

FOOD SAFETY AND HYGIENE PRACTICES ASSOCIATED WITH THE NATIONAL SCHOOL NUTRITION PROGRAMME AMONGST QUINTILE 1-3 SCHOOLS IN WELKOM, SOUTH AFRICA

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Dissertation submitted in fulfilment of the requirement for the degree

M_HSEN: Master of Health Sciences in Environmental

Health in the

Faculty of Health and Environmental Sciences

at the

Central University of Technology, Free State

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Bloemfontein, South Africa, 2023

DECLARATION OF INDEPENDENT WORK

I, Tlholohelo Precious Tsolo, do hereby declare that this research project submitted to the Central University of Technology, Free State for the degree MSc: ENVIRONMENTAL HEALTH is my own work, and that it has not been submitted before to any institution by me or any other person in fulfilment of the requirements for the attainment of any qualification.

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SUMMARY

Poverty is defined as the inability of people to obtain adequate resources measured in calories or nutrition to support a minimum level of physical health, resulting in malnutrition. The consequences of poor nutrition during foetal development and in early childhood cause severe and irreversible mental and physical damage. In 1994, to alleviate poverty conditions, the schools nutrition programme was initiated in South Africa. Later in 2006 after a survey was conducted, it was decided that an expansion to high schools was deemed necessary. Upon its expansion in 2009 to high schools, the PSNP was renamed and became known as the National School Nutrition Programme (NSNP). A pro-poor funding model has been applied to fund public education in this system of governance; the schools are classified based on the level of poverty in their surrounding areas and infrastructure. Since its inception, inadequate storage facilities whereby the foodstuffs are stored directly on the floor, in humid environments and in other cases in areas/rooms that are not rodent proof to prevent pests such as ants, rats from gaining access and unsuitable meal preparation have emerged as challenges and concern in the NSNP. Lack of infrastructure resulted in foodstuffs being stored in bookstores, classrooms turned into kitchens and the like. Schools participating in the NSNP have limited provision for dining facilities and in other cases, the learners have to eat outside without any supervision - a scenario that exposes the food to contamination from environmental factors. The vulnerability of the individuals depending on the food, such as age and health status, emphasizes the fact that the food is of good microbial quality and that food safety must be a priority.

Microbial contamination is associated with many foodborne outbreaks around the world. In South Africa, the individuals that are employed to do the catering for the NSNP are mostly women from the surrounding area, closer to the school or parents to a child/children attending a specific school. In most cases, these women have only limited knowledge of food safety and hygiene which they acquired from one generation to the other and through their experiences growing up. Episodes of microbial contamination occur mostly via cross-contamination, where the microbes on the food contact surfaces get transmitted to the

hands of a food handler and eventually, the food or vice versa, this triggers food-borne pathogens to multiply and cause illnesses and in some instances may escalate to foodborne outbreaks. As mentioned, control of food-borne pathogens is a major challenge in a setting such as the NSNP, where food is served by a variety of people with different hygiene practices, beliefs and to a large group of people. Good personal hygiene and proper food handling practices can minimise the transfer of pathogenic microorganisms between the food, food contact surfaces and consumers. In the last decade, the food safety fraternity has evolved tremendously whereby authors have shifted the focus from a formal and technical-orientated Food Safety Management System (FSMS) to a more human dimension of food safety such as food safety culture and food safety climate.

The overarching aim of this study was to evaluate hygiene practices and to investigate the microbial composition of the foodstuffs associated with the National School Nutrition Programme (NSNP). To achieve this an inspection checklist was used to assess the hygienic status of the food preparation area. The results indicated that the kitchens vary notably from one school to another, and the issues of hygiene observed were mostly contributed to lack of equipment, infrastructure and the limited knowledge of the food handlers. Various food samples were analysed for the presence of hygiene indicator organisms including *Staphylococcus* species (indicator of human contact and activity), *Listeria* species (indicator of presumptive mesophilic, environmental pathogens) and Total Coliforms (indicator of sanitary hygiene). Twenty-eight percent of all food samples collected, were positive for *Staphylococcus spp* and 59% for Total Coliforms. Also, the hands of the food handlers indicated 63% detection of *Staphylococcus spp.* and 50% for Total Coliforms. Food contact surfaces showed 50% for *Staphylococcus spp.*, 56% for Total Coliforms and 50% presumptive *Listeria spp.* The results obtained from the microbiological quality of municipal water indicated that the water stored in the buckets had a higher Total Coliform count as opposed to water coming from the tap. Statistical analyses did not show a statistical significance ($p = 0,425 > 0,05$) between Total Coliform from water collected from the tap vs water from the bucket, suggesting that the water quality was likely affected during storage and not during collection. To assist the schools in establishing and implementing food safety prerequisite programmes (PRP's) and

