged, schools, accommodation establishments (such as hotels and guesthouses) and health establishments (such as hospitals) are inspected only twice a year.

Food handling premises are subject to a similar inspection frequency. This infrequent inspection schedule highlights a gap in the regulatory processes that could lead to unsafe food handling and preparation practices going unnoticed. Without more frequent and comprehensive inspections, there is a higher risk of contamination of food sources, exposure to environmental hazards and the spread of diseases. Therefore, while the regulatory structure supports reporting and investigating outbreaks, the current inspection practices may not provide the necessary scrutiny to prevent these issues effectively. This emphasises the need for stricter regulatory processes and inspection frequency to ensure consistent adherence to food safety standards and protect public health.

2.6 Quality in Food

Safety is the most important component of food quality. As the desired goal of any foodservice is the consumer's acceptance of food, it is important that a quality product be produced and maintained until the consumer receives the item. Acceptability of the food depends upon such quality characteristics of food as sensory, microbiological and nutritional values (Fiorentini *et al.*, 2020). It is important to implement quality control measures for food items throughout all stages, including procurement, storage, processing, handling, and service, as illustrated in Figure 2. While the figure focuses specifically on microbiological hazards at various points along the food chain, this does not imply that such hazards are absent at the consumer level. Safety Culture (2025) states that in addition to microbiological risks, physical hazards, such as foreign objects like glass shards, metal fragments, or plastic pieces can contaminate food during preparation, storage, or serving. Chemical hazards, including pesticide residues, cleaning agents, or food additives, may also pose risks if not properly managed. Together, these microbiological, physical, and chemical hazards represent critical points of concern in food safety, and all will be addressed to provide a comprehensive overview of potential risks and the necessary control measures throughout the food supply chain (FDA, 2022).

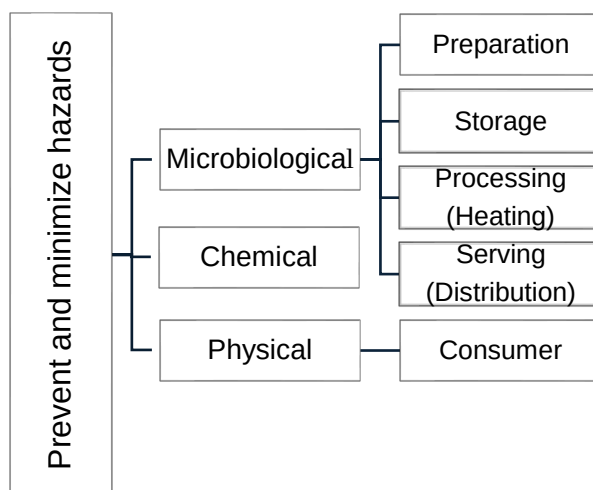


Figure 2: Microbiological threats to food safety

It is important to note that hazards can enter the food supply chain at various stages, including production, harvesting, packing, transportation, storage, and distribution. Therefore, it is crucial to control and minimise these hazards from the point of production through to the consumer, a concept commonly referred to as the 'farm to fork' approach. Ensuring food safety requires the collective effort of all stakeholders involved in the food chain (Vågsholm *et al.*,

2020). It may be difficult or even impossible to decontaminate food, once contaminated; for this reason, prevention is key. To prevent hazards from infiltrating the food chain, it is vital to identify potential risks at each stage. Hazard management, which involves proactively identifying, minimising, and eliminating risks (i.e., the likelihood of a hazard occurring), forms the foundation of all food safety systems (Vågsholm *et al.*, 2020).

2.7 Control and Preventive Measures

Unlike hospital kitchens, many old age homes and assisted living facilities have kitchens that are inadequately equipped, often serving both as places for food preparation and storage (National Health Act 61 of 2003) (RSA DoH, 2003). Given that the food is meant for individuals with weakened immune systems, it is important to pay special attention to how meals are prepared and consumed by the elderly (Woh *et al.*, 2016; WHO, 2013). Therefore, ensuring food safety involves the creation of food safety plans designed to continually monitor any potential sources of contamination. One example of such a safety strategy is the training of food handlers in matters of food hygiene and safety, which ultimately aids in compliance with national and international food regulations (Mensah *et al.*, 2012). These training programmes provide food handlers with both knowledge and practical experience related to factors associated with disease outbreaks caused by unsafe food practices. Furthermore, maintaining cleanliness in the environment where food is prepared and consumed is important for preventing foodborne illnesses (Insfran-Rivarola *et al.*, 2020).

Food service establishments in the Republic of South Africa are expected to adhere to the Regulations Governing General Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018) (RSA DoH, 2018b). This regulation sets the foundation for the implementation of food safety practices and grants authority to EHPs to ensure compliance among these establishments. They must possess the necessary resources, infrastructure and conditions to ensure the safe handling of food, as stipulated by the DoH (RSA DoH, 2015). Additionally, some restaurants opt to employ the HACCP system as a method to ensure the production of high-quality food, as mentioned in studies by the CDC (2020), Osaili *et al.* (2017) and Mensah *et al.* (2012).

2.8 Conclusion

Despite the presence of established standard operating procedures, food safety standards, and training programmes, elderly individuals remain susceptible to foodborne illnesses due to possible negligence and a lack of understanding among food handlers. Limited legislative enforcement by Environmental Health Practitioners, occurring only twice a year, further

increases the risk. Ensuring the safety and quality of food in old age homes is vital for the well-being of elderly residents, given their heightened vulnerability to foodborne pathogens and the complications associated with weakened immune systems. Conducting comprehensive assessments of food safety measures within these facilities is therefore essential to mitigate risks and prevent adverse health outcomes. The implementation of strict food safety protocols including proper handling, storage, and preparation of food is necessary to protect residents from potential contaminants. Upholding high standards of food quality not only supports physical well-being but also contributes to the overall satisfaction and comfort of residents, thereby enhancing their quality of life. Recognising the increased vulnerability of elderly populations highlights the need to prioritise the evaluation and improvement of food safety practices in old age homes, as this is not merely a matter of regulatory compliance but a core element of compassionate and responsible care. This study evaluated food safety practices and quality assurance mechanisms at old age homes in the Free State.

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CHAPTER 3

QUANTIFYING AND IDENTIFYING MICROORGANISMS PRESENT ON FOOD PREPARATION SURFACES WITHIN THE KITCHENS OF OLD AGE HOMES

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3.1 Abstract

Given the global and public health challenge of foodborne illnesses, the importance of comprehensive continuous food safety evaluations as actions to assess and assure food safety quality becomes even more important within the unique setting of old age homes. Kitchen surfaces are considered critical areas that come into contact with food and have been recognised as potential carriers of foodborne pathogens if correct cleaning measures are not in place. Thus, this study assessed the effectiveness of the processes in place for cleaning surfaces involved in providing food to elderly individuals in old age homes. This assessment focused on the isolation, quantification and identification of microorganisms present on food preparation surfaces in the kitchens of old age homes. Microbiological samples were collected from food preparation surfaces at each old age home using contact plates with various agar media. The samples were collected to assess the total number of living microorganisms that can lead to foodborne illnesses. Identification at both genus and species levels was done using Matrix-Assisted Laser Desorption/Ionisation Time-of-Flight Mass Spectrometry (MALDI-TOF MS). The current investigation revealed that 13 of the 14 old age home kitchens in Mangaung and Lejweleputswa were below the required cleanliness and hygiene standards, indicating a widespread potential health risk to the elderly residents. Surfaces were considered unclean if microbial counts exceeded the acceptable limits set by South African guidelines, (Regulation R692 of 1972) and SANS 5763, where surfaces with colony-forming units (CFU) below 100 CFU/cm² (non-food-contact) and 200 CFU/cm² (food-contact) were considered clean. Furthermore, the identification of bacterial pathogens in 13 of the 14 old age home collected samples indicates non-compliance with correct personal hygiene practices and inadequate cleaning and disinfection of surfaces.

Keywords: Food safety, food hygiene, microbial quantification, microbial identification, kitchen surfaces

3.2 Introduction

The correct management of microbiological contaminants and hygienic handling of food in food preparation environments plays an important role in ensuring the safety and quality of the food served, particularly in sensitive settings such as old age homes. According to Carstens *et al.* (2022), understanding the distribution of microorganisms on surfaces within kitchen facilities is an important food safety quality assurance (QA) action for assessing potential health risks to elderly residents, who may be more susceptible to foodborne illnesses. The main health hazard associated with preparation surfaces is microbial contamination. Microbial contamination in the kitchen environment can occur through various pathways,

posing a potential threat to food safety and human health (Stein and Charilă, 2017). Food contamination can occur at several stages, including through cross-contamination (transfer of microorganisms from a raw product to another surface or product) by individuals preparing or handling the food, improper cleaning of surfaces and utensils, inadequate cooking or storage temperatures and poor hand hygiene in the kitchen. The identification of the stages where contamination may occur is an important control mechanism that should inform and guide the development of proactive steps to minimise microbial contamination at these facilities. Carstens *et al.* (2019) reported that food handlers and individuals in the kitchen may inadvertently transfer microorganisms from their hands to surfaces, utensils or directly onto food during preparation. Failure to put control measures that encourage the practice of proper hand hygiene, such as washing hands thoroughly and regularly, increases the risk of microbial transfer. Cross-contamination occurs when pathogens from raw food, especially meat and poultry, come into contact with ready-to-eat foods, surfaces or utensils (Kirchner *et al.*, 2021; Dewey-Mattia *et al.*, 2018). Food preparation surfaces, such as tables, are essential in food handling and preparation, making them susceptible to microbial contamination. Contamination can occur through various pathways, including direct contact with raw ingredients, contaminated utensils, or improper cleaning and sanitation practices, leading to potential foodborne illnesses (Kirchner *et al.*, 2021; Evans and Redmond, 2018). Therefore, knowledge about and identification of areas at facilities where control mechanisms can be put in place to limit the spread of microorganisms becomes an important step towards ensuring food safety.

Kitchen basins/sinks are susceptible to microbial contamination due to their frequent use in food preparation and dishwashing activities (Moretro *et al.*, 2022). According to Griffith (2016), the presence of organic matter, food residues and moisture can create an optimal setting for microbial growth, which often leads to potential contamination. Cross-contamination may occur when basin surfaces come into contact with raw food items or when contaminated water splashes onto adjacent areas (Wolde and Bacha, 2018). Moreover, inadequate cleaning practices, such as using contaminated sponges or towels, can lead to the spread of microorganisms from kitchen basins to preparation surfaces. This contamination may extend to holding areas when food handlers wipe surfaces during the cleaning process (Griffith, 2016). Contamination in kitchen basins may occur through various means; for instance, food residues left in the basin can provide a nutrient-rich environment for microorganisms to multiply. Cross-contamination may also occur when raw food items, such as meats and vegetables, come into contact with the basin surface. Inadequate cleaning practices, including insufficient rinsing or the use of contaminated cleaning tools, can contribute to the build-up of microbial populations (Cho *et al.*, 2020). Additionally, a study by Qiu *et al.* (2022) stated that the presence of moisture and warmth in basins creates favourable conditions for microbial

growth. By assessing the total viable counts (TVCs) on a kitchen basin, researchers aim to quantify and analyse the overall microbial load, providing insights into the hygiene status of the basin and, by extension, the potential risk of foodborne contamination in the kitchen environment.

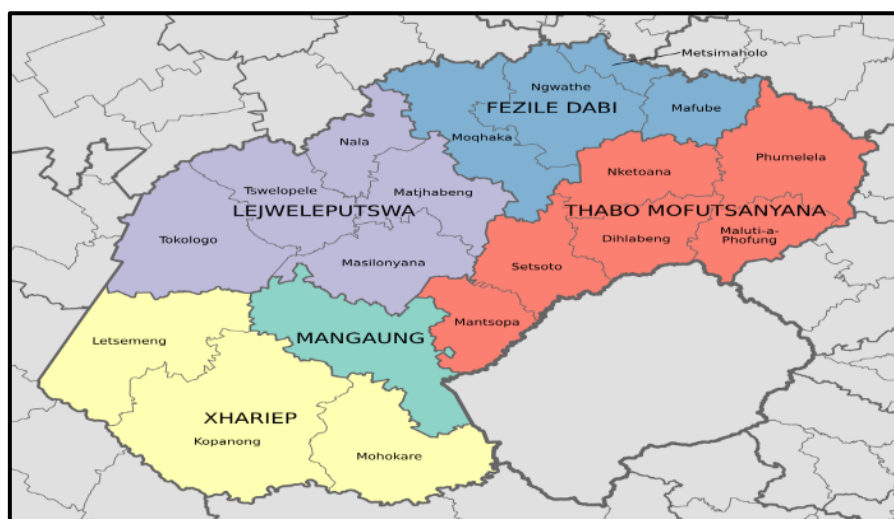
In facilities such as old age homes, holding areas are an important point in the food safety value chain within a kitchen environment as they are used to store the utensils and equipment used for food preparation and even to prepare food items temporarily. Microbial contamination in holding areas can occur through various means. First, inadequate cleaning practices or irregular cleaning schedules may lead to the accumulation of food residues, creating a conducive environment for microbial growth. Additionally, if correct food safety practices (e.g. handwashing with soap) are not adhered to, cross-contamination from hands, utensils or contaminated surfaces during the handling of food items can introduce bacteria to holding areas. Moreover, airborne microorganisms can settle on these surfaces over time (Ripolles-Avila *et al.*, 2019). Previous studies have indicated that common kitchen items, such as hand towels, dishcloths, sponges, tea towels, steel sinks and work surfaces, can harbour bacteria that contribute to food contamination (Carstens *et al.*, 2022; Osaili *et al.*, 2020). This emphasises the necessity of regularly cleaning and sanitising these items to ensure food safety. Foodborne illnesses linked to foods prepared in unhygienic kitchens are frequently associated with *Salmonella*. Additionally, various bacterial infections related to contaminated kitchen environments are caused by bacterial species such as *Listeria*, *Campylobacter*, *Bacillus cereus*, *Staphylococcus aureus* and *Escherichia coli* (Nethathe *et al.*, 2023; Bintsis, 2017). The presence and strategic placement of resources, such as handwash basins, cleaning guidelines and frequent assessment of the food safety control mechanisms play an important role in encouraging proper hygiene practices in kitchens. When handwash basins are conveniently located in key areas where food is prepared, they promote a culture of regular handwashing among food handlers. This helps ensure that individuals can easily clean their hands before and after handling raw and ready-to-eat foods, reducing the risk of cross-contamination. By placing these resources in accessible spots, food handlers are more likely to adhere to hygiene practices, which is important for preventing microbial contamination and foodborne illnesses. However, in facilities where resources that promote a food safety culture are not strategically located at critical points, the possibility of surface contamination increases. Therefore, sampling surfaces for microbial contamination is not only vital for food safety and protecting people at old age homes but also a compliance matter as emphasised by South African regulations such as the Regulations Governing General Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018) promulgated under Foodstuffs, Cosmetics and Disinfectants (FDC) Act 54 of 1972. The study

isolated, quantified and identified microorganisms in food preparation areas at old age homes in the Free State.

3.3 Materials and Methods

3.3.1 Sampling site

The current study was conducted in selected old age homes located within the Mangaung metropolitan and Lejweleputswa district municipalities. The old age homes are based in the Free State Province, one of South Africa's provinces situated in the central part of the country with a population of approximately 2.1 million inhabitants. The Free State is divided into the Mangaung metropolitan municipality and four other district municipalities, which are then subdivided into 18 local municipalities (Figure 3).



Municipalities.co.za

Figure 3: Visual representation of the Free State Province showing the Mangaung Metropolitan Municipality and Lejweleputswa District Municipality, where the selected old age homes for this study are located

3.3.2 Sample collection

Fourteen (14) old age homes were selected from two regions in the Free State Province, Mangaung metropolitan and Lejweleputswa district municipalities. These areas were chosen to provide geographic and socio-economic variation in kitchen settings and food safety practices. Mangaung represents a more urbanised, metropolitan environment, while Lejweleputswa is predominantly rural and peri urban. This variation allowed the study to capture a broader perspective of food safety issues, although the study did not aim to conduct a direct comparison between the two areas. Of the 14 old age homes, 8 were in Mangaung

and 6 in Lejweleputswa. These 14 were the only facilities operational at the time of data collection. Homes that were closed, under reconstruction, or undergoing renovations were excluded. The final selection included only those that had valid Certificates of Acceptability (CoAs) issued by Environmental Health Officers. Additionally, old age homes were selected purposively based on a list of 22 registered facilities obtained from the Department of Social Development. The inclusion criteria were current operational status, possession of a valid CoA, and willingness to participate. This purposive sampling ensured that the study focused on facilities with active food handling operations, reducing variability from inactive or non-standardised settings.

Samples were collected in the morning using different agar medium types: nutrient agar (NA), mannitol salt agar (MSA), and plate count agar (PCA). Two samples were taken for each agar medium type in every sampling area of the 14 old age home kitchens (kitchen preparation surfaces, food preparatory surfaces, basin, and holding shelf), resulting in a total of 84 representative samples. For this study, a kitchen preparation surface includes areas such as sinks, storage tops, or equipment surfaces, which may not come into direct contact with food but are often touched by food handlers (Byrd-Bredbenner *et al.*, 2013). On the other hand, a food preparation surface refers to areas where food is directly handled or prepared like cutting boards and counters used during meal preparation; therefore, any contamination here poses a direct risk to the food being served, as supported by Castro *et al.* (2024). Both types of surfaces were sampled because bacteria from kitchen preparatory areas can easily be transferred to food through hands or utensils, making it important to monitor these spaces to protect the health of consumers. Although samples were not taken in triplicate, two samples were consistently taken from the same specific spots in each area to ensure reliability and reduce sampling error. Following that, 42 cultured plates exhibiting growth were analysed further, focusing specifically on those with colony counts ranging from 30 to 300. These 42 plates accounted for half of the total number of cultured plates. The selected plates underwent phenotypic examination to assess the appearance, colour, and texture of the microbial colonies, particularly emphasising those with better growth, as duplicates were taken for this purpose.

3.3.3 Study design

In the current study, the researcher used a descriptive cross-sectional study approach to assess the cleanliness of kitchen preparation surfaces in old age homes. All surface samples were collected using contact plates containing NA, PCA, and MSA media (Merck, Germany). NA and PCA were selected as general-purpose media capable of growing a wide variety of non-fastidious microorganisms from food environments, while MSA was used as a selective

medium for the isolation of pathogenic *Staphylococci* (Merck, 2024). Each microbial plate was incubated following standardised and appropriate procedures, which involved placing the plates upside down at a specified temperature (37°C) for a designated period (24-48 hours) to promote microbial growth. After incubation, enumerated microorganisms were identified using Matrix-Assisted Laser Desorption/Ionisation Time-of-Flight Mass Spectrometry (MALDI-TOF MS), BioTyper (Bruker, Germany), as shown in Figure 4, which displays the MALDI-TOF MS equipment.



Figure 4: MALDI-TOF MS machine

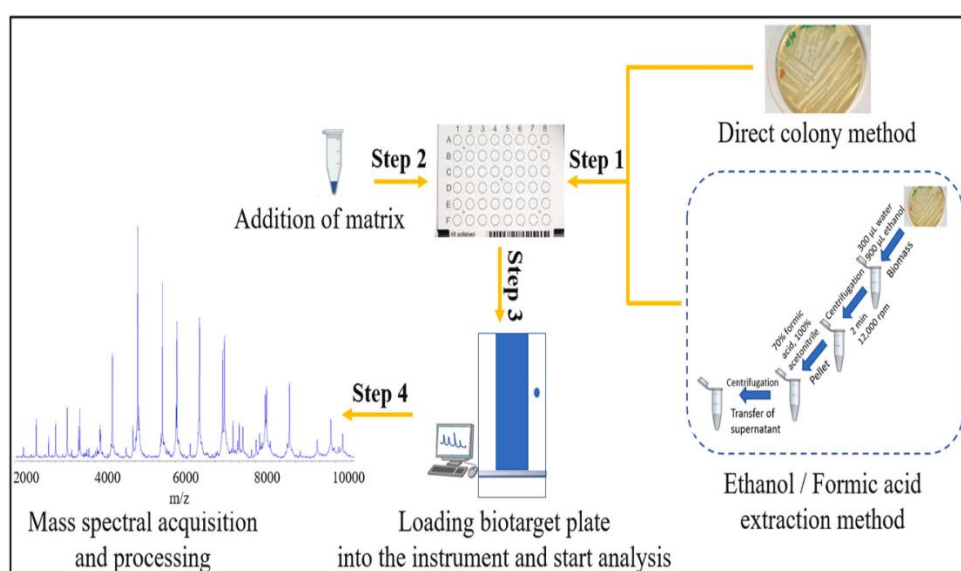
3.3.4 Analysis of data

After distinguishing microbial colonies based on their appearance, colour, and texture, the count was conducted using a Synbiosis aCOLade colony counter and reported as colony-forming units (CFUs) per square centimetre (cm²) per plate. The evaluation of these results was done following the guidelines provided in the FDC Act 54 of 1972 under Section 4(b)(i) (RSA DoH, 1972). The results were categorised into three groups based on the number of viable counts from each isolated area: satisfactory (less than 5 CFU/cm²), acceptable (5–10 CFU/cm²), and unsatisfactory (more than 100 CFU/cm²), in accordance with the guidelines by Seed and Kurrein (2019). The FDC Act 54 of 1972, under Section 4(b)(i), sets a regulatory guideline for surface contamination not to exceed 100 CFU/cm² (RSA DoH, 1972). In this study, however, a total viable count threshold of 300 CFU/cm² was specified for microbial analysis on PCA. This threshold was selected for practical monitoring purposes, acknowledging that although regulations stipulate a maximum of 100 CFU/cm² before food contact, the 300 CFU/cm² benchmark served as an early warning system to flag potential

hygiene risks. This approach aimed to uphold the regulatory limit while offering a practical framework for identifying and addressing emerging contamination concerns.

3.3.5 Microbial identification using MALDI-TOF MS/fingerprinting

Following the quantification and phenotypic analysis, 42 separate colonies were isolated to obtain pure cultures from the initial plates. The objective was to conduct additional identification of the microorganisms isolated from surface samples, establishing their genus and species through the application of MALDI-TOF MS BioTyper (Bruker, Germany) (Alizadeh *et al.*, 2021; Blincoe *et al.*, 2020). Figure 5 provides an illustration of the MALDI-TOF MS process.



Nhabe and Malebo, 2025

Figure 5: MALDI-TOF MS step procedure

Figure 5 shows the step-by-step process of how the analysis was performed. The analysis took about 20 minutes to conclude and included isolating a colony from the initial petri dish containing microorganisms, mixing it with the matrix solution and placing it on a steel biotarget plate in the second step; the third step involves inserting the steel biotarget plate into the machine and starting the analysis. The bacterial detection readings from the machine are indicated in the fourth step. Cells (individual colonies) from biological material were collected by scraping the plate and transferring them into an Eppendorf tube with 300 μL of UltraPure water (Merck, 2024). After thorough mixing, 900 μL of absolute ethanol was added, mixed well and then centrifuged at maximum speed (13200 rpm) for 2 minutes at room temperature. The liquid above the sediment was poured off and the sediment was left to air-dry at room temperature. The dried sediments were well-blended using a vortex mixer with 50 μL of formic

acid (70%), followed by the addition of 50 μL of pure acetonitrile (Merck, 2024) and thoroughly mixed. The mixture underwent centrifugation at maximum speed (13200 rpm) for 2 minutes and approximately 1 μL of the resulting liquid was placed onto a micro scout plate (MSP); 96 polished steel target plate and allowed to dry at room temperature.

Afterwards, each sample received a coating of 1 μL HCCA matrix solution, a saturated mixture of α -cyano-4-hydroxy-cinnamic acid (Sigma, USA) in 50% acetonitrile -2.5% trifluoroacetic acid (Bruker Daltronics, Germany) and was left to air-dry at room temperature. The analysis of all strains utilised a Microflex LT mass spectrometer (Bruker, Germany) with Flex Control software (Version 3.0, Bruker, Germany). Spectra were recorded in the linear positive mode (laser frequency of 20 Hz; ion source 1 voltage, 20kV; ion source 2 voltage, 18.6 kV; lens voltage, 7.5 kV; mass range, 2 000 to 20 000 Da). Each spectrum involved 240 shots in 40-shot sequences from different positions of the bacterial test standard (BTS) spot (manual mode) and was subsequently analysed. The spectra underwent internal calibration using *Escherichia coli* ribosomal proteins as the standard. Raw spectra were imported into the BioTyper software (Version 3.0, Bruker, Germany), processed through standard pattern matching with default settings and results were presented in a ranking table with colour codes. Outcomes of the pattern-matching process adhered to the MALDI-TOF BioTyper manufacturer's guidelines, expressing identity (ID) scores from 0 to 3. Scores below 1.70 were deemed unreliable, $1.7 < \text{ID} < 1.9$ indicated identification at the genus level; scores exceeding 1.9 were considered reliable for species identification.

3.4 Results and Discussion

Chapter 3 primarily focuses on the sampling and identification of isolated microorganisms to assess the cleanliness and hygiene of old age home kitchen surfaces in selected Mangaung Metropolitan and Lejweleputswa district municipalities in the Free State area. Sample collections were conducted over a period of 2 months in the summer. The sampling period was not extended to the winter period due to funding limitations. However, collecting samples over the two months helped capture any changes in microbial levels and hygiene practices. Therefore, this timeframe provided a clearer picture of how different factors might influence food safety in the kitchen.