ensuring that they achieve acceptable hygiene statuses, the WHO “5 Keys to Safer Food” posters were distributed and presented comprehensively, to ensure food handlers and beneficiaries fully understand their role and responsibilities concerning food safety during food handling, preparation and serving. Re-assessing of the schools after a set period, to determine the effectiveness of the interventions, are recommended.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude towards the following individuals and organisations:

- ✠ The Almighty GOD, who kept shining the light through and through, His timing and blessings.
- ✠ Prof. Ryk Lues, (my supervisor) for his constant support, guidance, patience, for keeping me on course and never giving up on me, and MJ Manyatsa and Dr Manyi-Loh, my co-supervisor for the constant support, words of encouragement and being a shoulder to lean on.
- ✠ My mother (Limakatso) for her support, prayers, patience and believing in me when I didn't believe in myself. Most importantly, for always reminding me that I am the architect of my life. Not forgetting, my late father (Tsotetsi) for his unconditional love, being strict and all the sacrifices he made to ensure that I succeed in life. Oh! how I wish he was here to witness all these. Lastly, to my family for their support and unconditional love.
- ✠ My friends and colleagues, especially Maduna S, Majodina N and Masina T for the support, the encouragement and for always being there for me throughout the project. It would have not been possible without your assistance and cooperation.
- ✠ The Centre for Applied Food Safety and Biotechnology (CAFSaB) staff members more especially Dr O de Smidt for being the light in moments of darkness and hopelessness, and fellow research mates for their support, advice, and words of encouragement.
- ✠ Free State Department of Basic Education, Mr Thethani (DoE Lejweleputswa) and his team, not forgetting the principals, teachers,

coordinators, the food handlers and everyone who participated in the study in one way or the other and including those who opened their doors when I came knocking.

- ✦ The Central University of Technology, Free State, for financing my studies through the Research Innovation Fund, NRF block grant and the HWSETA.

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LIST OF ACRONYMS

BPA:	Baird Parker Agar
BPW:	Buffered Peptone Water
CGF:	Conditional Grant Framework
DBE:	Department of Basic Education
DoE:	Department of Education
DoH:	Department of Health
DoRA:	Division of Revenue Act
DWA:	Department of Water Affairs
<i>E. coli:</i>	<i>Escherichia coli</i>
EHP:	Environmental Health Practitioner
FBDG:	Food-Based Dietary Guideline
FIFO:	First in First Out system
FSMS:	Food Safety Management Systems
GHP:	Good Hygiene Practices
HACCP:	Hazards Analysis Critical Control Point
HOD:	Head of Department
IWRM:	Integrated Water Resource Management
KAP:	Knowledge, Attitude and Practices
LD:	Lethal Dose
MDGs:	Millennium Development Goals
MPN:	Most Probable Number
ND:	Not Detected
NMMP:	National Microbial Monitoring Programme
NSNP:	National School Nutrition Programme
OBL:	One Broth Listeria
PCA:	Plate Count Agar
PPE:	Personal Protective Equipment
PRPs:	Pre-requisite programs
PSNP:	Primary School Nutrition Programme
Q:	Quintile

R638: Regulation governing the general hygiene requirements for food premises, the transport of food and related matters.

SANS: South African National Standards

SBG: School Governing Body

SMT: School Management Team

S. aureus: *Staphylococcus Aureus*

TCs: Total Coliforms

TNTC: Too Numerous to Count

TVC: Total Viable Count

UNICEF: United Nations International Children's Emergency Fund

VFHS: Voluntary Food handler

WHO: World Health Organisation.