3.4.1 Microbiological results

Total viable counts

In the current study, a total of 42 samples were analysed across the Mangaung and Lejweleputswa regions. Of the kitchen preparation surface samples from old age homes, 14

were assessed for microbial contamination using PCA media. According to the FDA Act 54 of 1972, Section 4(b)(i) (RSA DoH, 1972), surfaces and facilities must be cleaned and washed as necessary during and/or immediately after handling food to prevent contamination. Figure 6 illustrates one old age kitchen with surfaces that were found to be microbiologically clean, based on the results of microbial analysis conducted during the study. For the purpose of this study, cleanliness was defined using microbial thresholds based on South African regulations (Regulation R692 under the FDC Act 54 of 1972) and SANS 5763. Surfaces with colony-forming unit (CFU) counts below 100 CFU/cm² for non-food-contact areas and below 200 CFU/cm² for food-contact areas were considered clean. Surfaces exceeding 300 CFU/cm² were classified as unsatisfactory. Of the 14 old age home kitchens assessed, 13 had food preparation surfaces with microbial counts exceeding the acceptable threshold for cleanliness, indicating non-compliance. One kitchen was found to be compliant, with all surface samples yielding CFU counts within the acceptable limits. For the purposes of discussion in this study, the term “unclean” refers to surfaces that exceeded the specified CFU thresholds, posing potential health risks.





Figure 6: Clean kitchen conditions in selected old age homes, based on microbial analysis. (a) Food preparatory surfaces and shelves where food is placed after preparation. (b) Handwash basins designated for dishes and food handlers' hands. (c) Food preparatory surfaces and stoves in a clean kitchen. (d) Clean utensils stored on stainless steel movable shelving after washing

Surfaces must contain no more than 100 viable microorganisms per cm^2 before food comes into direct contact. This requirement is based on recognised scientific microbiological methods, specifically following the swab technique outlined in the SANS 5763 for the Efficacy of Cleaning Plant, Equipment and Utensils (SABS, 2018). However, in this study, when the colony count exceeded 300 CFU/ cm^2 , it became impractical to count each individual colony; therefore, the count was recorded as 'too numerous to count' (TNTC).

Key Findings:

To assess hygiene compliance, this study applied CFU (colony-forming unit) thresholds as outlined in the Regulations Governing Microbiological Standards for Foodstuffs and Related Matters (R 692 of 1997) under the FDC Act 54 of 1972, which provides microbiological standards for food-contact and non-food-contact surfaces. These national regulations were used as the basis for evaluating microbial load and determining hygienic acceptability. Specifically, CFU counts below 100 CFU/plate were considered satisfactory for non-food-contact surfaces such as holding shelves. For food-contact surfaces, such as kitchen and food preparation areas, counts below 200 CFU/plate were deemed satisfactory. Values between 100 and 300 CFU/plate were classified as borderline and interpreted based on the surface's

use, risk of cross-contamination, and frequency of cleaning. Any CFU count exceeding 300 CFU/plate was regarded as unsatisfactory, indicating non-compliance with the FCD Act 54 of 1972 and the SANS 5763 and pose as a potential food safety risk. The following thresholds were used: CFU counts below 100 CFU/plate were classified as satisfactory for surfaces not directly involved in food preparation (e.g., holding shelves); for food-contact surfaces, more stringent criteria were applied, with <200 CFU/plate deemed satisfactory. CFU counts ranging from 100-300 CFU/plate were considered borderline and evaluated contextually depending on the surface's role in food handling and its cleaning frequency. Any CFU count exceeding 300 CFU/plate was classified as unsatisfactory, indicating a hygiene concern and non-compliance with the FCD Act 54 of 1972 and the SANS 5763.

In terms of findings:

Kitchen preparation surfaces: 9 out of 14 samples exceeded 300 CFU/plate and were classified as unsatisfactory; 5 samples ranged between 100-300 CFU/plate and were evaluated as borderline.

Food preparation surfaces: 11 out of 14 samples were unsatisfactory (>300 CFU/plate); 3 were satisfactory (<200 CFU/plate).

Holding shelves: 8 out of 14 samples exceeded 300 CFU/plate (unsatisfactory); 6 were satisfactory (<100 CFU/plate).

Basins: 11 out of 14 samples were unsatisfactory (>300 CFU/plate); 3 were borderline (100-250 CFU/plate), with final evaluation based on frequency of cleaning and potential contamination risk.

This matrix approach allowed for systematic interpretation of results across varying kitchen surface types and risk levels. In general, a total of 84 samples were collected across two regions, Mangaung Metropolitan Municipality and Lejweleputswa District Municipality, and from four different kitchen areas: kitchen preparatory surfaces, food preparatory surfaces, holding shelves, and basins. Each region contributed 42 samples, with 10 to 11 samples collected from each kitchen area, depending on the operational status of the old age home. To be specific, in the Lejweleputswa old age homes, 14.29% of the colonies were found on PCA plates used for food preparatory surfaces, corresponding to 2 out of 14 samples. Similarly, in the Mangaung old age homes, 50% of the colonies were observed on PCA plates used for holding shelf surfaces, representing 7 out of 14 samples. The presence of various colony colours and morphologies observed in the bacterial contamination assessment provides valuable insights into the types of bacteria that may be present on surfaces in old

age homes. For example, the study by Shi *et al.* (2023) indicate that yellow colonies often indicate the presence of *Micrococcus* bacteria, which typically appear as circular, convex and smooth colonies when grown on NA. These specific morphological traits reflect physiological and biochemical properties that aid in identifying bacterial species and their associated health risks. Some strains of *Micrococcus* are opportunistic pathogens that, while generally harmless to healthy individuals, can cause infections in people with weakened immune systems, such as the elderly. Additionally, the gathered appearance of yellow and white colonies raises further concerns regarding potential contamination from bacteria like *Staphylococcus aureus* and *Bacillus* species.

According to Taylor and Unakal (2024), *Staphylococcus aureus* can cause foodborne illness if ingested, leading to symptoms such as vomiting, diarrhoea and abdominal pain. Similarly, *B. cereus* is associated with foodborne illnesses that result in nausea, vomiting or diarrhoea (McDowell *et al.*, 2024). Given that some colonies were TNTC, this finding highlights the need for stricter sanitation practices to meet health and safety standards, minimising contamination risks and protecting the health of elderly residents in these facilities. High levels of microorganisms on food preparation surfaces can lead to cross-contamination, heightening the risk of foodborne illnesses. The microbial contamination results indicate a direct relationship between inadequate facilities and unsatisfactory hygiene standards. Griffith (2016) reported that high levels of microorganisms on food preparation surfaces can lead to cross-contamination. Additionally, regulations set clear standards for maintaining proper cleanliness in food handling areas, ensuring consistent hygiene practices and reducing contamination risks. The results observed indicate that the cleaning practices and hygiene standards at old age homes do not meet the criteria set by the Regulations Governing Microbiological Standards for Foodstuffs and Related Matters, R692 of 1997 (Microbiological Specifications). These standards are designed to ensure that food preparation surfaces are hygienic and meet safety requirements. By keeping microbial counts below the established threshold, food premises can demonstrate their commitment to maintaining high hygiene standards, thereby assuring consumers of the safety and quality of the food products. Generally, these findings align with the study by Bukhari *et al.* (2021), which highlights a higher risk of food contamination from preparation surfaces compared to holding areas. The diverse bacterial colonies on preparation surfaces suggest a lack of cleanliness in old age homes, emphasising the urgent need for improvements in construction and facility design to uphold food safety standards. Immediate action is required to rectify these deficiencies and ensure that facilities adhere to health and safety standards, thereby protecting the well-being of elderly residents.

3.4.2 MALDI-TOF MS microbial fingerprinting

MALDI-TOF MS is a modern analytical technique used to identify bacterial colonies and microorganisms (Haider *et al.*, 2023; Mortier *et al.*, 2021). This method allows for fast and accurate identification of bacterial species based on their unique mass spectral fingerprints. It works by ionising microbial proteins directly from bacterial colonies, which creates special mass spectra that serve as molecular signatures for different species. According to Tarfeen *et al.* (2022), the technique is very efficient and can identify a wide range of microorganisms quickly. MALDI-TOF MS was used in this study because of its effectiveness. In places such as old age homes, where many different bacteria can exist, the quick identification of microorganisms is very important. This rapid identification helps assess potential risks to elderly residents, who are often more susceptible to foodborne illnesses.

As detailed in Table 9 below, the microbial values varied, with the highest recorded value being 2.44 with a corresponding duplicate plate value of 2.18, both associated with *Kocuria rosea*. The lowest value observed was 1.71, with its duplicate having a value of 1.58, identifying *Bacillus pumilus* on the standard plate and no identifiable organisms on the duplicate. According to MALDI-TOF MS ratings, values above 2.0 indicate reliable species identification. At the same time, variations in microbial counts between the standard and duplicate plates likely reflect differences in hygiene and kitchen cleanliness. Adhering to microbial count regulations is important for ensuring food safety and maintaining low bacterial levels.

Table 9: MALDI-TOF MS identified microorganisms

Bacterial counts in CFU/cm ²				
Old age home	Organisms detected (best match)	Score value	Organisms detected (second best match)	Score value
1	<i>Bacillus pumilus</i>	1.90	<i>Bacillus pumilus</i>	1.83
2	<i>Bacillus pumilus</i>	1.85	<i>Bacillus pumilus</i>	1.82
3	<i>Kocuria rosea</i>	2.44	<i>Kocuria rosea</i>	2.18
4	<i>Bacillus pumilus</i>	1.89	<i>Bacillus pumilus</i>	1.81
5	<i>Bacillus pumilus</i>	1.97	<i>Bacillus pumilus</i>	1.92
6	<i>Bacillus pumilus</i>	1.89	<i>Bacillus pumilus</i>	1.70
7	<i>Bacillus subtilis</i>	2.06	<i>Bacillus subtilis</i>	1.96
8	<i>Bacillus pumilus</i>	1.93	<i>Bacillus pumilus</i>	1.47
9	<i>Bacillus subtilis</i>	1.80	No Organism Identification Possible	1.69
10	<i>Bacillus pumilus</i>	1.75	No Organism Identification Possible	1.62
11	<i>Enterococcus faecium</i>	2.10	<i>Enterococcus faecium</i>	2.02
12	<i>Exiguobacterium artemiae</i>	2.24	No Organism Identification Possible	1.42
13	<i>Bacillus cereus</i>	2.01	<i>Bacillus cereus</i>	1.93
14	<i>Bacillus licheniformis</i>	1.80	No Organism Identification Possible	1.67

Bacterial counts in CFU/cm ²				
Old age home	Organisms detected (best match)	Score value	Organisms detected (second best match)	Score value
15	<i>Bacillus subtilis</i>	1.91	<i>Bacillus subtilis</i>	1.85
16	<i>Bacillus licheniformis</i>	1.78	No Organism Identification Possible	1.55
17	<i>Bacillus altitudinis</i>	1.70	No Organism Identification Possible	1.64
18	<i>Staphylococcus sciuri</i>	2.16	<i>Staphylococcus sciuri</i>	1.80
19	<i>Bacillus subtilis</i>	1.95	<i>Bacillus subtilis</i>	1.95
20	<i>Bacillus pumilus</i>	1.71	No Organism Identification Possible	1.57
21	<i>Staphylococcus hominis</i>	2.17	<i>Staphylococcus hominis</i>	2.04
22	<i>Peribacillus muralis</i>	1.86	No Organism Identification Possible	1.69
23	<i>Bacillus pumilus</i>	1.80	No Organism Identification Possible	1.58
24	<i>Bacillus subtilis</i>	2.09	<i>Bacillus subtilis</i>	1.89
25	<i>Paenibacillus alvei</i>	1.73	No Organism Identification Possible	1.45
26	<i>Enterobacter cloacae</i>	2.39	<i>Enterobacter cloacae</i>	2.38
27	<i>Proteus mirabilis</i>	2.39	<i>Proteus mirabilis</i>	2.37
28	<i>Bacillus pumilus</i>	1.87	<i>Bacillus altitudinis</i>	1.83
29	<i>Staphylococcus cohnii</i>	1.85	No Organism Identification Possible	1.69
30	<i>Bacillus altitudinis</i>	1.78	No Organism Identification Possible	1.67
31	<i>Bacillus cereus</i>	1.86	<i>Bacillus cereus</i>	1.81
32	<i>Bacillus pumilus</i>	1.71	No Organism Identification Possible	1.58
33	<i>Bacillus pumilus</i>	1.77	<i>Bacillus pumilus</i>	1.77
34	<i>Bacillus altitudinis</i>	1.89	<i>Bacillus pumilus</i>	1.86
35	<i>Pseudomonas stutzeri</i>	2.10	<i>Pseudomonas stutzeri</i>	2.07
36	<i>Staphylococcus epidermidis</i>	1.81	<i>Staphylococcus epidermidis</i>	1.70
37	<i>Bacillus subtilis</i>	1.84	<i>Bacillus subtilis</i>	1.75
38	<i>Bacillus pumilus</i>	1.90	<i>Bacillus pumilus</i>	1.84
39	<i>Bacillus subtilis</i>	1.92	<i>Bacillus subtilis</i>	1.87
40	<i>Bacillus altitudinis</i>	1.86	No Organism Identification Possible	1.60
41	<i>Bacillus pumilus</i>	1.88	<i>Bacillus pumilus</i>	1.80
42	<i>Bacillus subtilis</i>	1.95	<i>Bacillus subtilis</i>	1.95

Identification of bacteria using MALDI-TOF MS

A variety of microorganisms were identified using MALDI-TOF MS in the 42 samples collected from kitchens in old age homes as illustrated in Table 9. Among these samples, 33 belonged to the Bacillaceae family, including important species such as *Bacillus cereus*, *Bacillus subtilis*, *Bacillus altitudinis*, *Bacillus licheniformis*, *Bacillus pumilus*, *Exiguobacterium artemiae*, *Peribacillus muralis*, and *Paenibacillus alvei*. One isolate was identified as *Enterococcus faecium* from the Enterococcaceae family. Two isolates were classified under the Enterobacteriaceae family: *Enterobacter cloacae* and *Proteus mirabilis*. Additionally, one

isolate was classified as *Pseudomonas stutzeri*, and another was identified as *Kocuria rosea* from the Micrococcaceae family. The presence of these bacteria on food preparation surfaces in old age home kitchens raises serious concerns about food safety and hygiene, especially given the vulnerability of the residents. Bacterial members of the Bacillaceae family, such as *Bacillus cereus*, are rod-shaped bacteria that can form highly resistant spores. They thrive in various environments, including soil and water, and can cause foodborne illnesses if proper hygiene and cooking practices are not followed (Rossi *et al.*, 2024; Dietrich *et al.*, 2021). For example, not cooling and reheating rice correctly can lead to contamination and gastrointestinal illnesses, which can be particularly dangerous for elderly residents (Ghosh *et al.*, 2024; Navaneethan and Effarizah, 2023). Furthermore, *B. pumilus* and *Exiguobacterium artemiae* can survive harsh conditions and contaminate food if handling practices are poor, posing health risks to the vulnerable population (McDowell *et al.*, 2024; Zhang *et al.*, 2021). While *Peribacillus muralis* and *Paenibacillus alvei* are associated with food spoilage, they are less frequently linked to severe illnesses (Karanth *et al.*, 2023; Manetsberger *et al.*, 2023; Sáez-Nieto *et al.*, 2017).

Enterococcus faecium, which is part of the normal intestinal flora, can cause serious infections, especially in elderly individuals (Astley *et al.*, 2023; Richiard *et al.*, 2023). These bacteria can contaminate food through faecal matter or poor hygiene, leading to possible outbreaks of foodborne illnesses in old age homes (Sangiorgio *et al.*, 2024). Similarly, *Enterobacter cloacae* and *Proteus mirabilis* are important in the context of foodborne illnesses, particularly when foods are not handled or stored properly (Balali *et al.*, 2020; Bintsis, 2017). *Pseudomonas stutzeri* and other species in the *Pseudomonas* genus are known for their ability to spoil various food products, including meats and dairy (Lianou *et al.*, 2017; Scales *et al.*, 2014). Additionally, while *Kocuria rosea* is typically non-pathogenic, it can contribute to food contamination if hygiene practices are inadequate (Manafe *et al.*, 2023; Ziogou *et al.*, 2023). The presence of these bacteria in kitchens serving elderly residents highlights the urgent need for strict hygiene measures, regular cleaning and adherence to food safety regulations to prevent bacterial growth and protect the health of the residents. The isolation of *Staphylococcus* (S) species in a kitchen environment was achieved using MSA, a selective medium for isolating Staphylococci, and identification using MALDI-TOF MS. *S. cohnii*, *S. epidermidis*, *S. hominis*, and *S. sciuri* are coagulase-negative Staphylococci commonly found on human skin and mucous membranes, as well as in soil and water (Taylor and Unakal, 2024). These bacteria, while generally less virulent compared to other Staphylococci, can still produce enterotoxins that cause foodborne illnesses if food is contaminated through poor handling or inadequate sanitation (Lee and Anjum, 2023; Franca *et al.*, 2020). Although *S. cohnii* is less frequently associated with infections, *S. epidermidis*, *S. hominis*, and *S. sciuri*

can cause infections in immunocompromised individuals, particularly in such settings (Michalik *et al.*, 2020). Their presence in food preparation areas is concerning, as these bacteria can contaminate food through contact with skin or contaminated surfaces. Effective hygiene and sanitation are important to minimise the risk of contamination and prevent foodborne illnesses (Mihalache *et al.*, 2021). The detection of these Staphylococci highlights the need for strict cleaning protocols and proper food handling practices to ensure food safety and protect vulnerable populations from potential health risks. Implementing these measures is important for complying with all food hygiene and safety regulations. The existence of various bacterial families implies that there are numerous potential origins of contamination on the food preparation surfaces in old age home kitchens. Most of the bacteria identified in this study are commonly associated with foodborne illnesses and are often isolated from soil and water contamination, such as *Proteus mirabilis*, *Pseudomonas stutzeri*, *Kocuria rosea*, and *Exiguobacterium artemiae*. Another source of contamination arises from faecal contamination, specifically from *Enterococcus faecium* and *Enterobacter cloacae*. Table 10 provides information about the bacterial species isolated from kitchen surfaces using MALDI-TOF MS, including their typical sources, associated implications, and symptoms.

Table 10: Sources of bacterial species on kitchen surfaces, their common sources, implications and symptoms

Isolated species	Common source	Implications	Predominant symptoms
<i>Bacillus altitudinis</i>	Maize, rice, wheat, sometimes fish	Food poisoning	Nausea, vomiting and diarrhoea
<i>Bacillus cereus</i>	Fish, dairy, meat, sauces, soups and stews, vegetables	Food poisoning	Intestinal illnesses with nausea, vomiting and diarrhoea
<i>Bacillus pumilus</i>	Dairy milk, pre-cooked rice	Food poisoning	Severe abdominal cramps, fever with chills, diarrhoea, dizziness and loss of appetite
<i>Bacillus subtilis</i>	Chicken intestines, beef tripe	Food spoilage, such as ropy bread and incidents of foodborne gastroenteritis	Diarrhoea and/or nausea; abdominal pain
<i>Bacillus licheniformis</i>	Raw milk, cooked meats, vegetables, wastewater	Food poisoning	Diarrhoea and/or nausea; abdominal pain

Isolated species	Common source	Implications	Predominant symptoms
<i>Peribacillus mutalis</i>	Soil and plants (fruits and vegetables)	Food poisoning	Nausea, vomiting and diarrhoea
<i>Paenibacillus alvei</i>	Soil, often associated with plant roots - fruits and vegetables	Food poisoning	Nausea, vomiting and diarrhoea
<i>Enterobacterium artemiae</i>	Raw milk, cheeses, meat products	Gastrointestinal illnesses	Nausea, vomiting, diarrhoea, abdominal cramps and other agent-specific symptoms
<i>Enterococcus faecium</i>	Raw milk, cheese products, processed foods	Severe nosocomial infections	Fever, chills, shortness of breath, abdominal pain and diarrhoea
<i>Exiguobacterium artemiae</i>	Seafood, soil, seawater	Food poisoning	Nausea, vomiting and diarrhoea
<i>Kocuria rosea</i>	Sausages, cheeses	Fermentation of foods, food poisoning	Nausea, vomiting and diarrhoea
<i>Proteus mirabilis</i>	Water, soil, human intestinal environments	Food poisoning, peritonitis and meningitis	Gastrointestinal illnesses (inflammation, infection or dysfunction of various components of the digestive system, such as the stomach, intestines, liver and pancreas)
<i>Pseudomonas stutzeri</i>	Chilled chicken, red meat	Spoilage bacteria – food poisoning	Gastrointestinal illnesses (inflammation, infection or dysfunction of various components of the digestive system, such as the stomach, intestines, liver and pancreas)
<i>Staphylococcus cohnii</i>	Milk products (cheese, yoghurt) derived from dairy cows' milk	Food poisoning	Human and animal infections, including toxin-mediated foodborne diseases
<i>Staphylococcus epidermis</i>	At several parts of the skin constituting 90% of microflora – foods that are not cooked after	Food poisoning	Nausea, vomiting and stomach cramps

Isolated species	Common source	Implications	Predominant symptoms
	handling, such as sliced meats, puddings, pastries, sandwiches		
<i>Staphylococcus hominis</i>	Milk, various cheeses, fermented fish products	Staphylococcal food poisoning	Severe nausea and vomiting. Abdominal cramps, diarrhoea and severe fluid and electrolyte loss (weakness) and very low blood pressure (shock)
<i>Staphylococcus sciuri</i>	Milk, French and Italian cheeses, fish sauces, fermented sausages	Food poisoning	Severe nausea and vomiting

Microorganisms have the potential to cause foodborne illnesses, particularly in susceptible groups like the elderly (Bintsis, 2017). Therefore, it is important to maintain consistent cleanliness and disinfection of food preparation surfaces to prevent cross-contamination. The findings from this study indicate that hygiene and food safety practices on kitchen surfaces in old age homes are not satisfactory, potentially due to improper handling by food handlers and structural design flaws that do not align with regulations. Thus, it is crucial to continuously remind food handlers about safe food handling practices and personal hygiene, while facilities must ensure compliance with relevant legislative frameworks. The study by Jevšnik *et al.* (2022) further highlights kitchen hygiene challenges. Their findings revealed a general lack of awareness about food safety practices, especially among individuals aged 36 to 55, with women demonstrating greater awareness than men. In their consumer-based study, only some food handlers consistently separated raw poultry from other foods, while others, particularly younger males, showed inconsistent practices. Moreover, most consumers (14 out of 16) did not wash poultry meat before preparation, reflecting poor adherence to hygiene guidelines.

Jevšnik *et al.* (2022) also assessed kitchen surface cleanliness using Total Colony Count (TCC) values and classified surfaces as adequately cleaned, acceptable, or inadequately cleaned based on the Guidelines for the Microbiological Safety of Food Intended for the Final Consumer (Veterinary Faculty, University of Ljubljana, 2019), which set the acceptable level for utensils at 100 CFU/20 cm² or 2.0 log CFU/20 cm². Their results showed that two cutting boards (12.5%) were inadequately cleaned, whereas 75% of consumer plates were

adequately cleaned and 25% acceptably cleaned. These findings relate closely to the current study, which also evaluates surface cleanliness in old age home kitchens, underscoring the importance of rigorous cleaning and hygiene practices in protecting vulnerable populations. Similarly, Flores *et al.* (2013) and Hassan and El-Bagoury (2017) found high bacterial loads in kitchen environments, including heterotrophs, pseudomonads, enteric species, Staphylococci, and micrococci. The current study found bacterial counts exceeding acceptable limits (e.g., >100 CFU/cm²), with some too numerous to count (TNTC), as per the standards from the BCCDC Environmental Health Officers Guide (Seed and Kurrein, 2019) and the FDC Act 54 of 1972. These elevated counts, along with visible microbial films, point to multiple contributing factors such as poor food handling, inadequate management, ineffective cleaning, and non-compliance with hygiene protocols, further emphasizing the urgent need for staff training, clear hygiene rules, and improved food safety practices in old age homes.

3.5 Conclusion

By assessing the presence of bacterial species on surfaces, the current investigation revealed that the cleanliness and hygiene conditions in the 14 old age kitchens in Mangaung and Lejweleputswa were below the required standard, posing a potential health risk to the elderly residents. Nevertheless, some of the old age homes adhered to FCD Act 54 of 1972 (RSA DoH, 1972). A limitation was that the study did not assess the knowledge, attitudes and behaviours of food handlers regarding food safety and foodborne illnesses; it solely focused on quantifying and identifying the distribution of microorganisms on food preparation surfaces to assess kitchen cleanliness and sanitation. The findings of the current study emphasise a notable presence of bacterial contamination by foodborne illness-causing species in the kitchen areas of the old age facilities, emphasising the importance of implementing improved hygiene measures. This is important for reducing the risk of cross-contamination and subsequently lowering the chances of foodborne illnesses. The detection of bacterial pathogens in all collected samples indicates insufficient personal hygiene practices and the inadequate cleaning and disinfection of surfaces.

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CHAPTER 4

EVALUATING FOOD SAFETY PRACTICES AND QUALITY ASSURANCE MECHANISMS IN OLD AGE HOMES

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4.1 Abstract

Poor food handling, improper cooking and inadequate storage can easily spread harmful pathogens in various settings, including old age homes. Questionnaires were used to collect data to assess food safety practices in these homes. Additionally, compliance with kitchen regulations and food handlers' behaviour were evaluated using a food safety checklist. The study found that participants generally had a good understanding of personal hygiene, proper food handling, sanitation and preventing microbial contamination. However, despite this knowledge and positive attitudes toward food safety, there is a clear need for continued education and training to bridge the gap between knowing what to do and applying the knowledge. The researcher observed discrepancies between what participants reported and their actual practices, especially in cleaning, as noted on food safety checklists. Non-compliance with regulations was found in 34.88% of the old age homes, with issues such as a lack of handwashing facilities, limited access to hot water and insufficient personal protective equipment. While some facilities demonstrated knowledge of food safety practices and compliance with regulations, strict implementation of food safety measures for food handlers is needed to ensure ongoing compliance in old age homes. This is essential to protect the health and well-being of elderly residents. Legislation enforcement should include follow-up inspections and facilities that fail to meet all requirements should be fined and potentially closed until they achieve full compliance. Inspections should address the specific needs of the elderly, ensuring that facilities are adequately equipped and staffed to meet hygiene standards, which will help reduce the risk of foodborne illnesses.

Keywords: Quality assurance, foodborne illness, food safety knowledge, food practices

4.2 Introduction

Ensuring food safety in old age homes is critical because residents often have weakened immune systems or chronic health conditions, making them more susceptible to foodborne illnesses. This highlights the need for strict food safety regulations and practices to protect elderly individuals in these settings. Preventing foodborne diseases requires a collaborative effort among government departments, agencies, and industries, emphasizing the importance of enforcing laws, implementing robust food safety systems, and providing ongoing training programs. Given the vulnerability of older adults, managers and food handlers in old age homes must consistently adhere to safe food handling procedures and quality assurance standards (WHO, 2015). This study identified key areas for improvement to enhance the health and well-being of the elderly by promoting stronger food management protocols. Questionnaires were used to assess food handlers' practices and their compliance with

existing regulations, while food safety checklists helped evaluate adherence to protocols and pinpoint gaps needing improvement to ensure better food safety and management for the elderly.

4.3 Materials and Methods

4.3.1 Study area

In this study, the researcher focused on kitchens in old age homes located in the Mangaung Metropolitan and Lejweleputswa District Municipalities in the Free State, South Africa, which hold a Certificate of Acceptability (CoA). In South Africa, food facilities must first apply to the local municipality to obtain a CoA, as outlined in the Regulations Governing General Hygiene Requirements for Food Premises (R638 of 2018) stipulated under the Foodstuffs, Cosmetics and Disinfectants (FDC) Act 54 of 1972 (RSA DoH, 2018b). An Environmental Health Practitioner (EHP) inspects the premises to verify compliance with hygiene and safety standards; any issues must be rectified before a CoA is issued. However, if the issues are minor and can be resolved quickly, a conditional CoA may be granted for up to six months, as stated in Section 3 of R638 of 2018: requirements for CoAs. The certificate is valid for a set period and must be renewed annually, with regular inspections to ensure ongoing compliance with food safety standards. It is important to note that before the questionnaire survey was conducted, a letter was sent to the Free State Department of Social Development (Head of Department) explaining the purpose and process of the study (Annexure 2). Ethical clearance for this study was requested and approved by the University of the Free State's General/Human Research Ethics (GHREC) and Environmental and Bio-Safety Research Ethics (EBREC) committees (Annexures 3 and 4). Following approval, questionnaires were distributed and completed by all food handlers involved in food hygiene practices at the old age homes.

4.3.2 Data collection

The current study used a quantitative approach to gather data using a questionnaire and a food safety checklist. The questionnaire, which took approximately 15 to 20 minutes to complete, was divided into four main sections: Section 1 addressed personal hygiene and the processes and procedures followed by food handlers; Section 2 focused on food safety management issues, including the construction and layout of the food premises for occupational purposes; Section 3 examined cleaning practices; and Section 4 covered pest control and proper waste disposal. The open-ended questions allowed qualitative responses from participants. Additionally, the researcher evaluated food handler's practices through

direct observation using a food safety checklist. For the current study, the researcher chose a purposive sampling method. The study included all the food handlers responsible for food preparation in the study. Eighty (80) food handlers from 14 old age homes in Mangaung and Lejweleputswa regions were requested to participate in the study, yielding a 100% response rate. The participants comprised food handlers and supervisors, where 97.5% (N=78) were females and 2.5% (N=2) were males, as observed and counted by the researcher (Figure 7).

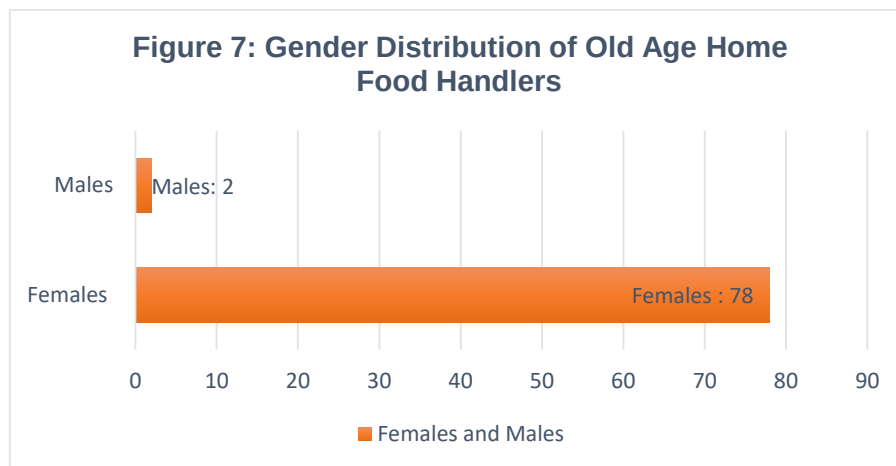


Figure 6: Gender distribution of old age home food handlers

4.4 Data Analysis

The researcher analysed the data using the Statistical Package for the Social Sciences (SPSS) Version 29, a widely recognised tool in social sciences research for data analysis. In this study, participant responses were coded in SPSS as '1.00' for 'Yes' and '2.00' for 'No' across various questions (SPSS, 2023). Descriptive statistics were used to summarize the data and assess hygiene practice compliance. This coding allowed for a systematic analysis, enabling comparisons and the identification of common responses concerning hygiene practices, food safety management and facility infrastructure in old age homes. SPSS outputs also provided summarised findings for key variables, such as handwashing facilities, temperature checks and cleaning protocols, displaying the percentage of respondents adhering to specific practices.

4.5 Results and Discussion

4.5.1 Questionnaire

Food handlers reported that they generally received food safety and hygiene training only at the start of their employment, with such training typically conducted by a supervisor. They further indicated that reinforcement of hygiene practices usually occurred during the biannual

inspections carried out by EHPs. This indicates a lack of continuous, structured training, which may negatively affect the consistent application of food safety protocols within these facilities. To further explore these practices, a questionnaire was administered, as this method allows for the efficient collection of data from a large number of participants, enabling comparisons across responses and the identification of patterns (Taherdoost, 2020). The data obtained were analysed and grouped into key themes that emerged, namely hygiene and sanitation practices, food safety practices, cleaning and maintenance, pest and waste management, and notable gaps in existing practices. These themes provided a structured framework for identifying areas of both compliance and non-compliance among participants. The SPSS output offered an overview of food safety and hygiene practices at the old age homes sampled (Table 11 and Figure 8). Table 11 shows the number (N) and percentage (%) of respondents who answered 'Yes' or 'No' to each food safety and hygiene-related question, highlighting the percentage of responses for hygiene and food safety practices.

Table 11: Quantitative analysis of food safety and hygiene practices

Question	Yes (N)	Yes (%)	No (N)	No (%)
Do staff have dedicated wash basins	67	83.8	13	16.3
Do handwash basins have hot & cold water	67	83.8	13	16.3
Is there soap at the wash basin	67	83.8	13	16.3
Is there a hygienic method for drying hands	66	82.5	14	17.5
Are staff provided with changing and storage facilities	66	82.5	14	17.5
Is there a designated restroom with a handwash basin	66	82.5	14	17.5
Is there a fitness to work policy	68	85.0	12	15.0
Are temperature checks taken upon food delivery	48	60.0	32	40.0
Do you ensure correct stock rotation	80	100.0	0	0.0
Do you ensure adequate separation of raw and cooked foods	80	100.0	0	0.0
Do you check temperature of chillers regularly	57	71.3	23	28.7
Do you check temperature of freezers regularly	57	71.3	23	28.7
Are foods defrosted on the premises	80	100.0	0	0.0
Is preparation of ready to eat food done	80	100.0	0	0.0
Will cooking be done on the premises	80	100.0	0	0.0
Are good methods used to ensure that food is thoroughly cooked	80	100.0	0	0.0
Do you cook foods to temperatures above 65°C	80	100.0	0	0.0
Are food safety management records kept	67	83.8	13	16.3
Do you have cooling methods for food	80	100.0	0	0.0

Question	Yes (N)	Yes (%)	No (N)	No (%)
Will reheating of food be undertaken on the premises	66	82.5	14	17.5
Do you monitor temperature of reheated food	66	82.5	14	17.5
Are sick employees' records kept	65	81.3	15	18.8
Are leftover foods warmed up before served	67	83.8	13	16.3
Will risk of contamination of foods on display be prevented	36	45.0	44	55.0
Are food surfaces well-constructed and easy to clean	60	75.0	20	25.0
Is lighting and ventilation satisfactory	80	100.0	0	0.0
Is there maintenance and repairs personnel on-site	65	81.3	15	18.8
Do you have a cleaning schedule	63	78.8	17	21.3
Are cleaning products conforming to BS EN 1276, BS EN 13697 and SABS standards	80	100.0	0	0.0
Do you have pest control in place	67	83.8	13	16.3
Do you have a formal pest control contract	67	83.8	13	16.3
Are there adequate facilities for storage and disposal of refuse	63	78.8	17	21.3
Are there adequate facilities for storage and disposal of waste oil	63	78.8	17	21.3

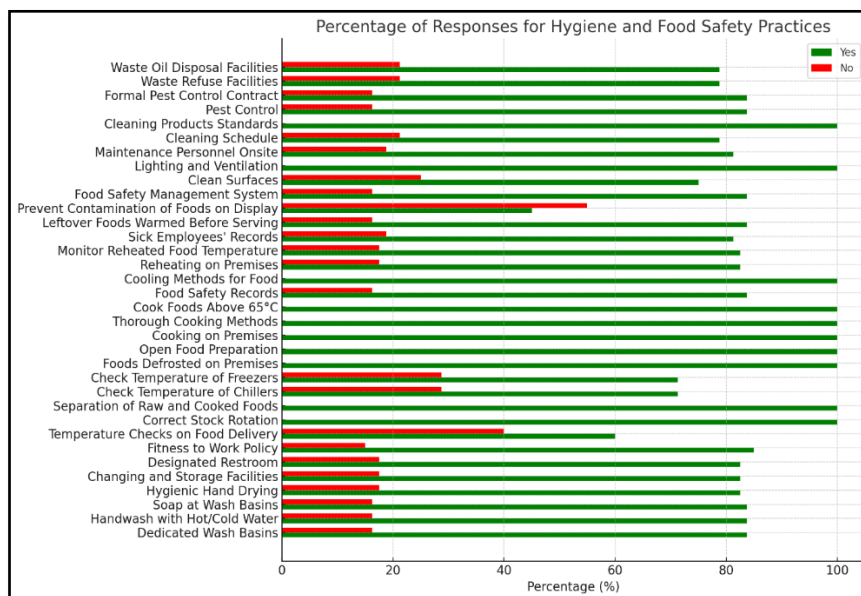


Figure 7: Percentage of responses for hygiene and food safety practices

Summary: The bar chart visualises the responses from the table provided. The chart shows the number of 'Yes' and 'No' responses for each food safety and hygiene practice question. The green bars represent 'Yes' responses, while the red bars indicate 'No' responses.

4.5.2 Analysis of sanitation and hygiene infrastructure in old age homes based on questionnaire responses

Dedicated handwash basins

In the previous chapter, the researcher discussed concerns about food contamination and emphasised the importance of good hygiene in reducing these risks. The study found that 12 out of the 14 old age homes had dedicated handwash basins (Figure 9). This was confirmed by 67 food handlers (83.8%) who reported their presence in the facilities. This shows strong compliance with the hygiene standards set out in the Regulations Relating to Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018) (RSA DoH, 2018b). Such high adherence reflects a positive commitment to maintaining cleanliness and following important hygiene protocols.



Figure 8: Handwash basin, stainless steel dishwashing area for utensils and cutlery, and a cooking stove located within the kitchen space, illustrating key components essential for maintaining hygiene and food safety compliance

However, out of the 14 old age homes, 2 were reported to lack dedicated handwash basins, based on the 16.3% (N=13) of respondents who highlighted this issue. Proper handwashing is crucial for preventing the spread of diseases from hands to food (Ahmednur *et al.*, 2022). Research shows that washing with soap reduces bacteria, viruses and pathogens, helping to lower the risk of foodborne illnesses and ensuring food safety (WHO, 2024; Cantrell *et al.*, 2023; Toney-Butler *et al.*, 2023; USDA, 2020). Non-compliance can lead to legal consequences, including fines and facility closure. Addressing the absence of handwash facilities could enhance hygiene standards, mitigate contamination risks and ensure

compliance with food hygiene and safety regulations aimed at maintaining public health standards.

Cold and hot water availability

The study revealed that 12 out of the 14 old age homes had access to both hot and cold water at their handwash basins, as 83.8% (N=67) of respondents reported this critical aspect of maintaining hand hygiene. However, 2 out of the 14 old age homes did not have proper handwash basins and instead relied on plastic washbasins (Figure 10). This accounts for 16.3% (N=13) of the facilities that reported lacking adequate handwashing facilities. The use of plastic washbasins is not recommended due to their higher risk of bacterial contamination and difficulty in proper cleaning (Querido *et al.*, 2019). Moreover, over time, plastic washbasins can wear down and degrade, which may pose additional hygiene risks in food preparation environments.

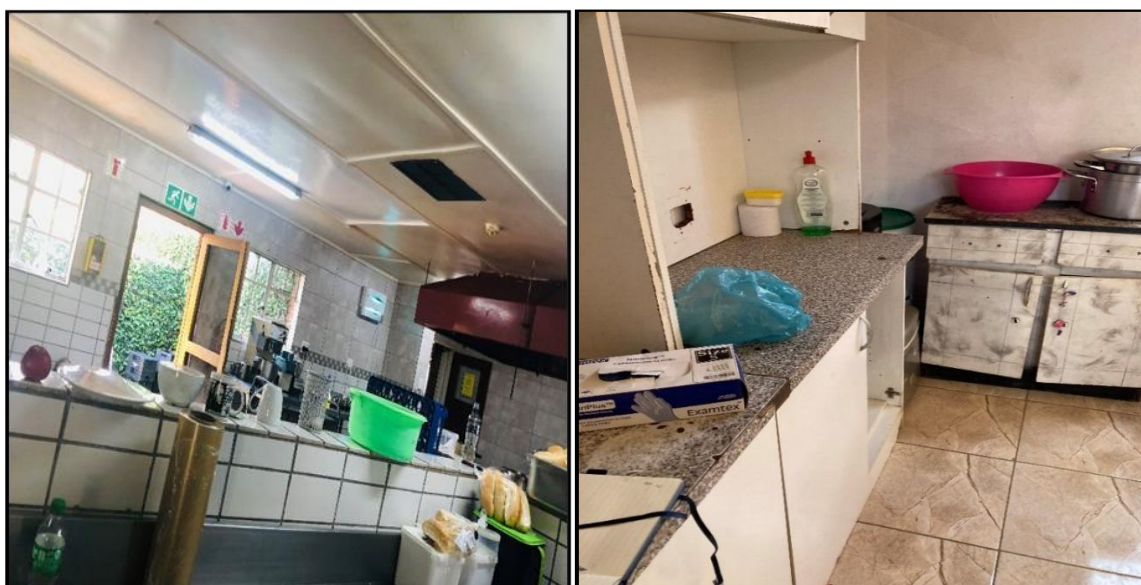


Figure 9: Plastic washbasins located in food preparation areas of old age homes, alongside stored items such as pots, liquid soap, sterile plastic wrap, and bread buns; highlighting potential cross-contamination risks due to inadequate separation of food and non-food items.

Regulatory standards, such as the Regulations Governing General Hygiene Requirements for Food Premises (R638 of 2018) (RSA DoH, 2018b), mandate the availability of both hot and cold water, soap and disposable hand-drying materials in food premises. Hot water is essential for sanitising utensils, equipment and surfaces, while cold water is needed for rinsing food to prevent bacterial growth (Bhagwat, 2019). Without consistent access to hot and cold water, maintaining hygiene becomes increasingly difficult, thereby increasing the risk of foodborne illnesses for consumers and food handlers alike. The study highlights that while most facilities

meet hygiene requirements, the two facilities without proper handwash basins, accounting for 16.3% (N=14), face a higher risk of bacterial contamination. Temporary solutions, such as plastic washbasins, point to potential lapses in compliance with food safety regulations. Improving infrastructure and ensuring that all facilities meet required hygiene standards is critical for reducing contamination risks.

Hygienic hand-drying methods

Hygienic hand-drying methods are very important, especially in old age homes where residents are more vulnerable to infections. Proper hand drying helps prevent the spread of disease and keep both food handlers and elderly residents safe. All 14 old age homes (N=80 [100.0%]) use single-use paper towels for hand drying, which reduces the risk of cross-contamination. Unlike cloth towels, which can harbor bacteria if not washed frequently, single-use paper towels ensure cleanliness with every use and help maintain a high level of hygiene. In South Africa, these practices are supported by the Regulations Governing General Hygiene Requirements for Food Premises (R638 of 2018) (RSA DoH, 2018b), which set minimum standards for cleaning and hygiene, including hand-drying methods that promote public health. Using a paper towel to dry hands effectively removes any remaining bacteria after washing. Many food safety guidelines and health departments recommend or require disposable paper towels in food handling areas to maintain hygiene and safety. In addition to handwashing, effective hand drying is key to reducing bacterial contamination and preventing bacteria from spreading to other surfaces such as skin, food, and objects. Research shows that bacteria are more likely to transfer from wet or poorly dried hands than from dry hands. Studies by Reynolds *et al.* (2021), Suen *et al.* (2019), Gerba *et al.* (2016), and Kimmitt and Redway (2016) all support this finding, stressing the importance of thorough hand drying for good hygiene.

Changing and storage facilities

Designated changing and storage areas for staff are important to prevent cross-contamination and keep food preparation areas clean. The Regulations Governing General Hygiene Requirements for Food Premises (R638 of 2018) (RSA DoH, 2018b) state that separate changing areas with storage should be available to ensure personal clothing does not touch food products. According to the study, 12 out of the 14 old age homes had these facilities, with 82.5% (N=66) of respondents reporting they were available. However, 2 out of the 14 old age homes did not have these facilities and relied only on aprons over personal clothing, affecting 17.5% (N=14) of the premises. This gap raises concerns about meeting hygiene standards.

Restrooms with handwash basins

Access to restrooms with handwash basins is important for personal hygiene, especially in old age homes where preventing foodborne illnesses is crucial. The study found that 2 out of the 14 old age homes, representing 17.5% of food handlers, do not have dedicated restrooms and instead use public facilities shared by all genders. This raises concerns about the thoroughness of inspections conducted by EHPs.

Conditional CoAs and non-compliance

Out of 14 respondents, 2 (17.5%) reported a lack of access to changing/storage facilities and restrooms, which raises concerns about whether hygiene standards are being consistently followed. This is particularly concerning as all the facilities had a CoA. This indicates that the Governing General Hygiene Requirements for Food Premises (R638 of 2018) may not be fully enforced, and some facilities may have been issued CoAs with conditions or restrictions due to instances of non-compliance (RSA DoH, 2018b). These conditionally issued CoAs permit the facilities to continue operating for up to six months, during which time they are expected to address and rectify the identified non-compliance issues. The infrequency of inspections, as required by the National Norms and Standards Relating to Environmental Health under the National Health Act 61 of 2003 (RSA DoH, 2003), may contribute to these hygiene lapses. More frequent inspections could help identify and fix these issues, improving compliance and reducing the risk of foodborne diseases.

4.5.3 Integrated safety and hygiene procedures

Fitness to work policy

Having a fitness to work policy is important to make sure that food handlers are healthy and able to do their jobs without risking food safety. Out of the 14 old age homes, 12 (N=68 [85%]) had the necessary policy in place to reduce health risks. However, 2 old age homes (N=12 [15%]) did not have this policy, which could increase the risk of foodborne illnesses. The fitness to work policy, as stated in the Occupational Health and Safety Act 85 of 1993 (RSA, 1993a), helps employees report illnesses that may affect their ability to handle food safely, reducing the risk of cross-contamination and ensuring a safe food handling environment.

Sick employee records

The study found that around 11 out of the 14 old age homes keep records of sick employees, with 81.3% (N=65) of respondents doing so. This closely matches the 85.0% (N=68) of facilities that follow a fitness to work policy, with about 12 out of 14 homes having such policies

in place. These practices show a strong commitment to food safety standards. Keeping sick employee records helps track potential contamination sources and ensures that sick workers are not handling food until they are fit to return. The small difference between the percentage of facilities with sick employee records (81.3%) and those following fitness to work policies (85.0%) indicates a minor difference in policy application, but it is unlikely to affect overall food safety. In South Africa, the Occupational Health and Safety Act 85 of 1993 requires facilities to keep records of employee health, including sick employees (RSA, 1993a). These records are important for monitoring health risks and ensuring workplace safety, which also aligns with the food safety standards in the Regulations Governing General Hygiene Requirements for Food Premises (R638 of 2018) (RSA DoH, 2018b). Following these regulations helps facilities meet legal requirements and reduce contamination risks, highlighting the importance of combining safety and hygiene procedures in food handling environments.

Stock rotation

Stock rotation is important for maintaining food quality and preventing spoilage. All 14 of the old age homes (N=80 [100.0%]) reported that they ensure correct stock rotation, indicating a strong commitment to this practice. The majority of the respondents indicated that they use the first in, first out system (FIFO). The system is an important inventory management method in food safety that ensures older stock is used before newer stock. According to Sembiring *et al.* (2019), this practice is important in preventing food spoilage as it minimises the risk of serving food that may no longer be safe to consume. Moreover, the system helps in minimising food waste by ensuring that all food items are used efficiently and timely, which is both economically beneficial and environmentally sustainable. This system also supports consistent food quality, as customers receive fresh products, enhancing customer satisfaction and trust. Another benefit of the FIFO system is that it helps keep track of inventory more accurately, making it easier to plan for future purchases and usage. Therefore, proper stock rotation is important because it prevents perishable goods from expiring before they are used and prevents serving consumers with spoiled or expired foods. Efficient stock rotation ensures that older stock is used before new stock comes, thus helping to reduce food waste, which is costly and bad for the environment.

Cleaning schedules

In a facility where food is prepared, cooked and stored, cleaning is a two-step process that must be followed for all surfaces and equipment that touch food. The first step is cleaning, where large residues, such as soil, are removed. The second step is sanitation, which uses disinfectants or heat to kill any remaining microorganisms that could cause foodborne

illnesses. Sanitation is essential to prevent contamination and keep food safe to eat. In this study, 11 out of the 14 old age homes reported having a cleaning schedule, making up 78.8% (N=63) of respondents. However, 3 out of the 14 homes did not have a schedule, as indicated by 21.3% (N=17) of participants who clean as they go. During visits to the old age homes, the researcher noticed differences between what participants reported and what was happening. The cleanliness of the kitchens varied; about 83.8% (N=67) were well-maintained, meaning they followed effective cleaning practices. This indicates that 12 out of 14 homes kept their kitchens clean, while two homes did not meet the same standards, as shown by 16.3% (N=13) of kitchens having visible dirt and grime, suggesting cleaning tasks were not done consistently.

High-touch surfaces such as countertops and work areas often need more attention to avoid contamination. Some kitchens met hygiene standards, but others needed to improve their cleaning practices to ensure a consistently clean and safe environment. These observations were noted on a checklist to address specific areas in need of improvement. Having a cleaning schedule is important for maintaining hygiene standards in old age home kitchens. It ensures that cleaning tasks are done regularly, which prevents dirt, bacteria and contaminants from building up (Moretro *et al.*, 2020). A cleaning schedule is key to good hygiene practices because it helps prioritise cleaning tasks and makes sure all areas are cleaned thoroughly. This organised approach, essential for effective hazard control, creates a clean and safe environment whether for the residents of an old age home or in any food preparation area. According to CAC/RCP 1-1969 of the Codex Alimentarius Commission (2003), extra attention should be given to cleaning equipment and surfaces that touch food. Any lapse in cleaning these surfaces could lead to food contamination. To reduce this risk, food preparation surfaces should be monitored and verified to ensure they are properly cleaned and sanitised. Monitoring includes checking that cleaning procedures are being followed; verification means documenting and reviewing cleaning practices to confirm they meet hygiene standards. These steps help reduce contamination risks and ensure food safety protocols are followed. By following these practices, old age homes can maintain safe food preparation and protect the well-being of those who consume it.

Cleaning products conforming to the British Standard European Norm (BS EN) 1276, BS EN 13697 and South African Bureau of Standards (SABS)

The British Standard European Norm (BS EN) 1276 and BS EN 13697 are standards set by the British Standards Institution (BSI) to ensure that cleaning products have been tested and proven effective against harmful microorganisms. These standards are important for maintaining hygiene and reducing the risk of infection or foodborne illnesses, especially in places like old age homes (Astral Hygiene, Limited, 2024). While these European standards

are useful, South Africa also has its own standards for cleaning products, typically set by the SABS 14045:2014 (SABS, 2014b). Both sets of standards are essential for effective cleaning and disinfection. Information on BS EN standards can be found on the BSI website and through authorised distributors and professional associations. It is important to note that the compliance confirmation (N=80 [100%]) with BS EN 1276, BS EN 13697 and the SABS in Table 11 is based on the researcher's findings for all 14 old age homes, not on the respondents' awareness. The respondents may not have been aware of the specific details of the British and South African Standards as they generally rely on suppliers and regulatory bodies to ensure cleaning products meet the necessary standards. The researcher verified that the cleaning products used were following these standards, as confirmed through observations. This compliance ensures that the products used in the facilities meet high efficacy standards, regardless of respondents' knowledge of the specifics. The Food Standards Agency (FSA, n.d.) highlights the importance of using cleaning products that meet these standards, particularly in sensitive environments such as old age homes. Residents in these settings often have weaker immune systems, making them more vulnerable to infections. If cleaning products are not properly tested and validated, they may not effectively eliminate harmful pathogens, putting residents' health and safety at risk. The SABS works alongside these international benchmarks to ensure cleaning products meet local requirements, helping maintain hygiene and preventing infections.