WSP: Water Service Provider

CHAPTER 1

INTRODUCTION

1.1 The global poverty cycle

Poverty is defined as the inability of people to obtain adequate resources measured in calories or nutrition to support a minimum level of physical health. As a result, poverty is the leading factor in malnutrition. Approximately, 1 billion children worldwide are living in poverty, and according to UNICEF (2013), 22,000 children die each day as a result of poverty. Hunger as a result of poverty is considered the leading cause of death around the world, killing more than HIV/AIDS, malaria and tuberculosis combined. Wardlaw, *et al.* (2004) and Blake *et al.* (2010) highlighted that the major contributing factor to child morbidity and mortality in developing countries is the combination of malnutrition and infection. It is estimated that nearly 30% of infants, children, adolescents, adults and elderly people in developing countries are suffering from one or more multiple forms of malnutrition, while each year 49% of the 10 million deaths reported are associated with malnutrition among children less than five years of age, and another 51% of them are associated with infections and other causes (FAO, 2004).

Poor nutrition during foetal development and in early childhood cause severe and irreversible mental and physical damage. Undernourished children are more likely to die young, are susceptible to diseases, and will suffer stunted physical and mental capability throughout their lives. They will perform worse in school, earn less in their adult life and become more susceptible to non-communicable diseases in adulthood (Bhutta, 2013; Haddad, 2013; Hoddinott, *et al.* 2011; Martorell, 1996; Martorell *et al.*, 2010; Nisbett *et al.*, 2014). Currently, the World Health Organisation (WHO) aims at ending all forms of malnutrition by 2030, including the achievement of internationally agreed targets on stunting and wasting in children under five (5) years of age, as well as to address the nutritional needs of adolescent girls, pregnant and lactating women alongside older persons by 2025 (WHO, 2021).

1.2 Conception of the school feeding schemes in South Africa

The Constitution of South Africa states that children have the basic right to nutrition, shelter, health care and social services. Despite this right being constituted due to the heightened rate of poverty that affects many communities around South Africa, it is difficult for this right to be fulfilled, as many people live in conditions where the availability of food and portable water is limited. In the country, 39% of the population is affected by food insecurity, with chronic malnutrition affecting 22% of children below the age of nine (9) years (MDG report, 2015). More than half of South Africans live below the national poverty line, and more than 10% live in extreme poverty, on less than R15.85 per day. In 1994, to alleviate these conditions, the nutrition programme was initiated to develop a nutrition strategy for South Africa. This initiative resulted in the launch of the Primary School Nutrition Programme (PNSP) in September 1994, which targeted only primary schools. This was the result of an announcement by former President Nelson Mandela that such a nutritional feeding scheme would be implemented in every primary school where such a need was recognised (Bonti-Ankomah, 2002).

In 2006, following a survey that was conducted, it was decided that an expansion of the nutrition programme to high schools was necessary, and upon the expansion of the PNSP to high schools in 2009, the PSNP was renamed and became known as the National School Nutrition Programme (NSNP). The NSNP is classified as one of the essential components of the government's programme of action, specifically assigned the responsibility of addressing children's ability to learn by providing them with nutritious meals (Department of Basic Education (DBE), 2009). The NSNP is funded through a conditional grant that is transferred to all the provinces based on the Division of Revenue Act (DoRA) and related policies. The implementation of the programme derives its mandate from the NSNP Conditional Grant Framework (CGF) stipulating certain conditions that the education departments must adhere to (NSNP report, 2014). A pro-poor funding model is used to fund public education in this system of governance. Schools are classified based on the level of poverty in their surrounding areas and infrastructure. The schools are then ranked between quintiles 1 and 5. Schools in quintiles 1 to 3 are

no-fee-paying schools wholly subsidised by the government, whereas schools in quintiles 4 to 5 are fee-charging schools with partial subsidy from the government (Dass & Rinquest, 2008).

1.2.1 Delineation of the feeding scheme setting

Many of the learners who benefit from the NSNP are children from poor backgrounds and communities, and they have been grouped in the quintiles 1-3 category, who in some instances depend merely on that single meal they receive at school. Nutrition programmes in schools not only provide essential nutrients for the learners, but also teach children to make informed decisions regarding their diets (Lucas, 1993), this can be incorporated into the syllabus and learning subject such as life skills or life orientation. Furthermore, it reduces the increased drop-out rate of children from schools due to hunger, and also aids children to be attentive, active, social and to participate in classroom activities at school.