4.5.4 Comprehensive temperature management - delivery, storage and post-cooking

Food temperature checks upon delivery

Keeping raw and cooked foods separate is crucial for reducing the risk of harmful bacteria such as *Salmonella*, *Escherichia coli*, and *Listeria*, which can transfer from raw to cooked foods. This practice is essential for preventing serious health problems caused by cross-contamination. Luna-Guevara *et al.* (2019) emphasise the importance of this separation, citing increased foodborne outbreaks linked to raw vegetables, particularly involving *Escherichia coli*. In this study, food handlers reported using designated containers and colour-coded utensils to maintain separation between raw and cooked items, demonstrating adherence to best practices in food safety. Equally important is maintaining proper food temperatures during delivery and storage. Data from this study shows that 60.0% (N=48) of respondents representing 8 out of the 14 old age homes check food temperatures at delivery, while the remaining 6 homes lack proper equipment, as indicated by 40.0% (N=32) of respondents. This gap suggests that some staff may either lack the tools or the knowledge needed for effective temperature monitoring. SANS 10156:2014 (SABS, 2014a) stipulates that frozen foods should be delivered at or below -5°C, and the USDA (2020) adds that keeping meat at or below 5°C

is critical to preventing bacterial growth. In addition to temperature checks, food handlers assess other indicators of food quality during deliveries, including inspecting meat temperature, evaluating food appearance, smell, and texture, checking best-before and expiry dates, and identifying any packaging damage. Karanth *et al.* (2023) note that these sensory checks are crucial for identifying spoilage, while Vasile and Baican (2021) point out that damaged packaging increases contamination risk. Adherence to these checks aligns with South African food safety legislation and contributes to protecting both consumer health and the institution's reputation. Proper training and continuous reinforcement are key to ensuring food handlers understand the significance of temperature monitoring and cross-contamination prevention. The use of clear signage in storage areas supports knowledge retention and helps maintain consistent compliance with hygiene standards.

Chiller and freezer temperatures

Regular temperature checks of chillers and freezers are important not only for maintaining food quality but also as a requirement under the Regulations Governing General Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018) Annexure E (RSA DoH, 2018b). The study found that 10 out of the 14 old age homes (71.3%) had these facilities, showing they are following this requirement in their food safety system, while 4 out of the 14 homes did not have the right equipment to follow proper food safety practices. However, 28.7% (N=23) of participants were unaware of how to conduct these checks, indicating that some homes may need extra training and support to meet food safety standards. Regular temperature checks are necessary to ensure food stays at safe temperatures, preventing spoilage and contamination. Facilities that follow this practice usually have systems to record temperature readings and address any problems if temperatures fall outside the required range, with these practices regularly checked through audits and inspections often conducted by private companies to ensure compliance with regulations. Chillers and freezers are key for storing perishable items, and keeping such items at the correct temperature is crucial for food safety. According to SANS 10156:2014 (SABS, 2014a), chillers and freezers should be kept between 5°C for chillers and -12°C for freezers to prevent bacterial growth and spoilage. Food stored at higher temperatures, especially between 5°C and 65°C, can allow harmful bacteria to grow, leading to food spoilage (Karanth *et al.*, 2023). Perishable foods such as raw meat, dairy, and fish are particularly at risk of bacterial contamination if not stored properly. Maintaining the right temperature, especially below -4°C, prevents harmful bacteria that cause foodborne illnesses, ensuring the food remains safe to eat (SANS 10156:2014) (SABS, 2014a). Routine checks help spot issues with cooling systems early, making it easier to fix problems and avoid equipment breakdowns,

while regular temperature monitoring also ensures compliance with regulations, which helps protect public health.

Defrosting (thawing) of food on the premises

Table 11 shows that all 14 old age homes, representing 100% (N=80) of the respondents, agreed that food is defrosted (thawed) on the premises. This suggests that food handlers regularly carry out this step as part of food preparation. Thawing food at the right temperature (at 5°C or below) helps prevent bacterial growth that can occur if food is defrosted at the wrong temperature (SANS10156:2014) (SABS, 2014a). The USDA (2020) advises that frozen food should not be thawed at room temperature, as this can cause the outer layer of the food to warm up above 5°C, creating a safe environment for harmful bacteria to grow, which can lead to food poisoning. Thawing food in designated areas also helps reduce the risk of cross-contamination by keeping these areas separate from those used for ready-to-eat foods. By controlling food storage temperatures, food handlers ensure that food stays out of the 'danger zone', where bacteria can grow and spoil the food. Following these practices also ensures compliance with food safety regulations, which help reduce the risk of foodborne illnesses. On-site defrosting allows for better monitoring and documentation, which is important for passing food safety audits and inspections.

Preparation of ready to eat foods

Table 11 shows that all study participants from the 14 old age homes, totalling 100% (N=80), reported that they prepare ready to eat foods, indicating a universal practice among the surveyed individuals. This indicates that preparing open foods, such as sandwiches, salads and wraps, is common in old age homes. This common practice emphasises the importance of strict food safety measures to prevent contamination and ensure the safety of these foods. The preparation of food in the kitchen environment should be done safely to prevent harm to the consumers. It should not violate food safety rules and regulations in South Africa. Food handlers need to meet the standards provided by the Regulations Governing the General Hygiene Requirements for Food Premises and the Transport of Food and Related Matters (R638 of 2018) (RSA DoH, 2018b). Because ready to eat foods are being prepared, the regulation has laws that food handlers should follow under Section 11 (Duties of a Food Handler); sub-regulation (1) states that food, a facility or a container shall not be handled by any person -

- Whose fingernails, hands and clothes are not clean,

- Who has not washed their hands thoroughly with soap and water or cleaned them in an effective manner –
 - Immediately prior to the commencement of each work shift,
 - At the beginning of the day's work or after a rest period,
 - After every visit to the latrine or urinal,
 - Every time he or she has blown his or her nose or after his or her hands have been in contact with perspiration or with his or her hair, nose or mouth,
 - After handling a handkerchief, money or a refuse container or refuse,
 - After handling raw vegetables, fruits, eggs, meat or fish and before handling ready-to-use foods,
 - After he or she has smoked or on return to the food premises, or
 - After his or her hands have become contaminated for any other reason.

Therefore, as open food is naturally exposed to kitchen surroundings, it is susceptible to contamination from bacteria and other harmful microorganisms. It is important to handle and prepare it correctly to reduce this risk and prevent foodborne illnesses.

Cooking on the premises

Table 11 provides information on cooking practices at the old age homes, showing that all 14 facilities confirmed cooking is done on-site. It is good to follow safe cooking practices in these kitchens as elderly residents often have weakened immune systems, making them more vulnerable to foodborne illnesses (Thaivalappil *et al.*, 2020). Bintsis *et al.* (2017) also explain that older adults are more at risk of foodborne pathogens like *Vibrio*, *Escherichia coli* O157, Norovirus, *Campylobacter*, *Salmonella* and *Listeria*, which can be found in different types of food. Stein and Chirilă (2017) note that *Escherichia coli* O157 is often found in undercooked ground beef, dairy products and contaminated fruits and vegetables. Norovirus is usually linked to contaminated water and ready-to-eat foods handled by infected people. Facciola *et al.* (2017) mention that *Campylobacter* is commonly found in raw or undercooked poultry, milk and untreated water. *Salmonella* is found in raw or undercooked eggs, poultry, meat and dairy products (Ehuwa *et al.*, 2021), while *Listeria* is often found in dairy products, deli meats, soft cheeses and polony, as seen in the 2017 outbreak (Thomas *et al.*, 2020). These bacteria pose serious health risks, especially for vulnerable groups such as older adults, highlighting the need for safe food handling and thorough cooking to prevent foodborne illnesses (Facciola *et al.*, 2017). By following safe cooking practices, the risk of contamination is reduced, protecting the health of these vulnerable individuals.

Methods for thorough cooking

The study found that all 80 respondents (100%) from the 14 old age homes confirmed they use proper cooking methods, such as boiling, baking, and frying to ensure that food is cooked and reaches safe internal temperatures. This aligns with the Regulations Governing General Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018) (RSA DoH, 2018b), which state that food must reach internal temperatures above 65°C to prevent bacterial growth. Food handlers reported using thermometers to check these temperatures. However, if they were unsure how to use them, they said they cooked food to boiling point as an alternative. These practices are crucial for ensuring the safety of vulnerable groups, such as the elderly, by reducing the risks of undercooking and foodborne illnesses. Following food safety regulations consistently helps build public trust as it shows that food is being prepared safely, which reassures residents and their families. This focus on proper cooking methods supports public health and enhances the reputation of food facilities.

Cooking foods to appropriate temperatures

All 80 respondents (100%) from the 14 old age homes confirmed that they use effective methods to ensure food is cooked thoroughly. These methods include cooking food to temperatures above 65°C, as recommended by food safety guidelines, and preventing cross-contamination between raw and cooked items. Cooking to the correct internal temperature is critical for keeping food out of the 'danger zone' (4°C to 60°C), where bacteria can multiply rapidly. According to the WHO (2006), food should be cooked above 65°C to eliminate harmful microorganisms, and Regulation 8(4) of R638 of 2018 requires that heated food products reach a core temperature above this threshold (RSA DoH, 2018b). This practice is important for killing pathogens such as *Salmonella*, *Escherichia coli*, and *Listeria*, which are known to cause serious foodborne illnesses (Tadini and Gut, 2022). Elbehiry *et al.* (2023) further emphasise that undercooked food can create conditions conducive to bacterial growth. By adhering to these standards, the old age homes not only comply with regulations but also help protect the health of vulnerable elderly residents, ensuring both food safety and quality (Langsrud *et al.*, 2020).

Monitoring and reheating of food on the premises

Regarding the reheating of leftover foods, 83.8% (N=67) of respondents from 12 out of the 14 old age homes reported that they reheat leftovers for elderly residents. Conversely, 16.3% (N=13) of the respondents from 2 old age homes do not reheat leftovers, opting instead to carefully measure portions to avoid leftovers altogether. This practice highlights a clear distinction in the approach to handling leftover food, with most facilities prioritising reheating to ensure food safety. The importance of reheating food to temperatures of 65°C or higher is

well-documented in food safety literature (James *et al.*, 2021). Reheating leftovers to these temperatures is essential to kill any bacteria that may have grown during storage, thereby ensuring the food is safe for consumption. This is particularly critical for vulnerable groups, such as the elderly, who may have weakened immune systems and are at a higher risk of foodborne illnesses. Food safety regulations, including the General Hygiene Requirements for Food Premises, Transport of Food and Related Matters (R638 of 2018) (RSA DoH, 2018b), emphasise the need to reheat leftovers to specific temperatures to comply with health and safety standards.

In terms of equipment, 82.5% (n=66) of the respondents indicated that they check the temperature of reheated food using thermometers, and 12 out of the 14 old age homes reported having the necessary tools for this task. However, the remaining two facilities appeared to lack this equipment, which may compromise their ability to monitor food temperatures accurately, potentially affecting food safety. According to food safety guidelines such as R638 of 2018 (RSA DoH, 2018b) and SANS 10049:2019 (SABS, 2019), controlling food temperatures during reheating is essential to eliminate harmful bacteria and reduce health risks. For reheating, 12 out of the 14 old age homes reported having the means to reheat food, typically using a microwave (Figure 11). For those homes that do not reheat food, meals are carefully portioned to avoid leftovers. Proper reheating not only ensures the destruction of harmful bacteria but also helps preserve the nutritional value and flavour of the food, contributing to a safe and pleasant dining experience for the residents (Gowans, 2023). The FSA (n.d.) further advises that leftover food should be reheated until it is steaming hot to eliminate potential foodborne pathogens.

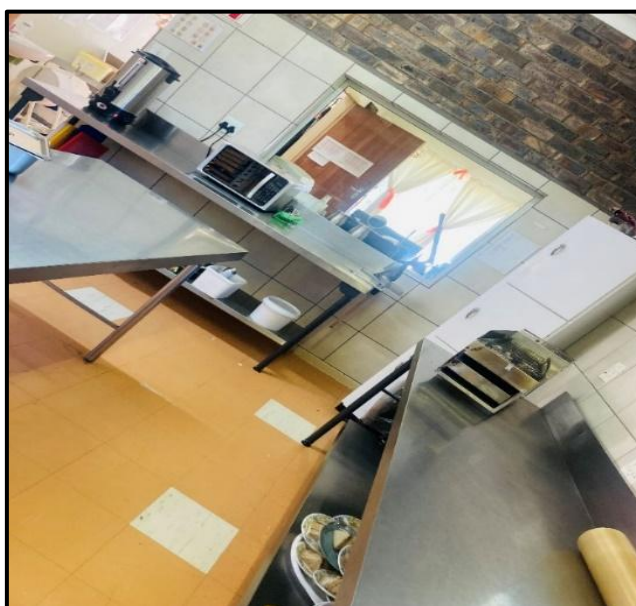


Figure 11: Microwave used for reheating food, positioned on stainless steel countertops in a kitchen that also features metal shelving and storage units.

Cooling methods for food

The questionnaire results show that all participants (N=80 [100%]) from the 14 old age homes confirmed they have methods for cooling food in their facilities. Most participants said they use air circulation to cool food at room temperature, ensuring proper airflow to speed up the process. They also mentioned that they do not leave food out for too long to prevent bacterial growth. This is a good practice, as leaving food at room temperature for extended periods can create conditions that promote bacterial growth. The study by Qiu *et al.* (2022) found that bacteria grow quickly between 4°C and 60°C, so keeping food in this temperature range for too long increases the risk of bacterial contamination, which can lead to foodborne illnesses. Coorey *et al.* (2018) warn that improper cooling can be dangerous to health. Their study notes that cooling food at the right temperature and rate is important to prevent the growth of harmful bacteria. To reduce the risk of bacterial growth, food, especially cooked meats, rice and pasta, should not be kept in the temperature danger zone. Proper and effective cooling methods must be used and monitored.

According to the Regulations Governing General Hygiene Requirements for Food Premises and the Transport of Food (R638 of 2018) (RSA DoH, 2018b) and the SANS 10049:2019 (SABS, 2019), food must be cooled quickly to below 5°C to prevent bacterial growth and ensure safety. Some key strategies are essential to help food handlers consistently follow best food safety practices. Regular training sessions are important to help staff understand and apply proper food safety measures, such as temperature control and cooling methods. Clear, simple standard operating procedures (SOPs) also guide safe food handling. In the facilities visited, more than half (83.8% [N=67]) with food safety management records outsourced training to consulting companies, meaning 12 out of the 14 old age homes had access to these training services. EHPs provided basic training for staff after issuing a CoA and conditional CoAs to facilities that needed to address non-compliance issues. This basic training mainly covered hygiene practices and regulatory requirements but may not have been detailed enough for all food safety situations. As a result, many facilities sought additional training from external consultants to improve staff knowledge and adherence to more advanced food safety standards. Routine inspections and audits by EHPs help ensure compliance, confirming that food is stored and reheated at the correct temperatures. Keeping detailed records of training and procedures also adds accountability.

4.5.5 Preventing contamination through adequate food separation and display practices

Adequate separation of raw and cooked foods

Preventing cross-contamination and foodborne illnesses requires properly separating raw and cooked foods. In this study, all 80 respondents (100%) from 14 old age homes confirmed their commitment to this practice, showing their dedication to safe food preparation. To ensure this is consistently followed, facilities have established food safety systems that include specific rules for temperature checks and food safety, such as how to check temperatures and keep records. Regular internal audits by private companies ensure these systems are being followed, verifying that temperature checks are done correctly, and records are up to date. Expert assessments help ensure compliance with food safety standards and all temperature checks, and any corrective actions are regularly reviewed to maintain high standards. This approach, supported by external audits, helps keep food safety and quality high, protecting the health of elderly residents. In addition to temperature control, keeping raw and cooked foods separate is crucial for reducing the risk of harmful bacteria such as *Salmonella*, *Escherichia coli* and *Listeria*, which can transfer from raw to cooked foods. This practice is important for preventing serious health problems caused by cross-contamination. A study by Luna-Guevara *et al.* (2019) highlights the importance of this separation, noting an increase in foodborne outbreaks linked to raw vegetables, especially involving *Escherichia coli*. Contamination can happen at various stages, from pre- to post-harvest, and can come from sources such as manure, soil, sewage, surface water and wildlife (Luna-Guevara *et al.*, 2019). Improper handling during washing, slicing, soaking, packing and food preparation can also increase the risk. Therefore, following proper separation practices and careful monitoring are essential parts of a strong food safety system. Maintaining separation not only protects consumer health but also helps preserve the quality of meals. This practice follows regulatory guidelines and food safety standards, ensuring that facilities meet health and sanitation requirements. According to the WHO's five keys to safer foods (WHO, 2006), keeping raw and cooked foods separate is a key food safety practice, as shown by the survey results where 100% of respondents confirmed their commitment to this principle. This separation is good for preventing cross-contamination, especially when harmful bacteria from raw foods, particularly meats, come into contact with cooked foods, which can lead to foodborne illnesses. Keeping raw and cooked foods separate also helps maintain the quality of meals by preventing damage to their texture, flavour and overall quality from contaminants in raw foods.

Risk of contamination of foods on display prevention

Less than half of the respondents (N=36 [45%]) from 6 out of the 14 old age homes reported that they take steps to prevent contamination of foods displayed for serving. On the other hand, 7 out of the 14 old age homes do not follow this practice, as most respondents (N=44 [55%]) indicated that they do not display their foods. Instead, they prepare measured amounts of food for consumption within a day and night. One method to prevent contamination of displayed food is covering it with sterile plastics or food-grade wraps to protect it from airborne particles, dust or insects (Alamri *et al.*, 2021). Ensuring strict hygiene practices among food handlers is also crucial to avoid contamination, particularly when food is frequently handled during service. Food handlers should wash their hands regularly, use gloves when necessary and use clean utensils to reduce the risk of introducing contaminants (Putri and Susanna, 2021). These practices are part of the Standards and Requirements for Display, Storage and Temperature of Food under Section 8, of the FDC Act 54 of 1972 (RSA DoH, 1972) which states that -

- Food that is displayed or stored shall not be in direct contact with the floor or any ground surface.
- Any shelf or display case used for displaying or storing food or any container shall be kept clean and free from dust or any other impurity.
- Non-prepacked, ready-to-consume food, including foods that are served as meals and displayed in an open container, shall be protected in accordance with the best available method against droplet contamination or contamination by insects or dust.

Therefore, implementing these measures not only ensures compliance with food safety regulations but also serves to protect the health and well-being of consumers, thereby enhancing trust and confidence in the establishment.

4.5.6 Facility infrastructure and maintenance standards

Food preparation area surfaces construction and cleaning

Table 11 shows that out of 60 responses, 75% (11 homes) reported that their kitchen surfaces are well-constructed and easy to clean. However, 25% (3 homes) stated that their food surfaces do not meet these standards. This suggests that these homes may have received a conditional CoA, allowing them to continue operating while they address issues identified during inspections. As old age homes are inspected only twice a year, it can be challenging to ensure ongoing compliance with food safety regulations. Any issues missed during the first inspection may not be resolved before the second inspection. The study found no records of when the second inspections took place for any of the 14 old age homes, with only the first

inspections documented. This lack of information makes it hard to address problems in a timely manner and it is unclear whether these homes had enough time to fix the issues before the follow-up inspection. The role of EHPs is key in these situations as they must ensure that homes meet food safety standards during the limited inspections. If the second inspection does not resolve problems, the CoA could be revoked, and the home may be forced to stop operating. This means the limited frequency of inspections and unclear timing add pressure on both the homes and EHPs to fix any issues quickly to protect public health. According to Section 6(1) of the Standards and Requirements for Facilities on Food Premises, all surfaces that come into contact with food must be made of smooth, rust-proof, non-toxic and non-absorbent materials without open joints or seams (RSA DoH, 2018b). Wooden chopping blocks, cutting boards and utensils are allowed if they are kept in good condition and do not accumulate dirt. Food surfaces are essential in any kitchen as they directly affect the safety of the food being prepared. The ease of cleaning these surfaces is crucial for maintaining cleanliness and preventing contamination. If surfaces are hard to clean, bacteria from previous food can remain, which may then contaminate other foods and cause food poisoning.

Satisfactory lighting and ventilation

As shown in Table 11, all 80 respondents (100%) from the 14 old age homes reported being fully satisfied with the lighting and ventilation in their workplace. Good lighting and ventilation are important for creating a safe and comfortable kitchen. Bright lighting helps food handlers notice potential dangers, such as slippery floors or sharp objects, which reduces the chance of accidents or injuries. Good ventilation keeps the kitchen from becoming too hot or humid, which can lead to dizziness or overheating. It also helps to clear out cooking smells and other odours that could make people feel unwell, making it easier to keep the kitchen clean. The Standards and Requirements for Food Premises, outlined in Section 5, sub-regulation 3 of the Regulations Governing the General Hygiene Requirements for Food Premises and the Transport of Food and Related Matters (R638 of 2018), promulgated under the FDC Act 54 of 1972, specify strict requirements for ventilation and illumination in food premises. According to the regulations:

Ventilation requirements:

- Each area of a food premises must be effectively ventilated by either:
 - Natural ventilation through openings or openable sections directly connected to the outside air.
 - These openings must be positioned in external walls or the roof to allow cross-ventilation.

- The total surface area of these openings must be at least 5% of the floor area of the room concerned.
- Alternatively, artificial ventilation may be used if it complies with the National Building Regulations and Standards Act 103 of 1977.
- The chosen ventilation system must:
 - Provide adequate fresh air.
 - Effectively remove polluted or stale air, including gases, vapours, steam, and warm air generated during food handling.
 - Prevent the emergence of any unhygienic or unhealthy conditions in the food handling area.

Illumination requirements:

- Illumination must be provided by either:
 - Unobstructed transparent surfaces in external walls or roofs admitting daylight equal to at least 10% of the floor area; or
 - Artificial lighting compliant with the National Building Regulations and Building Standards Act 103 of 1977.
- Artificial illumination must ensure:
 - A minimum illumination strength of 200 lux on all food handling surfaces.

Additionally, the Environmental Regulations for Workplaces 2281 of 1987, promulgated under the Occupational Health and Safety Act 85 of 1993, reinforce these requirements. Section 3 of the Act states that:

Section 3(1): Lighting

- Every workplace must be illuminated according to the specified illuminance values.
- Employers must provide specialised lighting where necessary for tasks, regardless of whether the task is listed in the regulation schedule.

Section 4(1): Windows and Visual Contact

- Rooms smaller than 100 square metres, where employees spend most of their shift, must be equipped with windows that allow visual contact with the outside environment.
- The total glazed area of the windows must be at least three-fifths of the square root of the room's floor area (both measured in square metres).
- Windowsills must not be higher, and window heads must not be lower than one and a half metres above the floor level.

- All windows must be glazed with transparent material.

Section 5(1): Ventilation

- Workplaces must be ventilated by natural or mechanical means to ensure that the air employees breathe does not endanger their safety or health.
- The time-weighted average concentration of carbon dioxide over an eight-hour period must not exceed 0.5 percent by volume.
- Carbon dioxide levels must never exceed 3 percent by volume at any time.
- Exposure to airborne substances must remain within the prescribed exposure limits.
- The concentration of explosive or flammable gases, vapours, or dust must not exceed the lower explosive limit of the respective substance.

These regulations collectively highlight the importance of providing food handlers with a safe and comfortable working environment to ensure hygienic practices and operational efficiency.

Maintenance and repairs personnel on-site

Observing the 14 old age homes, 81.3% (11 homes) reported having maintenance and repair staff on-site. On the other hand, 18.8% (3 homes) stated that they do not have on-site maintenance staff and instead depend on outside contractors. This suggests that homes with on-site maintenance staff can handle issues more quickly, showing the benefits of having dedicated personnel to address problems right away. This approach reflects a financial commitment to maintenance, either by hiring staff or budgeting for outside help when needed. However, some old age homes lack the funds to provide immediate assistance. In these cases, they may depend on external contractors, which could lead to delays in repairs and potential ongoing issues. Having maintenance staff on-site is important for smooth facility operations. Their immediate availability allows for fast responses to problems, reducing disruptions. They can also perform regular checks and preventive maintenance, catching issues before they worsen. Additionally, having on-site maintenance staff may save money eventually, as they can handle routine tasks and minor repairs without the need for costly emergency services. Overall, on-site maintenance staff are crucial for ensuring the safety, functionality and efficiency of the facilities and equipment.

Pest control management

The Occupational Health and Safety Act 85 of 1993 classifies pesticides as hazardous chemicals, which must be applied by a registered pest control operator (RSA, 1993a). It mandates that all food facilities, restaurants, kitchens, and other places involved with food or

drinks undergo pest control treatments monthly. In contrast, other facilities are required to have pest control every three months. Additionally, pest control in areas accessible to the public or staff must be carried out by a registered pest control operator (RSA, 1993a). Pest control is critical for preventing food contamination by pests such as rodents, insects, and birds, which can carry harmful bacteria and pathogens. Many of the respondents (N=67 [83.8%]) from 12 out of the 14 old age homes reported having pest control measures in place, with most indicating that they use professional pest control companies. In contrast, 16.3% (N=13) of respondents from two old age homes reported not having pest control measures in place. The use of professional pest control services is generally more effective than managing infestations independently, as these companies have the expertise and equipment to address pest problems safely and thoroughly.

The Agricultural Pests Act 36 of 1983 provides guidelines for controlling agricultural pests, prescribing control measures that must be complied with by land users (RSA, 1983). These measures include the destruction of infected plants, combating pathogens, and preventing the spread of insects or exotic animals. Section 6(1) of the Act under Prescribing of Control Measures states that the Minister may, by notice in the Gazette, prescribe control measures that a user of land must carry out. These measures are intended to prevent and combat the spread of pathogens, insects, and exotic animals. They can include actions such as the destruction of plants, cleansing infected materials, or the removal of pests from specified areas. Bintsis (2017) highlights the dangers of not having pest control systems in place, noting that pests can spread harmful bacteria, leading to serious foodborne illnesses. This situation not only poses a health risk but also leads to legal issues, with non-compliance to the National Health Act 61 of 2003, which mandates pest control in all food facilities (RSA DoH, 2003). Pests can contaminate food, causing harm to consumer health and damaging food quality. Furthermore, pests can cause structural damage to buildings and equipment, leading to costly repairs. Professional pest control companies are not only equipped with the necessary expertise and tools but also follow strict safety protocols to minimise risks to human health and the environment. Their trained technicians are skilled in identifying the causes of infestations and implementing effective solutions that reduce risks to residents while eradicating pests. Many of these companies also offer follow-up inspections and preventive measures to ensure long-term pest management. By maintaining effective pest control systems, food facilities can reduce the risk of foodborne illnesses, protect the integrity of food production and storage areas, and comply with food safety regulations. Furthermore, pest control helps preserve property and food supplies, enhances the reputation of the premises, and fosters trust among consumers and regulatory bodies.

Formal pest control contract

The previous section explains why pest control is crucial in food safety facilities. According to Pakdel *et al.* (2023), pest control helps prevent various types of contamination; physical, biological and chemical. For example, physical contamination includes hair, excrement and pest body parts. Biological contamination happens when pests carry harmful pathogens such as *Salmonella*, *Escherichia coli*, *Listeria*, as well as viruses and parasites that lead to serious foodborne illnesses. Chemical contamination can occur due to improper use of pesticides, spread of cleaning agents or toxins from certain pests. As shown in Table 11 and noted by the current study researcher, 83.8% (N=67) of respondents confirmed that they have pest control measures, meaning 12 out of the 14 old age homes have these in place. In contrast, 16.3% (N=13) of respondents, representing 2 out of the 14 old age homes, reported they do not have pest control measures. Pest control is also important for meeting food safety regulations set by the FDA, USDA and local health departments. Following these regulations helps avoid fines, closures or legal actions. Additionally, effective pest control is part of HACCP, which is a systematic approach to food safety.

Facilities for storage and disposal of refuse

Proper storage and disposal of waste in old age homes are essential to protect the health, safety and well-being of elderly residents. These facilities are crucial for maintaining cleanliness and hygiene, especially important for residents with weaker immune systems or health conditions. Effective waste management reduces infection risks, creating a safer environment. As shown in Table 11, 78.8% (N=63) of respondents from 11 old age homes reported having storage and disposal systems for waste at their facilities. However, 21.3% (N=17) of the three homes indicated they do not have formal systems in place, pointing to a gap between perceived and actual compliance with proper waste management. Although many facilities believe they have adequate systems, the lack of formal procedures suggests that not all meet the required standards. This finding aligns with the checklist review, confirming that while most homes have waste management systems, some still lack structured procedures. A reliable system for storing and disposing of waste is key to maintaining cleanliness, health and safety in old age homes. Proper waste management ensures that trash and other waste materials are handled safely, reducing risks of contamination, disease and pests. In environments with residents who may be more vulnerable, prioritising waste storage and disposal helps create a clean, healthy and supportive space, enhancing residents' overall health and quality of life.

Facilities for storage and disposal of waste oil

Based on observations, 11 out of the 14 old age homes and 78.8% of the interviewed respondents (N=63) confirmed the availability of convenient facilities for the storage and disposal of waste oil by answering 'Yes'. Additionally, 17 respondents (21.3%) from three of the old age homes indicated 'No', suggesting that these homes may lack proper facilities for storing or disposing of their waste oil. The table provides an overview of how well the surveyed facilities are following safe practices for managing waste cooking oil. Proper disposal of waste oil is crucial for several reasons. It helps prevent soil and water pollution, which can harm the environment, wildlife and plants. According to Alengebawy *et al.* (2021), safe disposal also protects human health by reducing the risk of harmful substances, such as heavy metals and toxic chemicals, contaminating drinking water, food or soil. As cooking oil is flammable, disposing of waste oil correctly also reduces the chance of fires and accidents. Proper waste oil management is essential to maintain community health standards because improper disposal can lead to unpleasant odours, attract pests and create unhealthy living conditions. Some laws require facilities such as old age homes to follow safe practices for the handling and disposal of hazardous waste such as used cooking oil.

In South Africa, the National Environmental Management: Waste Act 59 of 2008 is the primary legislation that governs the management, storage and disposal of waste (RSA, 2008). This Act provides a framework for managing waste sustainably to reduce its impact and ensure safe disposal, protecting both human health and the environment. The Waste Act 59 of 2008 requires waste management planning, licensing and waste classification and sets out responsibilities for waste generators, transporters and disposal facilities. It promotes the waste hierarchy, prioritising prevention, minimisation, reuse, recycling, recovery and safe disposal. Specific regulations under the Waste Act 59 of 2008 also address waste management in various settings, including healthcare facilities, residential areas and institutions such as old age homes, to ensure waste is managed safely across the country and to protect public health and the environment.

4.5.7 Qualitative analysis based on questionnaire results

In the current study, some information could not be presented in tables because detailed explanations were needed; therefore, it was reported as qualitative data.

Food suppliers

Each old age home used two or more reliable suppliers, including well-known names such as Econo Foods, Roots Butchery and Bid Foods. Reliable food suppliers are essential because

they help ensure a steady and safe supply of food, which is important for the health and well-being of residents in sensitive settings such as old age homes. These suppliers generally follow strict quality standards, which greatly reduces the risk of foodborne illnesses. Additionally, having dependable suppliers makes it easier to trace and address any sources of food poisoning or disease if an outbreak occurs, allowing for a quicker and more effective response. The Agricultural Standards Act 119 of 1990, Section 3, governs the sale of products, setting out the required product classes or grades and the quality standards they must meet for safe consumption (RSA, 1990). Section 3 specifies that:

The Minister may-

(a) Prohibit the sale of a prescribed product -

- (i) Unless that product is sold according to the prescribed class or grade,
- (ii) Unless that product complies with the prescribed standards regarding the quality thereof, or a class or grade thereof,
- (iii) Unless the prescribed requirements in connection with the packing, marking, and labelling of that product are complied with,
- (iv) If that product contains a prescribed prohibited substance or does not contain a prescribed substance; and
- (v) Unless that product is packed, marked, and labelled in the prescribed manner or with the prescribed particulars.

How will the food be protected from contamination during storage?

A total of 80% (N=64) of food handlers from 11 out of the 14 old age homes understand the importance of keeping food safe by storing it on raised surfaces or shelves rather than on the floor. This prevents contact with potentially dirty surfaces, such as floors where bacteria may be present. In contrast, 20% (N=16) of food handlers from three old age homes reported placing food wherever there was space, ignoring hygiene and safety guidelines. Additionally, 80% (N=64) of participants from the 11 old age homes stressed the need to keep raw and cooked foods separate to avoid cross-contamination. Many food handlers also mentioned covering open or displayed food with lids or plastic wrap to protect it from dust and droplets, reducing the risk of harmful bacteria. They are also careful to avoid splashes from cleaning water, which could carry detergent or other contaminants. By following these practices, food handlers aim to keep food safe and uncontaminated, thereby protecting consumer health. These steps not only uphold food safety standards but also help prevent foodborne illnesses and build public trust in the safety of the food provided.

Methods for cooling food

According to the USDA (2020), the temperature danger zone, where bacteria can multiply rapidly, ranges from 4°C to 60°C, and if hot food is placed directly into a warmer without proper cooling, it might not cool down quickly enough, allowing harmful bacteria to grow by remaining too long within this range. Therefore, to prevent bacterial growth and minimise the risk of foodborne illnesses, food must be cooled within two hours before being placed in the chiller room. Most food handlers reported that they follow all safety procedures and cool food properly before transferring it to the chillers, ensuring the temperature of hot food is brought down to below 4°C within the safe time frame, thus minimising the time food spends in the danger zone. Furthermore, Regulation 8(4) under the Regulations Governing General Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018) (RSA DoH, 2018b) states that cooked foods should be kept under safe temperature conditions that do not favour bacterial growth, recommending 65°C or above. The results from food handlers indicate compliance with these legislative recommendations, demonstrating their commitment to maintaining the safety and well-being of residents during food preparation.

Additional insights from study respondents on old age home kitchens not covered in the questionnaire

Personal protective clothing

Depending on the nature of handling high-risk, high-care or ambient temperature, applicable PPE can range from wearing hairnets, beard nets, disposable gloves, sleeves and aprons to other suitable personal protective clothing. The facility should determine which personal protective clothing is most suitable based on the nature of the process, the risk of product contamination and the impact of the food handling process on the food handler. The standard and requirements for protective clothing as per Regulations Governing General Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018) under Section 9(1) states:

9(1) A person may not handle or be allowed to handle food without wearing suitable protective clothing as specified in sub-regulation (2).

9(2) The protective clothing, including head and other coverings and footwear, of a person handling food that is not packed must:

(a) Be clean and neat when the person begins to handle the food,

(b) at all times during the handling of the food, be in such a clean condition and be of such design and material that it cannot contaminate the food.

Preferably, PPE should be of a bright colour to ensure it can be easily spotted when soiled or dirty, as unhygienic PPE can potentially contaminate food products with harmful bacteria, rendering food unsafe for consumption. PPE must not have buttons above the waist, since buttons may fall into food as physical hazards, and should not have exposed zippers because food residue can stick in between, leading to microbial contamination. Based on this, most respondents (N=67 [83.8%]) from 12 out of 14 old age homes expressed concern about not being provided with proper PPE, with most food handlers wearing their personal clothes and only an apron as PPE. This situation creates a health hazard for residents because food handlers cook while wearing the same clothes they arrived in. In the food industry, PPE mainly serves to keep food safe from contamination by the person handling it, and it is crucial that this clothing stays clean and is only worn inside the food handling area. Improper use of PPE can lead to food contamination, causing illness or injury to consumers. PPE helps keep food clean and protects both food and people from foodborne illnesses; therefore, before starting their shift, food handlers should put on clean protective clothing and wash their hands thoroughly. Wearing personal clothes instead of designated protective clothing in food preparation poses several health hazards, as personal clothes can carry contaminants from outside the kitchen, including dirt, bacteria, and allergens that may transfer to food during preparation. This increases the risk of cross-contamination between raw and cooked foods, surfaces, and equipment, potentially leading to foodborne illnesses. Additionally, personal clothes are often not as clean as regularly washed and sanitised protective clothing, introducing harmful microorganisms into the food preparation area, and may also introduce physical hazards such as loose fibres, hair, or debris, which can fall into food and pose risks to consumers.

When was the food safety management system last reviewed?

Ensuring that all facilities implement and maintain strict food safety management systems is crucial for upholding high standards and protecting elderly health. During her visits, the researcher observed that all 14 old age homes (100%) had a food safety management system in place; however, only 9 of these systems were reviewed and updated by external contractors in 2022, while 5 homes did not prioritize this important aspect. Although this represents a small fraction, addressing this gap is vital as it can significantly impact food safety and hygiene practices. Having the food safety management system reviewed is essential because it ensures compliance with regulatory standards and food industry norms, thereby guaranteeing the maintenance of food safety standards (RSA DoH, 2018b; SABS, 2014a; CAC/RCP 1-

1969, 2003). Additionally, these reviews act as a critical quality assurance mechanism to identify weaknesses or deficiencies within the system, such as gaps in procedures or staff training, allowing for prompt corrective actions. Regular reviews also facilitate ongoing improvement by highlighting areas for enhancement and implementing necessary adjustments to strengthen food safety practices. Furthermore, the review process aids in assessing and mitigating risks associated with food handling, minimizing the potential for foodborne illnesses. Lastly, committing to regular review and improvement of the food safety management system enhances consumer confidence in the safety and quality of the products or services provided.

Details of the equipment used in connection with the premises

The equipment commonly used in connection with the premises includes microwaves, gas stoves, food processors, chest freezers, food warmers and chiller rooms, the most noted pieces of equipment. Collectively, these pieces of equipment contribute to safe food handling, storage and preparation practices.

Where will cleaning materials/chemicals be stored on the premises

Many respondents (N=63 [78.8%]) from 11 out of the 14 old age homes reported storing their cleaning materials in the storeroom, which aligns with their use of cleaning schedules for the facilities. In contrast, respondents from three old age homes (N=17 [21.3%]) indicated a lack of a dedicated storage room and instead stored cleaning chemicals in the kitchen, following practices similar to those used in their own homes. While insufficient storage space for cleaning chemicals may pose challenges, it does not necessarily prevent old age homes from developing cleaning schedules; however, the absence of adequate cleaning chemicals could contribute to the lack of established schedules. Since many cleaning chemicals are hazardous and can pose health risks if ingested or if they come into contact with food, storing them separately reduces the likelihood of accidental exposure and ensures the safety of food handlers and consumers. It is therefore essential to store cleaning chemicals separately from food and in designated storage areas to help prevent contamination. Rather *et al.* (2017) indicate that contact between cleaning chemicals and food or food preparation surfaces can introduce harmful substances, potentially leading to poisoning or intoxication. Moreover, chemical contamination poses serious health risks, often causing gastrointestinal problems and potentially fatal conditions affecting the liver, kidneys, and brain, making it important to address these hazards to ensure community well-being. Separating cleaning chemicals from food storage and preparation areas is typically mandated by food safety regulations (RSA DoH, 2018b; SABS, 2014a; CAC/RCP 1-1969, 2003), so adherence to these regulations is

important for compliance and maintaining a safe working environment. From a facility standpoint, storing cleaning chemicals in designated areas improves efficiency by making it easier for staff to locate and access them when needed, thereby reducing the risk of confusion and accidental spills.

Cleaning chemical details

Many of the respondents noted that they usually use bleach, Biocide, SuperKleen Multipurpose Cleaner, Ultimate Hygx Concentrate Alcohol-Free Disinfectant, Sunlight Liquid, Handy Andy, Pine Gel and washing powder to clean the kitchen area in their old age home premises. The products mentioned are suitable for cleaning kitchen areas in old age homes as they address a variety of cleaning tasks, from disinfecting to removing grease and grime. However, it is important to follow each product's instructions and safety guidelines to ensure cleaning is both effective and safe.

Do the cleaning products conform to the BS EN 1276, BS EN 13697 and SABS standards

To determine whether these products conform to the BS EN 1276 and BS EN 13697 standards, it is necessary to review the product specifications or contact the manufacturers directly. BS EN 1276 is a European standard for the bactericidal activity of chemical disinfectants, ensuring their effectiveness against bacteria, while BS EN 13697 pertains to the performance of surface disinfectants in real-life conditions, assessing their efficacy in food, industrial, domestic, and institutional environments. In addition to these European standards, products are also required to meet SABS (2019) requirements. SABS standards (SANS 14045:2014) align closely with international benchmarks and provide guidelines to ensure that cleaning products meet rigorous safety and performance criteria (SABS, 2014b). Bleach and multipurpose cleaners often conform to these standards, particularly those designed for disinfecting purposes, and this compliance ensures that such products are effective against a broad spectrum of microorganisms and safe for use in various environments, including food preparation settings, thereby maintaining high hygiene and safety standards. The researcher observed that all 14 (100%) old age homes used products that met these standards, although compliance was not necessarily required from the food handlers.

4.5.8 Food safety checklist

The study employed a detailed food safety checklist to assess the compliance of 14 old age homes with the Regulations Governing General Hygiene Requirements for Food Premises, Transport of Food and Related Matters (R638 of 2018) (RSA DoH, 2018b), evaluating practices in areas such as personal hygiene, food storage, preparation, equipment

maintenance, and waste management. Compliance scores ranged from 1% to 100%, with higher scores indicating better adherence to the prescribed standards, while scores below 50% highlighted areas needing improvement. This checklist, supplemented with observational and interview data, provided a reliable analysis of actual practices, addressing potential discrepancies between self-reported practices and observed behaviours. The results were then categorised into different compliance levels across various domains (Table 12).

Table 12: Compliance levels across key food safety domains

Domain	Compliance level (%)	Observations
Policy Arrangements	100	All facilities registered food premises and documented policies effectively.
Personal Hygiene	60	Gaps noted in handwashing compliance and adherence to clothing and hair restraint standards.
Food preparation	80-100	High compliance in thawing and utensil use, but moderate adherence to temperature documentation.
Refrigeration practices	60-100	Cleanliness of refrigerators was suboptimal, despite maintaining recommended temperatures.
Food storage	60-80	Proper food storage off the ground was common, but contamination prevention required improvement.
Utensils & equipment cleaning	50-80	Thermometer cleaning between uses was notably low, raising contamination concerns.
Dishwashing & waste management	60-90	Waste storage cleanliness and pest control presented challenges in some facilities.

Following Table 12, compliance varied across different food safety domains. Personal hygiene showed mixed results, with 60% of food handlers adhering to clothing and hair restraint standards but only 20% demonstrating proper handwashing practices, highlighting the need for targeted interventions to improve hygiene behaviours. Food preparation practices were strong in some areas, with 100% compliance observed for thawing frozen foods and the use of suitable utensils; however, documenting cooking temperatures using clean thermometers was slightly lower at 80%, indicating room for better monitoring. Refrigeration and freezer practices reflected consistent maintenance of recommended temperatures (100% compliance), yet only 60% of facilities adhered to cleanliness and contamination prevention standards, raising concerns about neglected cleaning that poses significant cross-contamination risks despite adequate temperature control. Food storage was generally adequate, with 80% of facilities storing food off the ground, but only 60% ensured the use of

food-grade containers and sufficient contamination prevention measures, emphasizing the need for stricter guideline adherence.

Utensils and equipment maintenance showed 80% compliance in cleaning and sanitising, but only 50% of facilities cleaned thermometers between uses, presenting potential contamination risks during temperature monitoring. Dishwashing practices were largely compliant (90%) regarding proper sink setup and water temperature; however, waste storage and pest control revealed gaps, as only 60% of facilities maintained clean waste cans and effectively prevented pest activity, raising hygiene concerns. Overall, these findings underscore the importance of continuous improvement in specific food safety areas. While adherence to documentation and policy communication was commendable, lapses in personal hygiene, equipment cleanliness, and storage practices suggest deficiencies in training, supervision, and accountability, with particular concern over refrigerator cleanliness potentially enabling cross-contamination despite proper temperature monitoring. This comprehensive overview provided by Table 12 allows for a clear identification of strengths and weaknesses across key food safety areas, guiding targeted interventions to enhance compliance and ultimately safeguard the health of residents in old age homes.

4.6 Conclusion

Through the comprehensive analysis of food safety management practices in old age homes, several key compliance issues were identified. Despite the presence of food safety policies in most facilities, evidence of non-compliance highlights gaps in practice, suggesting potential issues in the implementation and enforcement of these policies; having policies in place alone is not enough. Deficiencies in application or adherence may stem from inadequate communication, insufficient training, or a lack of emphasis on creating a strong food safety culture. Although communication through meetings and training was reported, the effectiveness of these methods may be undermined because staff responsible for food safety often have multiple roles, where food safety is only one of several key performance areas (KPA's), leading to lapses in enforcement. This indicates the need for clearer role definitions and stronger prioritisation of food safety within staff responsibilities. Additionally, integrating food safety culture theories, which examine how organisational culture shapes food safety behaviours and practices, could provide valuable insights into compliance challenges and opportunities for improvement; this approach is further explored in Chapter 5. Generally, while food safety policies exist, addressing non-compliance requires a multifaceted approach including enhanced communication, more frequent training, and applying food safety culture theories. These findings can guide researchers in advising old age homes on improving their practices and compliance with standards. Furthermore, it is crucial to evaluate existing records

such as pest control contracts, cleaning schedules, and external audit reports, which are essential components of an effective food safety management system. Assessing the effectiveness and completeness of these control measures is a vital aspect of risk management and is necessary to determine whether missing or inadequately maintained records contributed to non-compliance. By implementing and regularly reviewing these measures, food safety practices can be more effectively executed and sustained, thereby protecting the health and well-being of residents and ensuring regulatory compliance.

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CHAPTER 5

FRAMEWORK TO REDUCE SURFACE CONTAMINATION AND INCREASE FOOD SAFETY KNOWLEDGE IN OLD AGE HOMES

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5.1 Abstract

This research study looks at important food safety practices in old age homes in South Africa and how these practices follow national legislation. As elderly residents are more likely to get sick from foodborne illnesses, it is important to ensure that effective food safety measures are in place. The framework developed in this study highlights key areas of food safety, such as personal hygiene, safe food handling and preparation, cleaning and sanitising and regular monitoring. These practices comply with the South African National Health Act 61 of 2003, and the Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972 and create a safe environment for food handling. To propose a framework that responds to the context of old age homes, the study used food safety theories, findings from a questionnaire and a food safety checklist and assessment of alignment with legislations and regulations at the old age homes of the Mangaung Metropolitan and Lejweleputswa District Municipalities. The results in Chapter 4 indicated that while many facilities have a good understanding of food safety standards, there were gaps in the application of these practices, particularly concerning personal hygiene and monitoring. Of the 14 old age homes, nine (66.67%) complied with the questionnaire and food safety checklists, while five (34.88%) did not meet the required food safety regulation standards. These findings reveal the need for consistent training programmes, regular inspections, clear communication of food safety policies and the development of a context-based framework. Developing a strong food safety framework is important for protecting the health of elderly residents and meeting food hygiene and safety legislation. This framework will help prevent foodborne illnesses and encourage a culture of safety in old age homes. By following these guidelines, facilities can improve their food safety standards, promoting the well-being of residents. Regular training and clear communication about food safety policies are important. Focusing on food safety and ensuring that they receive safe meals will create a healthier living environment for elderly individuals and improve their quality of life.

Keywords: Food safety practices, food safety theories, old age homes, hygiene practices, food safety compliance

5.2 Introduction

The ageing population in South Africa, like many other nations, faces unique challenges, particularly in maintaining health and well-being in institutional settings such as old age homes (Solanki *et al.*, 2019). Among these challenges, ensuring food safety practices stands as a critical concern, as food safety in such settings remains vulnerable due to various factors contributing to foodborne illnesses and contamination risks. Despite advancements in technology, regulations, and awareness campaigns, several challenges persist (Fekadu *et al.*,

2024), notably the complexity of the global food supply chain, which involves multiple stages from production to consumption, thereby increasing potential points of contamination. Additionally, human error, including improper handling, storage, and preparation of food, continues to contribute to foodborne outbreaks. Thus, according to Lee *et al.* (2021), addressing food safety concerns demands a multifaceted approach involving collaboration among stakeholders across the food industry, policymakers, regulatory agencies, and consumers to implement and enforce robust food safety practices effectively. To understand the behaviours driving food safety practices, different theories and models have been designed to explore the interaction between food safety knowledge and food handlers' practices (Putri and Susanna, 2021). The theories selected for this study include the Social Cognitive Theory (SCT), the Socio-Ecological Model (SEM), and the Knowledge, Attitude, and Practice (KAP) model.

5.2.1 Rationale for development

The decision to develop a framework aimed at enhancing food safety practices in old age homes was driven by a recognition of the urgent need for improvement. This urgency became apparent upon reviewing the results of microbial analysis conducted on food preparation surfaces within the study's sampled areas. The findings revealed concerning levels of contamination, which highlight the potential risks to food safety within these environments. Additionally, the feedback collected from the study participants through questionnaire analysis further underscored the necessity for enhancement, shedding light on existing challenges and concerns. Research by Awuchi (2023), Elbehiry *et al.* (2023) and Farber *et al.* (2021) highlights the urgent need for action. Their findings show that elderly people are at a higher risk of foodborne illnesses due to age-related changes in their immune systems and pre-existing health conditions that make them more vulnerable. Their studies also stress that inadequate hygiene protocols and surface contamination in institutional settings increase these risks, posing serious threats to the health and safety of elderly residents.

The findings from the current study's questionnaire evaluation chapter reveal that the challenges extend beyond surface contamination. Issues such as inadequate hand hygiene practices, improper food storage and handling, ineffective pest control and insufficient staff training also contribute to the overall risk. Therefore, addressing these various aspects of food safety is important for creating a comprehensive approach to protecting the health of elderly residents. Any action plan must incorporate strategies that tackle not only surface contamination but also the other critical areas identified in the questionnaire survey. This holistic approach will ensure meaningful improvements in food safety and hygiene practices. Given the identified challenges and the need for a comprehensive approach to food safety in

old age homes, it is important to understand the behaviours and factors that influence food safety practices. Several theoretical frameworks can help guide this understanding and inform effective interventions. Theories, such as the SCT, SEM and KAP model, are well-suited to analysing the factors that impact food safety behaviours among food handlers.

5.2.2 Social cognitive theory

The SCT, developed by Albert Bandura in the 1970s, was created to address the limitations of behaviourism and other psychological theories that failed to explain human behaviour fully. Bandura's theory integrates cognitive, behavioural and environmental factors to offer a more comprehensive understanding of how people learn and develop (Bandura, 1977). One of the key reasons behind the development of the SCT was Bandura's observation that behaviourist theories, which focused primarily on observable behaviours and stimulus-response mechanisms, could not adequately explain complex human processes such as decision-making, self-regulation and goal setting (Bandura, 1986). The SCT suggests that humans are active agents in their own learning, capable of processing information, making choices and exercising control over their actions (Figure 12). Bandura emphasised that cognitive processes such as attention, memory and motivation are necessary in shaping behaviour. At the core of the SCT is the concept of observational learning, where individuals acquire new behaviours and attitudes by observing others without necessarily having to perform the behaviour themselves. People learn through observing models, imitating actions and experiencing vicarious reinforcement, meaning they see the consequences of actions performed by others.

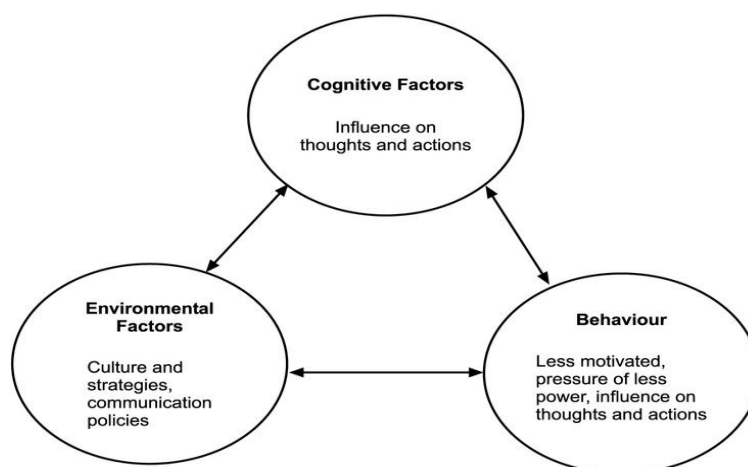


Figure 10: Social cognitive theory (Bandura, 1986)

In the context of the current study's proposed food safety framework, incorporating elements of the SCT, particularly the role of observational learning and reinforcement, will help solidify

the importance of modelling good food safety practices. As food handlers observe experienced personnel following correct hygiene protocols, they can internalise these practices and integrate them into their own routines. The proposed framework already highlights incentivising good behaviour, an approach that fits with SCT's reinforcement concept, where positive reinforcement, such as rewards for adhering to safety protocols, motivates food handlers to practice and improve their food safety behaviour continuously. Additionally, modelling during training sessions enables workers to see best practices in action, making it easier for them to replicate these behaviours in their day-to-day tasks. Furthermore, by combining SCT principles with practical elements, such as clear manuals and training, the framework enhances food handlers' ability to retain and apply food safety knowledge effectively. This integration ensures that food safety practices are not only learned but also consistently reinforced and applied, contributing to better food safety outcomes in old age homes. Generally, the inclusion of SCT in this framework enhances its effectiveness by incorporating methods of learning through observation and reinforcement, highlighting the role of cognitive processes in learning, and supporting the development of sustained food safety behaviour in food handlers, ultimately contributing to improved hygiene and safety standards in vulnerable environments, such as old age homes.

5.2.3 Social ecological model

According to Caperon *et al.* (2022), the Social Ecological Model (SEM) was developed to provide a comprehensive framework for understanding the various influences on human behaviour, particularly in relation to health, by acknowledging that individual behaviours are shaped not only by personal choices but also by multiple factors across different levels, including individual, interpersonal, organisational, community, and societal influences. This layered understanding is crucial for promoting effective health interventions. In the context of food safety, the SEM is particularly valuable as it highlights how external factors such as resources, social norms, and policies shape individual behaviour. For example, the proposed food safety framework in this study emphasises the importance of providing food handlers with the necessary tools, training, and support to ensure compliance with hygiene standards, but the SEM reveals that individual efforts alone are insufficient. The environment in which food handlers operate, whether it provides adequate access to hot water, personal protective equipment (PPE), or proper handwashing facilities directly affects their ability to implement food safety protocols effectively. Figure 13 illustrates how health behaviours are influenced by both individual choices and environmental factors. In old age homes, where there may be a lack of resources such as sufficient handwashing stations or proper sanitation infrastructure, food handlers may face barriers to practising safe food handling despite possessing the

knowledge and training, highlighting the importance of addressing organisational and community-level factors to create an environment conducive to food safety.

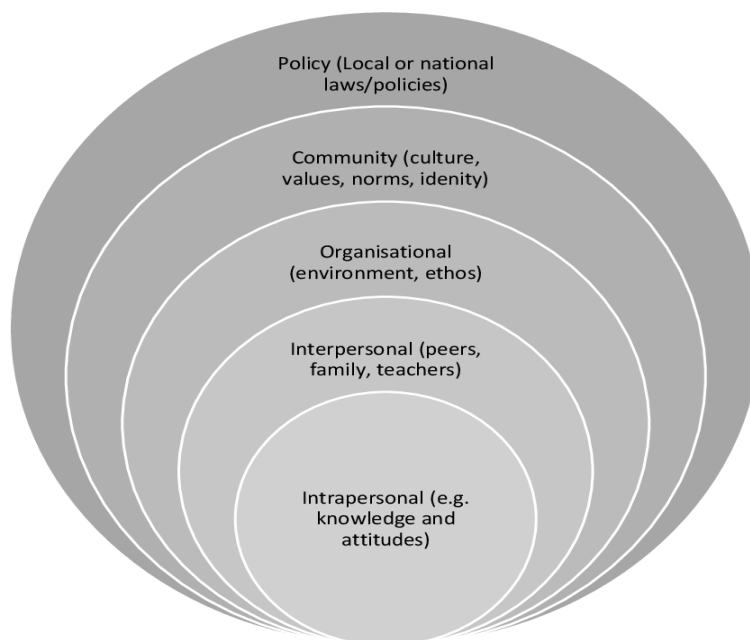


Figure 11: Social ecological model

Bronfenbrenner's (1977) ecological systems theory, which laid the foundation for the Social Ecological Model (SEM) in the 1970s, illustrated that human development occurs within a series of interconnected systems; public health practitioners have since adapted this model to emphasize that health behaviours are shaped by these interacting systems, with interventions needing to address multiple levels to be effective. Ngwenya *et al.* (2020) highlight the value of the SEM in informing interventions that target various levels simultaneously, leading to more sustainable behaviour change and better health outcomes for individuals and communities. Incorporating the SEM into the food safety framework proposed in this study strengthens the overall approach by stressing the need for systemic changes, including ensuring that old age homes are adequately resourced and equipped to meet hygiene standards. While individual training and reinforcement, as emphasised by the social cognitive model (SCM), are important, they must be supported by an environment that provides the necessary resources and infrastructure. By addressing both the individual and environmental factors, a more comprehensive and effective approach to food safety can be achieved, ultimately protecting the health and well-being of the elderly residents in these facilities.

5.2.4 Knowledge, attitudes and practices model

According to the study by Tuglo *et al.* (2021), the KAP model is a widely used framework in food hygiene and safety studies. This model aids in identifying gaps between knowledge and

behaviour in food safety, allowing for the development of strategies to address these gaps. Specifically designed to explore the complex relationships among knowledge, beliefs and habits, the KAP model provides valuable insights for individuals working in the food safety field. It confirms that being familiar with food safety does not automatically imply good behaviour; however, through the KAP model, the food industry sector reaps several benefits (Meher *et al.*, 2022). In Chapter 4, the KAP model informed the analysis by shedding light on the dynamics associated with food handlers' conduct, including their level of awareness, beliefs and perceptions about food safety (Figure 14). The model suggests that an individual's practice (P) is dependent on their knowledge (K), which influences their attitude (A) and, ultimately, their behaviour. By applying the KAP model, a better understanding of the factors impacting food safety practices among food handlers in the study was acquired.

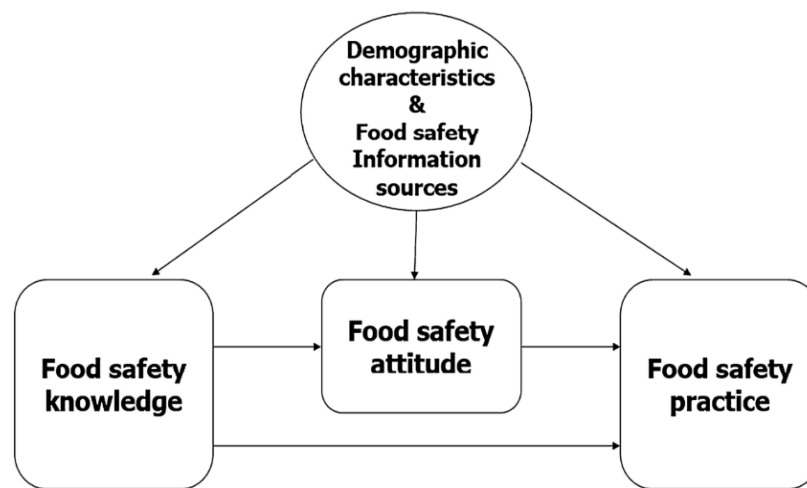


Figure 12: Knowledge, attitudes and practices model

As demonstrated in the study by Achiro *et al.* (2023), the KAP model can be effectively used to enhance food safety among food handlers in old age homes, thereby ensuring the health and well-being of elderly residents. This model can provide a structured approach to identify and address gaps in food safety KAP among food handlers, which is good for preventing foodborne illnesses in this vulnerable population. The steps of the KAP model that can be used to improve food safety among food handlers in old age homes are as follows:

Knowledge assessment

The first step involves assessing the current level of knowledge among food handlers regarding food safety protocols. This assessment includes understanding their awareness of hygiene practices, food preparation methods, proper cooking temperatures, cross-contamination prevention and food storage requirements. By conducting surveys or interviews, managers and researchers can identify specific areas where food handlers may

lack important knowledge. For example, if food handlers are unaware of the temperature danger zone where harmful bacteria thrive, targeted educational programmes can be implemented to fill this knowledge gap. The SCM emphasises that people learn by observing and modelling behaviours, which highlights the importance of providing clear examples of correct food safety practices during training sessions. The SEM highlights that individual knowledge is influenced by the social environment, including the availability of educational resources and support from supervisors. Understanding these influences can help tailor educational interventions to enhance food handler's knowledge effectively.

Attitude evaluation

The second step focuses on evaluating the attitudes of food handlers towards food safety practices. Managers can use questionnaires to understand how food handlers perceive food safety, their commitment to guidelines and any misconceptions they might have (Putri and Susanna, 2021). For instance, if some food handlers perceive certain hygiene practices as unnecessary or burdensome, this understanding can guide the customisation of motivational approaches to emphasise the role of these practices in protecting residents' health. In practical terms, if food handlers believe that wearing gloves during food preparation is unnecessary because they wash their hands frequently, managers can highlight that while handwashing is important, gloves provide an additional layer of protection against potential contamination. The SCM reinforces the idea that positive attitudes can be developed through observational learning and reinforcement. Demonstrating the correct practices and their benefits can motivate food handlers to adopt them. Meanwhile, the SEM points out that social norms and organisational culture can shape attitudes. By creating an environment that prioritises food safety, managers can positively influence food handlers' attitudes towards these practices.

Practice observation

The third step involves observing and documenting the actual food handling practices at old age homes, including monitoring how food handlers implement their knowledge and attitudes in daily routines such as handwashing, use of thermometers, proper storage of raw and cooked foods, and overall kitchen sanitation. Identifying discrepancies within the KAP model allows for targeted interventions; for example, if food handlers understand proper handwashing techniques but fail to practice them consistently, additional training sessions, reminders, and incentives can reinforce proper behavior. The SCM suggests that consistent practice can be reinforced through positive feedback and observation of peers, with managers using modelling to demonstrate effective practices that help food handlers internalize and repeat these behaviors. Additionally, the Social Ecological Model (SEM) emphasizes that

environmental factors, such as the availability of necessary tools and resources influence practice, so ensuring food handlers have the right equipment and support facilitates consistent application of their knowledge and attitudes in daily practice.

Intervention and training programmes

Based on findings from the KAP assessment, tailored intervention programmes can be developed to address specific gaps among food handlers in old age homes, including comprehensive training sessions on food safety standards such as proper handwashing techniques, safe food handling procedures, and maintaining clean, sanitised kitchen environments. Hands-on demonstrations allow food handlers to practice essential skills under supervision, while regular refresher courses ensure they stay informed about the latest protocols, address emerging issues, and foster continuous learning. Emphasising the direct impact of safe practices on residents' health during these workshops motivates food handlers to prioritise food safety in their daily routines, as noted by Putri and Susanna (2021), who highlight that ongoing training helps food handlers remain up to date and consistent in applying best practices. Additionally, strict cleaning and sanitisation procedures, including detailed cleaning schedules and appropriate agents are vital for maintaining a contaminant-free environment, supported by regular monitoring and auditing to ensure compliance and prompt corrective actions, thereby enhancing the overall food safety culture. This approach aligns with the SCT and SEM; SCT emphasises the value of learning new behaviours through observing and imitating proper techniques demonstrated during training, creating a supportive environment for skill reinforcement, while SEM acknowledges how social and environmental factors influence behaviour, necessitating that facilities provide adequate resources and support. Combining these theoretical frameworks strengthens intervention effectiveness and ultimately aims to protect the health and well-being of elderly residents in old age homes.

Monitoring and evaluation

Continuous monitoring and periodic reassessment of the knowledge, attitudes, and practices (KAP) of food handlers in old age homes are essential for ensuring the sustained effectiveness of intervention programmes aimed at enhancing food safety. Regular KAP surveys help track progress over time and identify new areas of concern or ongoing challenges, enabling managers to determine whether their initiatives are achieving the desired impact and measure changes over time. For instance, persistent misunderstandings of certain food safety concepts among food handlers despite training indicate the need for further refinement, prompting managers to develop targeted interventions such as additional training sessions or new strategies to reinforce understanding and compliance. This proactive approach facilitates

continuous improvement by highlighting areas of success and those requiring additional support. Moreover, ongoing assessment keeps managers informed about evolving trends, regulations, and best practices in food safety, allowing adaptation and updating of training programmes. Feedback from food handlers provides valuable insights into the effectiveness of training methods and the practicality of food safety protocols in real-world scenarios. Incorporating the Social Cognitive Model (SCM) and Socio-Ecological Model (SEM) into the KAP framework further enhances monitoring and evaluation efforts by emphasizing teamwork and community involvement, creating a supportive environment for food safety programmes. Involving food handlers in the evaluation process fosters responsibility and better adherence to food safety practices. The SEM demonstrates how individual behaviours are influenced by broader social and environmental factors, such as workplace culture and available resources, ensuring that evaluations consider not only knowledge and attitudes but also these contextual influences. In summary, integrating the SCM and SEM into the KAP evaluation process provides a comprehensive understanding of the factors affecting food safety in old age homes.

Policy and procedure development

Using the insights gained from the KAP model assessment conducted in the current study and feedback from food handlers, the management of old age homes can develop or refine policies and procedures to enhance food safety practices more effectively. The assessment identifies specific gaps in KAP among food handlers and informs targeted interventions. For instance, the assessment has revealed deficiencies in knowledge about proper hand hygiene practices. To address this, it is important to implement focused training programmes that provide detailed instruction on effective handwashing techniques and highlight the importance of hand hygiene in preventing foodborne illnesses. Additionally, supplying informational materials, such as posters and handouts, reinforces these practices and serves as a constant reminder for food handlers. These resources play an important role in the KAP model, helping to increase knowledge and awareness of proper handwashing. When combined with the SCT, they show how visual aids can improve food handlers' behaviour and decision-making. As the SCT emphasises the impact of learning by observing others and social influence, regular reminders, such as posters, encourage good practices. Therefore, combining the SCT with the KAP model would provide a more effective approach to promoting hand hygiene in food safety efforts. Targeted training sessions and refresher courses are also important for keeping food handlers up to date with the latest food safety standards. Regular updates and practical demonstrations help address new food safety challenges and reinforce best practices.

In addition, creating clear, practical guidelines based on the assessment findings is important. These guidelines should tackle the areas of improvement identified and offer clear steps for

improvement. For example, they should include methods for monitoring hand hygiene, procedures for safe food handling and protocols for cleaning, sanitation and waste management. Guidelines are valuable resources that can influence behaviour when viewed through the SEM. By providing structured protocols, these guidelines not only inform food handlers about best practices but also create an environment that supports following food safety measures. For example, they can promote a culture of accountability, where food handlers feel responsible for following the rules. By adjusting policies and procedures to address the needs identified in the assessment, management can improve food safety and ensure compliance with regulations. This coordination helps protect public health in old age homes and shows how both individual actions and the environment play important roles in promoting food safety. The current study found that while most old age homes (8 out of 14) were compliant with food safety regulations, six were not, highlighting areas for improvement. One key missing resource in these homes is easy-to-use checklists and protocols that specifically address food safety concerns for each facility. Implementing such checklists can help improve and maintain food safety practices, especially in non-compliant homes. These checklists provide clear guidelines and help food handlers consistently apply best practices. By making food safety protocols easy to understand and accessible, these resources support better implementation and adherence, ultimately improving food safety standards across all old age homes. These practical tools are important for enabling food handlers to understand and consistently follow food safety standards. Without clear visual cues and reminders for key practices, such as proper cooking temperatures and sanitation procedures, there is a higher risk of errors and inconsistencies. To tackle these issues, it is important to develop and provide checklists and protocols specifically tailored to reinforce food safety practices. These resources will help food handlers better understand and adhere to the required standards, improving the overall food safety in old age homes. In addition to written guidelines, old age home management can implement hands-on training sessions and demonstrations to complement the educational materials. Interactive training sessions allow food handlers to practice and internalise food safety protocols in a practical setting, fostering greater understanding and confidence in their ability to perform their duties safely and effectively.

5.2.5 Relation between theory and models

Relation to the social ecological model

The SEM highlights how individual actions are connected to larger social and environmental influences. In the assessment of old age homes, the findings show that the behaviour of individual food handlers, particularly their food safety practices, is affected by the resources available to them, such as easy-to-follow checklists and protocols. When these resources are

lacking, it becomes difficult for food handlers to follow effective food safety practices. This situation aligns with the SEM, which emphasises the need to address various levels of influence, including support from the organisation. By offering practical tools and training, management can foster an environment that encourages food handlers to comply with food safety regulations.

Relation to the social change model

The SCM highlights the need for teamwork and community involvement to create positive change. In this context, using checklists and hands-on training sessions is a joint effort to improve food safety practices in old age homes. By including food handlers in creating and using these resources, management encourages a sense of responsibility and accountability, fostering a culture of food safety. This involvement from the community is important for making lasting changes that improve compliance with food safety protocols, which ultimately leads to better public health outcomes.

Relation to the knowledge, attitudes and practices framework

The KAP framework looks at understanding knowledge, attitudes and practices related to health behaviours. The assessment shows that although food safety policies are in place, practical tools, such as checklists, to help connect knowledge with actual practices are needed. Providing clear and simple guidelines can improve food handlers' understanding of food safety standards, encouraging them to follow the rules more closely. Additionally, hands-on training sessions can reinforce this knowledge and boost confidence in using best practices, which will lead to better compliance with food safety regulations in old age homes. The assessment findings highlight the importance of resources such as checklists and training sessions in improving food safety practices. These components align well with the SEM's focus on environmental factors, the SCM's emphasis on community participation and the KAP framework's aim to connect knowledge, attitudes and practices to achieve better health outcomes.

5.3 Engagement and Motivation

Involving food handlers in food safety processes is important for fostering responsibility and continuous improvement in old age homes. When management includes food handlers in decision-making and seeks their input on food safety protocols, it shows respect for their experience and knowledge. This collaboration strengthens food safety efforts and motivates food handlers to take ownership of their roles, ensuring a safe environment for residents. Recognising and rewarding good practices is another effective way to encourage food

handlers. Publicly acknowledging individuals or teams who consistently follow food safety protocols reinforces positive behaviour and sets a standard for others to follow. Incentives, such as bonuses, certificates or additional training opportunities, can further inspire them to maintain high safety standards. The SCT emphasises the role of social interaction in shaping behaviour; therefore, sharing success stories of food handlers who excel in maintaining food safety can create role models, encouraging others to follow their example. This approach promotes teamwork and shared responsibility. In addition, organising peer feedback sessions where food handlers exchange constructive feedback can enhance learning and foster a supportive environment. This interaction aligns with the SCT by demonstrating how social influences shape behaviour and encourage collective efforts to ensure food safety. Creating a positive culture of engagement, recognition and teamwork ensures continuous improvement. These strategies also reflect both the SCT and the SEM, as they address how personal motivation and environmental factors influence behaviour. By promoting collaboration, management can enhance food safety practices and ensure these efforts are sustainable over time.

Bridging gaps between knowledge and behaviour

According to Tuglo *et al.* (2021), the KAP model helps identify gaps between what individuals know about and how they act regarding food safety. These gaps highlight the need for targeted strategies to ensure that knowledge translates into consistent behaviour. For instance, the absence of facilities, such as handwash basins and proper drying methods, combined with inconsistent soap availability weakens hygiene practices and increases the risk of cross-contamination. The SEM explains that the lack of resources can influence human behaviour, meaning food handlers may fail to wash their hands not by choice but due to limited access to the necessary facilities. Inadequate monitoring of food temperatures during delivery and storage also compromises food safety by encouraging bacterial growth. As identified earlier, unclear guidelines and insufficient training further hinder the proper implementation of food safety measures. To address these challenges, management must introduce practical tools such as checklists, visual reminders and step-by-step protocols. These tools will help food handlers maintain proper food storage, monitor cooking temperatures and follow sanitation practices.

Ensuring long-term food safety

Increasing the frequency of inspections or introducing follow-up visits will ensure that issues identified during initial assessments in the current study are resolved promptly. This proactive approach will reduce long-term risks to food safety and protect elderly residents from

foodborne illnesses. As elderly people are particularly vulnerable to infections, maintaining high standards of kitchen hygiene is important to their well-being. If food handlers are knowledgeable but fail to follow safety practices, interventions will need to address potential attitudes or misconceptions that prevent correct behaviour. The KAP model can also track the effectiveness of these interventions by comparing knowledge, attitudes and practices before and after implementation. This feedback will guide the design of effective training sessions and educational programmes.

5.4 Food Safety Framework

In South Africa, where the elderly population is steadily growing, ensuring hygienic living conditions in old age homes is critical (Solanki *et al.*, 2019). Developing a framework to minimise surface contamination and improve understanding of food safety practices is important to protecting the health of senior residents and supporting the ongoing efforts of management and food handlers to provide a safe and hygienic environment. According to Lee *et al.* (2021), a framework, in this context, refers to a structured approach or set of guidelines designed to systematically address and mitigate the risks associated with surface contamination in old age homes, where surfaces can harbour harmful microorganisms that pose health risks to residents. Ensuring these surfaces are kept clean and free from pathogens is important in preventing foodborne illnesses and other health issues. However, a comprehensive approach to food safety and hygiene must go beyond surface contamination. Effective hand hygiene is important for preventing contaminants from being transferred from hands to food and surfaces (Toney-Butler *et al.*, 2023). Rather than focusing solely on individual actions such as handwashing, the proposed framework adopts a broader approach to food safety by providing general guidelines that address multiple aspects simultaneously. For example, suitable cleaning and sanitising procedures tailored to old age homes help maintain surface cleanliness while also promoting good hand hygiene. Additionally, safe food handling and storage protocols, such as maintaining appropriate temperatures to inhibit bacterial growth and separating raw from cooked foods to prevent cross-contamination, are essential. By incorporating these components into an integrated strategy, the framework establishes clear, adaptable steps for the implementation of food safety practices. Thus, addressing surface contamination alongside hand hygiene, food storage and handling, pest control, staff training, cleaning, and monitoring enhances the overall safety and well-being of residents, ensuring a safer environment and reducing the risk of foodborne illnesses and other health complications.

5.5 Framework Incorporation

The framework combines food safety practices, hygiene protocols and educational initiatives, all of which align with the guidelines in HACCP (2018) and the Codex Alimentarius Commission (CAC/RCP 1-1969) (2003). To implement these practices effectively, it is important to provide adequate resources, such as training, proper equipment and pest control measures. Additionally, creating clear and easy-to-follow procedures will help food handlers comply with these standards. The study's findings highlight the importance of addressing key issues, such as inconsistent hygiene practices and limited understanding of food safety. The KAP model is useful for evaluating food handlers' knowledge and behaviours regarding food safety. This model can guide targeted training and educational efforts. Furthermore, the SCT highlights the role of learning from others and building confidence. By demonstrating positive behaviours and encouraging self-efficacy, adherence to food safety practices can improve. Lastly, the SEM shows the need to consider different levels of influence for individuals, organisations and the community to create an environment that supports sustainable food safety practices.

For example, within the context of HACCP, the framework would involve conducting a thorough hazard analysis specific to the old age home's food preparation and dining areas. This analysis would identify potential biological, chemical and physical hazards that could pose risks to elderly residents. Subsequently, critical control points (CCPs) would be established to monitor and control these hazards effectively (Awuchi, 2023). For instance, CCPs might include temperature control during food storage and preparation, sanitation procedures for kitchen surfaces and verification measures to ensure compliance with hygiene protocols. Moreover, the framework places importance on educational programmes, aligning with the principles of both HACCP and Codex Alimentarius. These principles emphasise the importance of personnel training and awareness in upholding food safety standards. Food handlers who are responsible for handling and preparing food must undergo thorough training covering topics such as effective handwashing, preventing cross-contamination and maintaining cleanliness. This educational aspect does not only improve staff skills but also promotes a culture of food safety awareness across the entire facility. In addition, the framework is designed to be flexible and adaptable to the individual circumstances and challenges faced by each old age home. This approach aligns with the principles of HACCP and Codex Alimentarius, which emphasise the importance of tailoring food safety strategies to specific contexts. Therefore, by recognising the unique needs of each facility, the framework allows for the customisation of protocols and procedures. For example, this would involve accommodating dietary preferences of elderly residents, implementing specialised cleaning

procedures for areas at high risk of contamination or adjusting educational materials to ensure they are easily understood by food handlers with varying levels of knowledge and experience. Generally, the framework aims to provide a thorough and systematic approach to ensure food safety in old age homes. Through steps such as hazard analysis, implementing control measures, regular monitoring and ongoing staff education, the framework aims to reduce risks, protect the health of elderly residents and foster a culture of high standards in food safety management within these facilities. A few studies have explored the creation and application of food safety frameworks, stressing their importance in protecting the health of individuals in diverse settings, including old age homes. For example, research conducted by Achiro *et al.* (2023) showcases the efficacy of such frameworks in improving food safety practices among food handlers in institutional settings such as long-term care facilities. Likewise, studies by Awuchi (2023) and Elbehiry *et al.* (2023) highlight the critical role of strict food safety frameworks in tackling the specific challenges encountered in institutional environments, particularly concerning the susceptibility of elderly populations to foodborne illnesses. These studies emphasise the necessity for tailored strategies and comprehensive approaches to food safety management, aligning with the overarching objective of protecting public health and well-being. By combining the findings from research studies and incorporating insights from stakeholders, including residents, staff members and healthcare professionals, the proposed framework aims to address current shortcomings and create a thorough strategy to ensure food safety in these facilities. Additionally, the findings of the current research have prompted the need for immediate action to improve the cleanliness and safety standards in old age homes, emphasising the urgency of implementing proactive measures.

5.6 Food Safety Control Measures

Food safety control measures are key procedures that are set up to keep the handling, preparation and serving of food safe to prevent foodborne diseases and maintain public health. Basic elements of food safety control include cleaning and sanitising food contact surfaces, frequent handwashing and the use of protective equipment, such as aprons, gloves and hairnets. Additionally, it emphasises the importance of proper storage conditions, cooking food at recommended temperatures and monitoring food handling processes to minimise the risk of foodborne pathogens. Adhering to these measures not only protects consumer health but also upholds the reputation and credibility of food establishments. Figure 15 provides a summary of the main practices that food handlers should follow in accordance with food safety regulations.

Food safety area	Key practices	Legislation	Responsible person
Personal hygiene	- Regular handwashing with soap and water	South African National Health Act 61 of 2003, Section 5 (Sub-regulation 2) (RSA 2003)	Food handlers, kitchen supervisor
	- Use of hairnets, aprons and closed-toe shoes	South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972, Section 6 (Sub-regulation 4) (RSA DoH, 1972)	Food handlers, kitchen supervisor
	- Prohibition of staff with communicable illnesses from handling food	South African Occupational Health and Safety Act 85 of 1993, Section 14 (RSA, 1993)	Facility manager
Food handling and preparation	- Proper storage of food items at appropriate temperatures	South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972, Section 14 (Sub-regulation 3) (RSA DoH, 1972)	Food handlers, kitchen supervisor
	- Thorough cooking of food to recommended internal temperatures	South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972, Section 14 (Sub-regulation 5) (RSA DoH, 1972)	
	- Use of separate cutting boards for raw and ready-to-eat foods	South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972, Section 6 (Sub-regulation 4) (RSA DoH, 1972)	
Cleaning and sanitising	- Regular cleaning and sanitising of kitchen surfaces and equipment	South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972, Section 5 (Sub-regulation 2) (RSA DoH, 1972)	All kitchen staff
	- Use of approved cleaning agents and sanitisers	South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972, Section 6 (Sub-regulation 4) (RSA DoH, 1972)	
	- Proper disposal of waste and garbage	South African National Health Act 61 of 2003, Section 15 (RSA, 2003)	
	- Pest control	South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972 (RSA DoH, 1972)	

Monitoring and compliance (self-evaluation)	- Establishing clear protocols that emphasise policies and guidelines at the facility level to ensure consistent and effective operations - Gather feedback from internal stakeholders using internally developed feedback tools - Regular monitoring of the CCP, including food safety practices, temperature control, sanitation, verification measures and record keeping - Develop improvement plans based on identified gaps to improve quality continuously	South African Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972, Section 14 (Sub-regulation 2) (RSA DoH, 1972)	Facility manager and EHP
	- Internal audits and inspections to identify areas for improvement	South African National Health Act 61 of 2003, Section 63 (RSA, 2003)	Facility manager and EHP
	- Reporting of food safety concerns or incidents (record keeping)	South African Occupational Health and Safety Act 85 of 1993, Section 23 (RSA, 1993)	
Motivation and recognition/rewards	-Clear goals, regular feedback, personalised recognition and rewards for continually applying food safety knowledge	As supported by SCT	Facility managers
Training and education	- Ongoing needs assessment, structured curriculum development and interactive learning methods - Development of posters, digital content etc. outlining key moments in food safety for awareness and reinforcement of training	Foodstuffs, Cosmetics and Disinfectants Act 54 of 1972: Regulations Relating to the General hygiene requirements for food premises, transport of food and related matters (R638 of 2018) (RSA DoH, 1972)	Facility managers, HR and EHP
Resource allocation	- Provision of basic equipment to support the continuous application of food safety practices	As supported by the SEM	Management (director of operations), facility manager
Summary: The framework outlines seven key food safety areas and corresponding practices for old age home kitchens, along with relevant legislation that governs each area. By adhering to these practices and legislative requirements, old age homes can ensure the safety and well-being of their residents through the provision of safe and hygienic food.			

Figure 15: Infographic illustrating a Food Safety Framework

As informed by food safety theories and paired with the relevant South African legislation that governs these practices, Figure 15 provides a structured overview of essential food safety practices that are required in old age home kitchens. Each section highlights critical aspects of food safety, ensuring that old age homes adhere to established standards for protecting the health and well-being of their residents. Personal hygiene is fundamental in preventing

foodborne illnesses. According to the National Health Act 61 of 2003 (RSA, 2003), Section 5 (Sub-regulation 2), food handlers must engage in regular handwashing with soap and warm water. Additionally, the FDC Act 54 of 1972 (RSA DoH, 1972), Section 6 (Sub-regulation 4) mandates the use of hairnets, aprons and closed-toe shoes to prevent contamination. The Occupational Health and Safety Act 85 of 1993a, Section 14 further prohibits workers with communicable illnesses from handling food. Adherence to these hygiene practices is important for minimising the risk of contaminating food and ensuring a clean food preparation environment (RSA, 1993a). In the area of food handling and preparation, it is essential to store food items at appropriate temperatures and thoroughly cook them to recommended internal temperatures. This practice, which is regulated under the FDC Act 54 of 1972, Section 14 (Sub-regulations 3 and 5), helps prevent the growth of harmful bacteria. The legislation also requires the use of separate cutting boards for raw and ready-to-eat foods, as outlined in Section 6 (Sub-regulation 4), to avoid cross-contamination. These measures are designed to ensure that food is handled safely throughout the preparation process (RSA DoH, 1972).

Cleaning and sanitising practices are important for maintaining a hygienic kitchen environment. Regular cleaning and sanitising of kitchen surfaces and equipment are required by the FDC Act 54 of 1972, Section 5 (Sub-regulation 2). The use of approved cleaning agents and sanitisers, as specified in Section 6 (Sub-regulation 4), ensures that surfaces are properly disinfected (RSA DoH, 1972). Additionally, the proper disposal of waste and garbage is mandated by the National Health Act 61 of 2003, Section 15 (RSA, 2003). These practices prevent the accumulation of contaminants and maintain a sanitary environment. Monitoring and compliance involve ongoing oversight to ensure that food safety practices are consistently followed. Regular monitoring, internal audits and inspections are required by FDC Act 54 of 1972, Section 14 (Sub-regulation 2) and the National Health Act 61 of 2003, Section 63 (RSA DoH, 1972). Reporting of food safety concerns or incidents is also necessary, as outlined in the Occupational Health and Safety Act 85 of 1993, Section 23 (RSA, 1993a). These measures are crucial for identifying areas for improvement and ensuring that food safety standards are upheld. Generally, the framework detailed in the table provides a guide to food safety practices and relevant legislation for old age home kitchens. By adhering to these practices and legislative requirements, facilities can better protect the health of their residents, ensuring a hygienic and safe food preparation environment. The discussion of this framework, therefore, emphasises the importance of each practice and regulation, highlighting the need for ongoing adherence and improvement to prevent foodborne illnesses and maintain high standards of food safety.

5.7 Applicability in Various Settings

The framework developed to enhance food safety practices in old age homes can serve as a model adaptable to various kitchen settings and institutional environments. While challenges may differ across settings, the framework's core principles such as regular sanitation, staff training, and adherence to hygiene protocols are universally relevant and can be tailored to suit the unique needs of hospitals, old age homes, and other residential care facilities. By fostering a culture of cleanliness, awareness, and accountability, the framework has the potential to elevate food safety standards and improve care quality for vulnerable populations, including the elderly, in diverse institutional contexts. To ensure that behaviours and practices are effectively reinforced within the framework designed to reduce surface contamination and improve food safety in old age homes, it is important to identify several key resources. Comprehensive training programmes for staff and food handlers on food safety practices, hygiene standards, and contamination prevention techniques are necessary, and regular workshops can help reinforce their knowledge and skills, promoting a culture of safety.

Additionally, implementing monitoring tools such as checklists and audits are important self-assessment tools for regularly assessing compliance with food safety protocols, which can be evaluated through external audits or inspections by EHPs; this approach helps maintain high standards and accountability at the facility level and ensures a proactive rather than reactive approach to food safety. Developing accessible educational materials, such as posters, brochures, and digital content, can keep staff and residents informed about best practices in food safety and hygiene. Furthermore, securing funding and allocating budgets are crucial for supporting these training programmes, purchasing necessary supplies, and conducting regular inspections. Collaborating with food safety experts and public health professionals can also provide valuable guidance in creating effective protocols. Establishing feedback mechanisms allows staff and residents to share their observations regarding practices and policies, helping identify areas for improvement and reinforcing a culture of continuous learning. Finally, implementing recognition and reward systems for staff who consistently follow food safety standards can encourage positive behaviours and strengthen their commitment to hygiene practices. By including these resources in the framework, old age homes can effectively reinforce desired behaviours and practices, ultimately improving the health and safety of elderly residents.

5.8 Conclusion

Having a food safety framework at facilities where food is handled, prepared and stored is important for several reasons. First, it protects the health of vulnerable groups, like elderly

residents, who are more at risk for foodborne illnesses. By following standard food safety practices, institutions can effectively reduce the risk of contamination and the spread of harmful germs, ensuring the well-being of older adults. Additionally, a food safety framework helps institutions comply with South African laws that set strict guidelines for food handling and hygiene. By following these legal requirements, institutions show their commitment to maintaining high standards, promoting public health and ensuring food safety. This not only protects consumers but also reduces the risk of legal issues and damage to the institution's reputation. Moreover, establishing a food safety framework is important for protecting residents' health and meeting legislative compliance, which in turn helps preserve the institution's credibility and commitment to public well-being. Therefore, by creating clear protocols for food handling, storage and preparation, facilities can ensure that their food handlers are well-trained and able to maintain high hygiene and sanitation standards. In general, implementing a food safety framework that follows South African laws is essential for protecting the health of residents in old age homes and other institutions. By adhering to legislative requirements and promoting best practices in food handling and hygiene, facilities can create safer environments for both residents and food handlers, ultimately benefiting the entire community.

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CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

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6.1 Introduction

Food safety in old age homes is crucial, as the health of elderly residents affects their ability to cope with foodborne illnesses. Research shows that older adults are at higher risk of foodborne diseases and have elevated mortality rates compared to younger, healthier individuals. Gallo *et al.* (2024) attribute this vulnerability to age-related changes such as increased stomach acidity, delayed gastric emptying, reduced liver blood flow, and diminished kidney function. Furthermore, the immune system naturally weakens with age, making older adults more prone to infections from foodborne pathogens (Calder *et al.*, 2022). Considering these risks, stricter food safety practices are essential in old age homes. Implementing food safety systems, including Hazard Analysis and Critical Control Points (HACCP) protocols and targeted training programmes, has been shown to improve the knowledge and behaviour of food service staff, thereby reducing the incidence of foodborne illnesses in such settings. In South Africa, examining microbial contamination on kitchen surfaces and surveying food handlers is particularly important, as elderly residents compromised immunity heightens the need to prevent contamination. Kitchens in these facilities serve many people daily, increasing the risk of cross-contamination if hygiene practices are inadequate. Identifying microorganisms on surfaces can pinpoint critical problem areas and lead to evidence-based recommendations for risk reduction. Additionally, evaluating food handlers' knowledge and practices through questionnaires can uncover gaps in food safety awareness and procedures, highlighting areas where further training or policy revisions are needed. Given the significant role food handlers play in maintaining safe environments and the lack of research on food safety in South African old age homes despite the unique risks, this study addressed an important gap by working to enhance food safety and protect elderly residents' health.

6.2 Chapter 3

6.2.1 Microbial quantification

In Chapter 3, the study focused on quantifying and identifying microorganisms present on food preparation surfaces in old age home kitchens. This research is important because elderly residents are more vulnerable to foodborne illnesses. Given the global public health challenge posed by foodborne diseases, regular and thorough evaluations of food safety are crucial, particularly in environments such as old age homes. Many residents may have weakened immune systems or pre-existing conditions, such as hypertension, dyspepsia and *Diabetes mellitus* (Elbehiry *et al.*, 2023), which increase their risk of severe health issues from foodborne infections. The study used a descriptive cross-sectional approach to evaluate the cleanliness of kitchen surfaces in old age homes to prevent food contamination. Such surfaces can

harbour harmful pathogens. Microbiological samples were collected from various kitchen areas using contact plates with different types of agars; nutrient (NA), mannitol salt (MSA) and Plate Count Agar (PCA), to measure the total number of living microorganisms, coliforms and bacteria associated with foodborne diseases. The results were analysed according to the British Columbia Guide for Environmental Health Officers, which outlines sanitation standards, food safety protocols, water quality, waste management and pest control, and the findings were classified based on the guidelines set by Seed and Kurrein (2019). Each agar type was selected for its specific role in microbial analysis (Aditi *et al.*, 2017). NA was used for general bacterial growth, MSA was selective for the *Staphylococcus* species and PCA was for counting total viable microorganisms. The bacteria from surface samples were cultured and colonies were distinguished and counted based on their appearance, colour and texture. The results were categorised according to cleanliness guidelines and revealed varying levels of microbial contamination, which provided insights into the hygiene practices at the old age homes and identified areas needing improvement for better food safety.

Of the 14 old age homes sampled, nine facilities (66.67%) met hygiene standards and were classified as satisfactory. However, five homes (34.88%) exceeded the hygiene limit of 100 colony forming units (CFU) per square metre, with many plates showing counts above 300 CFU/mL, indicating unsatisfactory conditions. Despite nine homes being classified as satisfactory, bacterial strains linked to foodborne illnesses were detected across multiple facilities, emphasizing the ongoing risks associated with poor hygiene practices. A total of 42 distinct bacterial colonies were later identified using Matrix-Assisted Laser Desorption/Ionization Time-of-Flight Mass Spectrometry (MALDI-TOF MS), emphasising the urgent need for stricter monitoring and improved sanitation. The 66.67% compliance rate does not ensure adequate food safety, especially considering the heightened vulnerability of the residents. These findings stress the necessity for effective waste management, pest control and regular hygiene monitoring to protect residents' health and maintain safe kitchen environments, in line with the Regulations Governing General Hygiene Requirements for Food Premises, the Transport of Food and Related Matters (R638 of 2018) (RSA DoH, 2018b). To address these challenges, the study recommends using the Social Ecological Model (SEM), which examines different levels of influence on food safety practices, from individual behaviours to broader environmental and institutional factors. This model encourages the provision of essential resources, such as handwashing stations, personal protective equipment (PPE) and regular inspections, to enhance compliance with hygiene standards. Additionally, the Social Cognitive Theory (SCT) complements this approach by emphasising the importance of observational learning and reinforcement in changing behaviour. By implementing role modelling and training, staff can better understand the significance of food

safety practices, leading to improved skills and attitudes. The Knowledge, Attitude, and Practice (KAP) model further aims to enhance staff knowledge and attitudes toward food safety, promoting safer practices. Together, these frameworks create a comprehensive strategy to improve food safety in old age homes, ultimately protecting the health of vulnerable residents. Based on the findings from this study, the proposed framework (Chapter 5) integrated these models to address both structural and behavioural barriers. It highlights the need for ongoing staff training, effective waste management and routine inspections to ensure long-term compliance with food safety standards. This approach aims to create safer facilities by reducing contamination risks, protecting residents' well-being and aligning with legislative requirements. Therefore, by implementing these measures, old age homes can enhance food safety practices and better protect their residents from the dangers of foodborne illnesses.

6.2.2 Identification using MALDI-TOF MS

The MALDI-TOF MS technique was also used to identify bacterial colonies and microorganisms from kitchen surfaces in old age homes. This method quickly and accurately identifies various bacterial species by creating unique mass spectral fingerprints (Haider *et al.*, 2023; Mortier *et al.*, 2021). Given the diverse bacteria found in environments such as old age homes, rapid identification is important for assessing potential risks to elderly residents, who are often more susceptible to foodborne illnesses. Using this technique, a variety of microorganisms were identified in the 42 samples collected from kitchens in old age homes. Among these samples, 33 belonged to the Bacillaceae family, which includes important species such as *Bacillus cereus*, *Bacillus subtilis*, *Bacillus altitudinis*, *Bacillus licheniformis*, *Bacillus pumilus*, *Exiguobacterium artemiae*, *Peribacillus mutalis* and *Paenibacillus alvei*. Additionally, one isolate was identified as *Enterococcus faecium* from the Enterococcaceae family and two isolates, *Enterobacter cloacae* and *Proteus mirabilis*, were classified under the Enterobacteriaceae family. One isolate was classified as *Pseudomonas stutzeri* and another identified as *Kocuria rosea* from the Micrococcaceae family. The presence of these bacteria on food preparation surfaces in old age home kitchens raises significant concerns about food safety and hygiene, especially given the vulnerability of the residents. Members of the Bacillaceae family, such as *Bacillus cereus*, are rod-shaped bacteria that can form resistant spores. These Bacillaceae bacteria thrive in various environments, including soil and water, and can cause foodborne illnesses if proper hygiene and cooking practices are not followed (Rossi *et al.*, 2024; Dietrich *et al.*, 2021). For example, failing to cool and reheat rice properly can lead to contamination and gastrointestinal illnesses, which can be particularly dangerous for elderly residents (Ghosh *et al.*, 2024; Navaneethan and Effarizah, 2023). Improper handling of rice, along with other food items, increases the risk of foodborne pathogens

multiplying and makes it crucial for food handlers in old age homes to follow strict cooling and reheating protocols to ensure safety. In Chapter 4, all food handlers (N=80 [100.0%]) reported having cooling methods for food; however, the effectiveness of these methods was not assessed, raising concerns about their proper implementation. Improper cooling, particularly of foods such as rice, can lead to contamination with *Bacillus cereus*, causing rapid-onset symptoms such as vomiting and diarrhoea (McDowell *et al.*, 2024; Zhang *et al.*, 2021). Similarly, *Salmonella*, which can thrive in inadequately cooled foods, such as eggs and poultry, poses a risk of severe gastrointestinal distress, which is especially dangerous for elderly residents.

Beyond these pathogens, other bacteria such as *Peribacillus mutalis*, *Paenibacillus alvei* and *Enterococcus faecium* can also present health risks in food handling. *Enterococcus faecium*, although part of normal intestinal flora, can cause serious infections in vulnerable individuals, especially if introduced into food through poor hygiene (Astley *et al.*, 2023; Richiard *et al.*, 2023). In addition, *Enterobacter cloacae* and *Proteus mirabilis*, both linked to foodborne illnesses, can multiply when foods are not stored or handled properly, further emphasising the need for careful cooling and storage (Balali *et al.*, 2020; Bintsis, 2017). The presence of bacteria such as *Pseudomonas stutzeri*, known for spoiling dairy and meats, and *Kocuria rosea*, which can contribute to contamination under inadequate hygiene conditions, further illustrates the need for strict food safety practices (Manafe *et al.*, 2023; Scales *et al.*, 2014). The identification of these microorganisms in kitchens serving elderly populations highlights the necessity of strict hygiene protocols and regular monitoring of contamination. Given the heightened risks for elderly residents, reinforcing effective cooling and reheating practices as part of broader food safety training is important to protect their health and prevent outbreaks in old age homes. Thus, this alignment with the findings from the current study emphasises the need for ongoing training and strict adherence to food safety measures to protect the health of elderly residents.

6.3 Chapter 4

6.3.1 Summary of questionnaire results

The questionnaire results offer valuable insights into food safety practices and facility management at old age facilities, highlighting the need for effective food safety protocols to protect residents' health. The majority (83.8%) of facilities have implemented food safety management systems that include components such as HACCP plans, staff training, record keeping and internal audits. These elements contribute to maintaining high standards of food safety and ensuring residents' well-being. Kitchen cleanliness was another important factor

noted, with 75% of respondents (N=60) across 10 facilities reporting that food preparation surfaces were easy to clean and well-constructed. However, 25% from four facilities highlighted deficiencies, suggesting that some facilities may have only met conditional standards for CoAs due to non-compliance issues. Considering that inspections occur twice a year and follow-up records are lacking, there is a risk that these facilities may struggle to maintain compliance between inspections. The results also indicated that all respondents (N=80) across 14 facilities were satisfied with lighting and ventilation in their kitchens, which aids in hazard identification and supports a clean and safe environment.

Maintenance is critical to operational efficiency and the safe functioning of these facilities, with 81.3% (N=65) of respondents reporting the presence of on-site maintenance staff. This availability allows for quick responses to maintenance needs; facilities relying on external contractors often face delays, partly due to financial limitations. Effective pest control was also prevalent, with 83.8% (N=67) of respondents noting that professional pest control services were in place. These services help prevent contamination and protect both residents and food preparation areas by adhering to safety protocols. Refuse management is another aspect of food safety; 78.8% of respondents (N=63) from 11 facilities reported established systems for waste storage and disposal. However, 21.3% (N=17) from three facilities indicated that formal systems were lacking, pointing to a need for improvements in these areas to minimise contamination and prevent pest problems, especially for residents with weakened immune systems. Regarding waste oil disposal, 78.8% (N=63) from 11 facilities confirmed having safe storage and disposal systems for waste oil, while 21.3% (N=17) from three facilities reported gaps in these areas. Adhering to the National Environmental Management: Waste Act 59 of 2008 (RSA, 2008) is thus vital to reducing environmental impacts and supporting health and safety standards. In summary, the findings emphasise the importance of comprehensive food safety practices, maintenance, pest control and waste management in old age facilities. These measures are essential for protecting the health of elderly residents and ensuring that the facilities operate in alignment with national standards. The observed gaps, such as in refuse management and waste oil disposal, reinforce the need for targeted improvements to maintain high standards of safety and hygiene in these vulnerable settings.

6.3.2 Summary of the food safety checklist

This section evaluated how well old age homes comply with food safety and hygiene policies. All 14 facilities showed 100% compliance with registration documents, including CoAs and conditional CoAs. They also had written food safety policies, with all staff being informed through regular meetings and training. However, despite these efforts, gaps in food safety practices that affect compliance and hygiene standards were identified. A notable issue was

the lack of adequate personal hygiene monitoring, as only 80% (11 of 14 facilities) had proper handwash basins installed. This shortfall poses a challenge to achieving optimal hygiene during food preparation. In terms of cleaning practices, 80% compliance was noted for utensils and equipment sanitation between uses, indicating that 11 facilities adhered to proper cleaning protocols. Similarly, work surface cleanliness and sanitation were upheld at an 80% compliance rate across facilities. Food storage practices, particularly with refrigeration, showed an 85% compliance rate, with 12 facilities meeting temperature guidelines necessary to prevent bacterial growth in perishable items. Proper refrigeration is important in food safety; the 85% compliance rate (12 facilities) in temperature regulation reflects positive efforts. However, some facilities showed inconsistent monitoring or maintenance issues, which can allow bacteria such as *Salmonella* and *Listeria* to thrive and pose health risks to elderly residents. Dry storage cleanliness also achieved 80% (11 facilities) compliance, highlighting a general commitment to proper food storage practices.

Dishwashing compliance was high, with 90% (13 of 14 facilities) having well-maintained dishwashing areas. However, only 80% (11 facilities) met the correct water temperature requirements for effective dishwashing. Additionally, adequate air-drying space was limited to 60% of the facilities (8 facilities), a concern as inadequate drying areas can promote moisture accumulation and microbial growth on utensils. Waste management practices were insufficient, with only 60% (8 facilities) meeting the standards for regular waste bin cleaning and emptying. In contrast, all facilities (100%) promptly removed delivery boxes, reducing potential contamination risks. Pest control measures presented another area for improvement, with a compliance rate of only 60%. Signs of pests were observed in 40% (6 facilities), highlighting the need for enhanced pest management. While old age facilities demonstrate some effective food safety practices, areas such as personal hygiene, waste management, pest control, and air-drying space for utensils require attention. The lack of handwashing facilities and inconsistencies in temperature monitoring highlight critical issues. Consistent adherence to safety guidelines and improvement in these areas will enhance the protection of the elderly residents' health and ensure a safer environment within these facilities.

6.4 Norms and Standards Applicable to all Premises

According to the applicable norms and standards, certain requirements must be met to ensure compliance and maintain health and safety at premises such as old age homes. Specifically, the building structure must adhere to the National Building Regulations 103 of 1977 (RSA, 1977) and SANS 10400 of 2015: Application of the National Building Regulations (SANS, 2015a). Additionally, health education should be a fundamental component of all environmental health compliance inspections. Observations of the old age homes indicated

that they did not fully meet the legislative requirements. Specifically, two facilities (N=13 [16.3%]) lacked handwash stations, which are important for maintaining hygiene. Proper storage and disposal facilities for refuse are vital for the health, safety and the overall well-being of elderly residents. These facilities play a role in upholding cleanliness and hygiene standards, which are particularly important for individuals with weakened immune systems or underlying health conditions. While 78.8% (N=63) of respondents reported having storage and disposal systems for refuse, indicating that 11 out of 14 homes implement these systems, three facilities (N=17 [21.3%]) indicated that they do not have formal systems in place. This discrepancy highlights a gap between perceived and actual compliance with proper refuse management. Generally, these deficiencies raise concerns regarding the health and safety of residents in these facilities. Water supply must meet SANS 241 (SANS, 2015b) standards for drinking water, ensuring that it is microbiologically, chemically and physically safe. Potable running water must be continuously available on all premises for drinking, food preparation and other important uses, including the handling and disposal of waste from the kitchen.

During the old age home visits, it was observed that all 14 old age homes (100%) had running tap water. Of these, 80% (12 facilities) provided both cold and hot water, meeting the standards for both, according to SANS 241 (SANS, 2015b). However, 20% (3 facilities) of the facilities lacked hot water. When running water is not available, it is necessary to store at least 10 to 25 litres of water per person per day in a hygienic manner on the premises and this requirement was observed during the visits. Maintaining high standards of water quality and availability is important for ensuring effective food preparation and sanitation practices, especially in environments catering to vulnerable populations such as those in old age homes. For waste management, old age homes must use approved methods for waste collection, storage, transportation and disposal. While 78.8% (N=63) of the facilities reported following these methods, meaning 11 out of 14 homes were complying, three facilities (N=17 [21.3%]) did not meet these requirements. Waste management must also follow Part U of the National Building Regulations, Sections 2-5 of the Norms and Standards for Waste Management (RSA, 1977) and the National Environmental Management: Waste Act 59 of 2008 (RSA, 2008). This legislation requires that there be an approved area for storing refuse until it is removed, with access limited to trained employees. Additionally, there should be enough refuse bins for general waste storage on the premises. Premises, including old age home kitchens, are responsible for ensuring that waste is managed in a manner that does not endanger health or the environment. This includes the proper storage, collection, transportation and disposal of waste. The National Environmental Management: Waste Act 59 of 2008 also promotes a waste hierarchy that prioritises avoidance, reduction, reuse, recycling and recovery over disposal, which encourages businesses to minimise waste generation and maximise recycling

and recovery efforts (RSA, 2008). Waste must be classified according to its type and risk level; hazardous waste, such as waste oil, must be managed with stricter controls to prevent contamination and environmental harm. Among the visited old age homes, all 14 facilities achieved a 100% compliance rate in ensuring that delivery boxes and containers were removed from the kitchen site. However, only 60% (8 facilities) of the kitchen waste cans were clean and emptied as required; 40% (6 facilities) did not meet these standards. Additionally, 60% (8 facilities) of the facilities showed evidence of pests, indicating a concern for pest control; 40% (6 facilities) did not have visible signs of pests. Adhering to waste management regulations is particularly important to protect the vulnerable elderly population from potential health hazards associated with improper waste handling.

6.5 Chapter 5

Food safety framework

The framework was designed to improve food safety and QA in old age homes by addressing key problems identified through microbiological testing and feedback from food handlers. It uses principles from HACCP to identify and control risks in food preparation areas. CCPs focus on areas such as temperature control, cleaning procedures, pest management and hygiene. Regular microbial testing is included to monitor and reduce contamination, especially in high-risk areas such as sinks and dishwashing stations. This ensures that cleaning practices are effective, and hygiene standards remain high (HACCP, 2018; Codex Alimentarius Commission, 2003). Training and education are key parts of the framework. Food handlers receive training on essential topics such as proper handwashing, avoiding cross-contamination, safe food storage and maintaining cleanliness. This training helps staff improve their skills and creates a strong focus on food safety at the facilities. The framework also emphasises the importance of improving kitchen infrastructure, including installing dedicated handwashing basins and carrying out regular maintenance. These upgrades address problems identified during inspections and provide the tools needed to maintain compliance with safety regulations (Berger *et al.*, 2023; Jackson and Meah, 2018). Stronger regulatory oversight is another important part of the framework. It highlights the need for frequent inspections, clear documentation of food safety practices and timely action to fix any issues found during inspections. The framework also includes steps to ensure the quality and safety of meals, such as reheating food to temperatures recommended by safety standards such as R638 of 2018 (RSA DoH, 2018b) and SANS 10049:2019 (SABS, 2019). This helps make food both safe to eat and appealing to residents (FSA, n.d.; Gowans, 2023). These combined measures aim to reduce risks, improve safety and raise food quality standards in old age homes.

6.6 Recommendations

Improving food safety practices requires collaboration and the use of diverse strategies to align the mandates of food safety laws with their practical implementation. To uphold food safety practices, specific actions can be undertaken to guide food handlers, policymakers and EHPs. These recommendations can be implemented through various means, including the following:

Training programmes and continuous education

Tailored training programmes are important to address the unique challenges faced by food handlers in different environments, including old age homes, and policymakers should recognise the need for these programmes to cover not only the basics of food hygiene but also the underlying principles behind each regulation. Understanding the reasoning behind food hygiene regulations, such as those outlined in the South African Regulations R638 (RSA DoH, 2018b), the National Health Act 61 of 2003, and the National Norms and Standards for Environmental Health (RSA DoH, 2013), is important for food handlers. Regulation R638 specifies the requirements for food hygiene and safety, including proper food handling, storage, and preparation to prevent contamination. The National Health Act 61 of 2003 provides a framework for public health, including measures for ensuring food safety and sanitation within various facilities, while the National Norms and Standards for Environmental Health set forth specific guidelines for maintaining hygiene standards, including those applicable to food handling and preparation areas. When food handlers understand the reasons behind these regulations, they are more likely to follow them correctly and consistently, and this knowledge also helps them manage unexpected situations by applying the fundamental principles of the regulations to make informed decisions. Training that explains the purpose of these rules is more effective, leading to better retention and application of the information, and continuous education ensures that food handlers remain updated on the latest food safety practices and regulations, highlighting the importance of ongoing learning to maintain high standards of food safety. Furthermore, when food handlers appreciate the importance of these regulations, they are generally more engaged and motivated in their roles; thus, by clarifying the reasons behind food safety regulations, policymakers can promote a more informed and proactive approach to food handling, thereby improving overall public health and safety.

Integration in food safety

Integrating technology into food safety management requires collaboration among policymakers, EHPs and food handlers. Digital tools for monitoring, reporting and maintaining compliance can streamline processes and enhance efficiency. Policymakers play a key role in supporting the adoption of these technologies by providing necessary resources and training to both food handlers and EHPs, emphasising how technological advancements can improve food safety practices. To make these tools accessible and widely adopted, the government can implement several strategies. Financial support through subsidies and grants can assist facilities, especially those with limited budgets, in covering the costs of these technologies. Additionally, fostering public-private partnerships can help technology providers offer discounted rates or tailored solutions for food safety compliance. Providing training programmes and technical support is essential to ensure that facilities can effectively implement and use these tools, thereby maximising their impact on compliance and general food safety.

Periodic audits and reviews

Regular audits at old age homes are essential for identifying and addressing problems in food safety practices and ensuring hygiene standards are upheld. These audits, typically conducted following self-assessments, should be performed by Environmental Health Practitioners (EHPs), who inspect food preparation and handling processes, evaluate cleanliness, and verify compliance with food safety regulations. Key focus areas include the condition of food storage, the effectiveness of sanitation practices, and the proper handling of food to prevent contamination. The integration of technology can enhance the audit process by providing EHPs with digital tools to monitor compliance in real time; for example, mobile apps enable on-site assessment, documentation of findings, report generation, and immediate feedback to food handlers, thereby increasing audit efficiency and reducing disruption to daily activities. Collaboration between EHPs and food handlers during audits is crucial, as it facilitates valuable feedback, practical support, and advice on improving hygiene practices and implementing corrective measures. Moreover, technology can improve communication between EHPs and food handlers, allowing easier sharing of best practices and resources. Since food handlers often lack direct access to policymakers, EHPs act as a vital link by relaying their feedback and concerns, ensuring that practical challenges are addressed and regulations remain relevant and effective. Overall, incorporating technology into the audit process enhances its effectiveness, contributing to continuous improvements in food safety practices in old age homes.

6.7 Study Limitations

The study focused specifically on old age homes in the Free State Province. However, not all facilities were operational at the time of data collection, as some were still awaiting registration approval. As a result, only 14 operational homes were included in the study. Data collection was based on self-reported information from food handlers, supplemented by direct observations conducted by the researcher to assess food safety knowledge and practices. While this approach provided valuable insights, it may introduce some bias, particularly when attempting to generalise the findings to broader contexts. Considering no formal statistical tests for significance (such as chi-square or t-tests) were conducted, the findings are presented using descriptive statistics only. Frequencies and percentages were used to report the extent to which food safety standards were followed across the selected facilities. Given these limitations, caution should be exercised when interpreting or generalising the results to other settings. Future research should aim to include a broader range of participants and apply more rigorous statistical analyses and data collection methods to enhance the reliability and depth of the findings.

6.8 Conclusion

This study provided useful insights into the cleanliness and hygiene practices of kitchen surfaces in old age homes, highlighting the need to improve hygiene standards to reduce the risk of foodborne illnesses among elderly residents. The MALDI-TOF MS analysis identified various types of bacteria on kitchen surfaces, revealing potential sources of contamination and underscoring the importance of strict hygiene practices. These results call on stakeholders in old age homes, including the Department of Social Development and Department of Health, to prioritise food safety and adopt thorough hygiene protocols. By adhering to regulations and applying best practices in food handling and sanitation, old age homes can create safer environments for residents and lower the risk of foodborne illnesses. Ongoing research and regular monitoring remain essential to maintaining hygiene standards and protecting the health and well-being of elderly residents. Importantly, this study contributes to knowledge by providing one of the first detailed microbiological assessments of kitchen surface contamination specifically in old age homes within the South African context, addressing a gap in existing research. While prior studies have generally focused on food hygiene in broader institutional settings, this research offers a focused understanding of microbiological risks in environments serving elderly populations, a group particularly vulnerable to foodborne diseases. Furthermore, by using advanced MALDI-TOF MS technology, the study presents a novel approach to accurately identifying bacterial contaminants, enhancing the specificity and reliability of hygiene assessments in these settings. This contribution not only expands the

scientific literature on environmental health risks in aged care facilities but also informs practical interventions tailored to the unique needs of this vulnerable population. By filling this knowledge gap, the study supports evidence-based policy formulation and the development of targeted hygiene training programs for food handlers in old age homes, ultimately aiming to improve resident health outcomes.

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ANNEXURES

Annexure 1

Permission Letter for Study Participation

Researcher:

Ms. Tshegofatso Nhabe

Central University of Technology

tshegofatson5@gmail.com

Supervisor:

Professor Ntsoaki J. Malebo

Central University of Technology

Centre for Innovation in Learning and
Teaching

nmalebo@cut.ac.za

PROJECT TITLE: Food Safety Practices and Quality Assurance Mechanisms at old age homes in Mangaung and Lejweleputswa.

My name is Tshegofatso Nhabe, a doctoral student from the Central university of Technology, Free State. I am currently conducting a study titled; Food Safety Practices and Quality Assurance at Old Age Homes in Mangaung and Lejweleputswa. I am kindly requesting you to participate in the study; its purpose is to investigate common food safety practices and quality assurance mechanisms related to food safety issues in old age homes. The study objectives include administering questionnaires to old age home food handlers and their managers to collect information on the knowledge and practices of these food-handlers; and quality assurance mechanisms related to food safety issues in old age homes.

The findings will be used to improve the food safety and quality mechanisms at old age residential facilities so that they comply with South Africa's Food Related Legislations.

Researcher Contact Information:

Tshegofatso Nhabe

Central University of Technology

9300

Tel: 073 9910 793

Annexure 2

Permission to Conduct Research



social development

Department of
Social Development
FREE STATE PROVINCE

OFFICE OF THE HEAD OF DEPARTMENT

Attention: Ms. T Nhabe
864 Mokgadinyana Street
Seloseshu
THABA NCHU
9783

Per email: tshegofatson5@gmail.com

Dear Ms. Nhabe

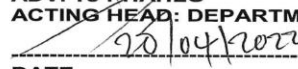
RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. Your letter dated April 05, 2022 pertaining to the above mentioned refers.
2. You are hereby informed that approval has been granted to conduct the research as per your request.
3. Kindly make contact with the Director: Special Needs, Me Mamosa Motsoeneng at 066 487 6278
4. It will be highly appreciated if you can share your findings with the Department.

Hoping you find the above in order.

Regards


ADV. TJ PHAHLO
ACTING HEAD: DEPARTMENT OF SOCIAL DEVELOPMENT


DATE

Office of the Head of Department
Private bag X20616, Bloemfontein, 9300
Standard Bank Building, 2nd Floor, Cnr West Burger & Charlotte Maxeke Streets, Standard Bank Building
Email: hodpa@fssocdev.gov.za

www.fs.gov.za

Annexure 3

Ethical Clearance (GHREC)



GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

01-Jul-2023

Dear Ms. Tshegofatso Nhabe

Application Approved

Research Project Title:

Food Safety Practices and Quality Assurance Mechanisms at Old Age Homes in the Free State.

Ethical Clearance number:

UFS-HSD2023/0476

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. Furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

Dr Adri Du Plessis

Chairperson: General/Human Research Ethics Committee

Adri Du Plessis
Digitally signed by Adri Du Plessis Date: 2023.07.02 15:22:39
205 Nelson Mandela Drive P.O. Box 313
Park West Bloemfontein 9301 South Africa
Tel: +27 (0)51 401 9337

Annexure 4

Ethical Clearance (EBREC)



Environment & Biosafety Research Ethics Committee

08-Jul-2023

Dear Ms. Tshegofatso Nhabe

Project Title: Food Safety Practices and Quality Assurance Mechanisms at Old Age Homes in Free State.

Department: CUT - Central University of Technology APPLICATION APPROVED

This letter confirms that this research proposal was given ethical clearance by the Environment & Biosafety Research Ethics Committee of the University of the Free State.

Your ethical clearance number, to be used in all correspondence is: UFS-ESD2023/0104

Please note the following:

This ethical clearance is granted for data collection for this project for the duration of 02 Year/s from the issuance of this letter.

If the duration of the data collection indicated above is less than one year, your ethics clearance will be valid for 12 months from the issuance of this letter. Please submit a Continuation Report to the Ethics Committee if your data collection takes longer than a year, or longer than the allotted time indicated above if it is longer than one year.

Please note that the maximum amount of time that ethical clearance will be granted is 5 years, and that a Continuation Report must be submitted for any projects where data is collected for longer.

If any changes are made during the research process (including a change in investigators), please inform the Ethics Committee by submitting an Amendment.

When the research is concluded, please submit a Final Report to the Ethics Committee.

Thank you for your application and we wish you well in all of your research endeavors. Yours
Sincerely



Prof. RR (Robert) Bragg

Chairperson: Environment & Biosafety Research Ethics Committee University of the Free State

Annexure 5

Research Study Information and Consent Form

Title of the research project: FOOD SAFETY PRACTICES AND QUALITY ASSURANCE MECHANISMS AT OLD AGE HOMES IN FREE STATE.

Principle investigator / researcher(s) name(s) and contact number(s):

Name of student/researcher: Tshegofatso Nhabe

Student number: 208048961

Contact number: 073 991 0793

Faculty and Department: Life Sciences

Name of Faculty: Health and Environmental Sciences

Name of Department: Life Sciences

Study leader(s) name and contact number:

Name of Study Leader: Professor Ntsoaki J. Malebo

Contact number: 051 507 3245

What is the aim/purpose of the study? This study investigates food safety practices and quality assurance mechanisms in old age homes across the Free State. The objective is to assess the food safety knowledge and practices of food handlers and managers using questionnaires, focus groups, and checklists, and to develop an evaluation tool for continuous food safety monitoring.

Who is doing the research? The study is led by Tshegofatso Nhabe, a doctoral candidate at the Central University of Technology, Free State, under the title "Food Safety Practices and Quality Assurance Mechanisms at Old Age Homes in the Free State Province." The research highlights the need for food safety among the elderly, a vulnerable population often overlooked in foodborne illness prevention efforts.

Has the study received ethical approval? Yes, the Research Ethics Committees of the University of Free State have reviewed and approved the study proposal.

Why are you invited to take part in this research project? Participants are selected from Free State old age homes, identified via the Department of Social Development, with support from Environmental Health Practitioners (EHPs). Approximately six participants per facility, totalling around 100 individuals, will take part to represent shifts.

What is the nature of participation in this study? Participants will share their understanding of food safety and hygiene in questionnaires (30 minutes) and focus groups (1 hour), covering topics like personal hygiene, food safety systems, and cleaning practices.

Can the participant withdraw from the study? Participation is voluntary, and participants may withdraw at any time without penalty. However, once questionnaires are submitted, withdrawal is no longer feasible.

What are the potential benefits of taking part in this study? This research may help improve Environmental Health Practitioner training and inspections, guide old age homes toward regulatory compliance, and enhance food safety practices, reducing foodborne illnesses in the public health sector.

What is the anticipated inconvenience of taking part in this study? There are no significant risks, though participants might feel uncomfortable if certain practices are shown to be unsafe and potentially cause foodborne illnesses.

Will what I say be kept confidential? All responses will be kept confidential, with answers coded or pseudonymized in publications. Only the research team and designated reviewers will have access to the data. Participants are encouraged not to share sensitive information in focus groups, although complete confidentiality in group settings cannot be guaranteed.

How will the information be stored and ultimately destroyed? Data will be stored securely at the Central University of Technology for five years. After this period, hard copies will be shredded, and electronic data deleted, following ethical standards.

Will I receive payment or any incentives for participating in this study? No payments or incentives will be provided for participation.

How will the participant be informed of the findings/results of the study? Participants interested in the final findings may contact Ms. Nhabe or Professor Ntsoaki J. Malebo, with findings available for five years. Concerns about research conduct can also be directed to Professor Ntsoaki J. Malebo. Thank you for reading and considering participation in this study.

Annexure 6

Questionnaire

SECTION 1 - PERSONAL HYGIENE

Do staff have access to a dedicated wash hand basin in the kitchen?

☐Yes ☐No

If NO, what facilities are available for hand washing and where are they located?

.....

.....

.....

Does the wash hand basin have hot and cold, or appropriately mixed water?

☐Yes ☐No

Is there soap or anti-bacterial hand wash available at the wash hand basin?

☐Yes ☐No

Is there a hygienic method for drying hands at the wash hand basin?

☐Yes ☐No

If YES, what method is used to dry hands?

.....

.....

.....

Are staff provided with changing and storage facilities for their outdoor clothes?

☐Yes ☐No

Is there a designated WC (“water closet” or toilet/restroom) with wash hand basin available to staff?

☐Yes ☐No

9. Please provide details of your “fitness to work” policy:

.....

.....

.....

PROCESSES AND PROCEDURES

Purchase and Delivery

Please provide the details of who you intend to use as your food suppliers and the products they supply.

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.....

What checks will be undertaken on receipt of a food delivery.

.....

.....

.....

Will temperature checks be taken on the food delivery?

☐Yes ☐No

If yes, what temperature are you looking for?

.....

Food Storage

How will food be protected from contamination during storage?

.....

.....

.....

How will you ensure correct stock rotation, please provide details?

.....

.....

.....

How will you ensure adequate separation of raw and cooked / ready-to-eat foods during storage?

.....

.....

.....

Do you check temperatures of chillers regularly?

☐Yes ☐No

What temperature should the chillers hold food at?

.....

Do you check the temperatures of freezers regularly?

☐Yes ☐No

What temperature should the freezers hold food at?

.....

Defrosting

Will any frozen foods be defrosted on the premises?

☐Yes ☐No

If YES, please provide details, including foods defrosted and how and where defrosting will take place.

.....

.....

.....

Preparation

Will the preparation of open food be undertaken on the premises, i.e., slicing meat/cheese, sandwich preparation, etc.?

☐Yes ☐No

If YES, please provide details,

.....

.....

.....

How will you keep raw and cooked/ready-to-eat foods separate during preparation?

.....

.....

.....

Cooking

Will any cooking of food be undertaken on the premises?

☐Yes ☐No

If YES, please provide details,

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.....

.....

What methods are used to ensure that foods are thoroughly cooked?

.....

.....

.....

What temperature do you cook food at?

.....

.....

.....

Will any records be kept?

☐Yes ☐No

If yes, what records are kept?

.....

.....

Cooling

Please provide details of foods and methods used for cooling.

.....

.....

.....

Reheating

Will any reheating of food be undertaken on the premises?

☐Yes ☐No

If YES, please provide details,

.....

.....

.....

How are temperatures of reheated foods monitored?

.....

.....

.....

Are sick employees' records kept? (In case there is a foodborne illness)

☐Yes ☐No

Hot Holding

Are foods kept 'warm' before served?

☐Yes ☐No

If YES, please provide details,

.....

.....

.....

How will the risk of contamination of food on display be prevented?

Provide details,

.....

.....

.....

Other Areas

Please provide any other details related to your kitchen which you feel are important, but were not covered in the answers to the questions:

.....

.....

.....

SECTION 2 - FOOD SAFETY MANAGEMENT SYSTEMS

Do you have a written food safety management system in place, e.g. Standard Operating Procedure manual, Hazard Analysis Critical Control Point (HACCP) for food safety?

☐Yes ☐No

If YES, what areas of work are covered, please provide details.

.....

.....

.....

When was your “food safety management system” last reviewed?

.....

.....

.....

PREMISES CONSTRUCTION AND LAYOUT (OCCU PURPOSES)

Are food storage, preparation areas, work surfaces and display units well-constructed and capable of being easily cleaned?

☐Yes ☐No

If YES, what materials are they made of?

.....

.....

.....

Are you satisfied that the premises have a satisfactory level of lighting and ventilation?

☐Yes ☐No

If YES, what type of lighting and ventilation do you have?

.....

.....

.....

Please provide details of equipment used in connection with the institution, e.g., oven, ice-machine, hot and cold display units, etc.

.....

.....

.....

Who is responsible for the maintenance and repair of the premises and equipment?

.....

.....

.....

SECTION 3 - CLEANING

Where will the cleaning materials / chemicals be stored on the premises?

.....

.....

.....

Will you have a cleaning schedule/roster?

☐Yes ☐No

If YES, please provide details including tasks, instructions, staff, etc.

.....

.....

.....

Please provide details of the cleaning chemicals you plan to use to:

Clean the floor:

.....

.....

.....

Clean food preparation surfaces:

.....

.....

.....

Hand-contact surfaces (such as door handles):

.....

.....

.....

Do the products conform to (British Standard European Norm) BS EN 1276 and BS EN 13697?

☐Yes ☐No

.....

SECTION 4 - PEST CONTROL AND REFUSE

How do you control pests found on the premises, e.g., bait stations, etc.

.....

.....

.....

Do you have a formal pest control contract?

☐Yes ☐No

If YES, please provide details of the company you will use and the frequency of their visits.

.....

.....

.....

If NO, please provide details

.....

.....

.....

Are there adequate facilities for the storage and disposal of refuse and food waste?

☐Yes ☐No

If YES, please provide details, e.g., waste contractor details, collection days, location of bins, etc.....

.....

.....

Are there adequate facilities for the storage and disposal of waste oil?

☐Yes ☐No

If YES, please provide details, e.g., waste contractor details, collection days, location of bins, etc.....

.....

.....

Annexure 7

Food Safety and Hygiene Checklist

SITE

DATE

POLICY ARRANGEMENTS

Food premises registration available and signed?

Yes		No		NA	
-----	--	----	--	----	--

Food policy statements in place

Yes		No		NA	
-----	--	----	--	----	--

Policy documentation available, signed and dated?

Yes		No		NA	
-----	--	----	--	----	--

Is the documentation brought staffs attention?

Yes		No		NA	
-----	--	----	--	----	--

PERSONAL HYGIENE

Employees wear clean and proper clothing, including closed toe shoes?

Yes		No		NA	
-----	--	----	--	----	--

Are effective hair restraints, such as a hairnet or hat, properly worn?

Yes		No		NA	
-----	--	----	--	----	--

Are hands washed properly, frequently, and at appropriate times?

Yes		No		NA	
-----	--	----	--	----	--

Is eating, chewing gum, smoking, and using tobacco only allowed in designated areas and away from preparation, service, and food storage?

Yes		No		NA	
-----	--	----	--	----	--

Staff beverages have lids and are kept where they cannot spill onto foods?

Yes		No		NA	
-----	--	----	--	----	--

Employees use disposable tissues when coughing or sneezing, and immediately wash hands and change gloves?

Yes		No		NA	
-----	--	----	--	----	--

Hand sinks are stocked with soap, disposable towels, and warm water?

Yes		No		NA	
-----	--	----	--	----	--

FOOD PREPARATION

Are food equipment, utensils, and food contact surfaces properly washed, rinsed, and sanitized before every use?

Yes		No		NA	
-----	--	----	--	----	--

Is frozen food is thawed under refrigeration, in the microwave, and cooked to a proper temperature from a frozen state, or in cold running water?

Yes		No		NA	
-----	--	----	--	----	--

Is the food handled with suitable utensils, such as single-use gloves or tongs?

Yes		No		NA	
-----	--	----	--	----	--

Are clean reusable towels used only for sanitizing equipment and surfaces and not for drying hands, utensils, or the floor?

Yes			No		NA	
-----	--	--	----	--	----	--

Is the food cooked to the proper internal temperature and tested with a clean, calibrated thermometer? Is the temperature documented?

Yes		No		NA	
-----	--	----	--	----	--

REFRIGERATOR AND FREEZER

Are the refrigerator and freezer units neat and clean?

Yes		No		NA	
-----	--	----	--	----	--

Is the refrigerator temperature at or below 4°C?

Yes		No		NA	
-----	--	----	--	----	--

Is the food protected from any sources of contamination?

Yes		No		NA	
-----	--	----	--	----	--

FOOD AND DRY STORAGE

Is every item of food stacked 6 to 8 inches off from the ground's surface?

Yes		No		NA	
-----	--	----	--	----	--

Is the food stored in the original container or a food grade container?

Yes		No		NA	
-----	--	----	--	----	--

Are there bulges or leaking on canned goods?

Yes		No		NA	
-----	--	----	--	----	--

Is the food protected from any source of contamination?

Yes		No		NA	
-----	--	----	--	----	--

Are the chemicals clearly labelled and stored away from food?

Yes		No		NA	
-----	--	----	--	----	--

EQUIPMENT AND UTENSILS

Are utensils and equipment cleaned and sanitized between uses?

Yes		No		NA	
-----	--	----	--	----	--

Are work surfaces and utensils clean?

Yes		No		NA	
-----	--	----	--	----	--

Are food carts or containers used to transport food cleaned daily?

Yes		No		NA	
-----	--	----	--	----	--

Is the thermometer cleaned and sanitized between uses?

Yes		No		NA	
-----	--	----	--	----	--

Are the can openers clean?

Yes		No		NA	
-----	--	----	--	----	--

DISH WASHING

Is the sink properly set up for ware washing or dish machine is working properly?

Yes		No		NA	
-----	--	----	--	----	--

Are water temperatures correct (Hot and Cold)?

Yes		No		NA	
-----	--	----	--	----	--

Does the smallware and utensils have space to air dry?

Yes		No		NA	
-----	--	----	--	----	--

WASTE STORAGE AND PEST CONTROL

Are kitchen waste cans clean and emptied as necessary?

Yes		No		NA	
-----	--	----	--	----	--

Are delivery boxes and containers removed from kitchen site?

Yes		No		NA	
-----	--	----	--	----	--

Is there evidence of pests present?

Yes		No		NA	
-----	--	----	--	----	--

Full Name and Signature of the researcher

.....

Annexure 8

Turnitin Report

PHD Document			
ORIGINALITY REPORT			
12%	10%	4%	5%
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