In South Africa, the individuals that are employed to do the catering for the NSNP are mostly women living in the surrounding area close to the school, or parents with either a child or children attending that specific school. These women are randomly selected by the School Governing Body (SGB) and the School Management Team (SMT) by drawing out an identity document from a box/hat, and they receive monthly stipends for a period between one to two years. In most instances, these women have basic knowledge about food safety and hygiene; mostly, it is knowledge they acquired from one generation to the other, through their experiences while growing up and running their households. The meals provided for the learners follow a Food Based Dietary Guideline as stipulated by the Department of Health with a voluntary food handler (VFHs) ratio of 1:200 learners (NSNP report, 2014). For each day of the week, the VFHs are provided with a set menu for the type of food to serve. However, in some schools, the VFHs, coordinator or SMT may swap the menu, especially if there is a shortage of a certain foodstuff. This serves as a measure to ensure that the learners are provided with a meal instead of not preparing a meal at all as this contributes to daily dietary requirements. In other instances, some

schools receive external funding or sponsors enabling the mentioned schools to have the luxury of eating outside the set standard menu which includes plant protein options such as soy foods and serving animal protein sources such as meat as an option. Furthermore, the ratios in which the learners are served vary amongst primary, special and high schools (see *Appendix 1*).

1.2.2 The gaps that exist

Inadequate storage facilities of foodstuffs and the lack of an area for proper meal preparation are the major challenges and concerns for schools participating in the NSNP. This has resulted in foodstuffs being stored in the school storeroom where books, etc. are stored, and in other cases, a classroom is converted into a kitchen as indicated in Figure 1.1.

Previous studies conducted by Manyatsa (2007) and Venter *et al.* (2003) revealed that inadequate storage facilities have the potential to contribute to foodstuff deterioration and contamination which occurs during food processing and handling, besides equipment coming into contact with foodstuffs as well as during the serving and packaging of food. Furthermore, the schools participating in the NSNP have no provision of dining facilities, and in other cases the learners have to eat outside without any supervision, consequently exposing the food to contamination from various environmental factors.

As a result, during food preparation it is imperative that the vulnerability of those depending on the meals be regarded of utmost importance to ensure that the food is of good microbial quality, does not contribute to any foodborne illnesses, and that the food safety standards are achieved.



Figure 1.1: Storage of NSNP groceries in some schools

1.3 RATIONALE

1.3.1 Delineating the problem statement.

During food preparation, the basic hygiene status implemented must be of high quality, as contamination occurs when there is insufficient cleaning of the food premises and improper disinfection of the equipment, the food contact surfaces and the hands of food handlers. Studies by Chan and Chan (2008); Food and Drugs Administration (2009); Greig *et al.* (2007) revealed that among the practices of food handlers which are associated with foodborne outbreaks are inadequate hand hygiene; inadequate hygiene of the equipment and the utensils; maintenance of ready-to-eat food at room temperature; preparation of meals in advance; insufficient cooking temperature and inadequate thawing. The implementation of the above aspects is a challenge, especially in settings such as the NSNP, since food is prepared in large quantities with limited resources

including a lack of proper equipment and utensils, sanitation programmes and infrastructure.

1.3.2. Aims and objectives

The general aim of this study was to evaluate hygiene practices and to investigate the microbiological composition of the food served to the learners. Furthermore, the aim was to make a significant contribution in terms of improving the knowledge, attitudes, behaviour and practices of the voluntary food handlers concerning the microbiological food safety of the food served within the NSNP; and to ensure that no learner becomes sick or suffer from food poisoning. The study was grounded on both analytical and qualitative (interpretive) enquiries amongst quintile 1 - 3 schools participating in the National School Nutrition Programme (NSNP) in Welkom, Free State Province, South Africa. This was achieved by setting the following objectives:

- I. Provide an extensive overview of the hygiene status of the food preparation area within the NSNP.
- II. Determine the knowledge, attitude and practices of the food handlers within the schools participating in the NSNP.
- III. Assess the microbial composition of the food, the hands and food contact surfaces within the schools participating in the NSNP.
- IV. Investigate the microbial quality of the water used for food preparation within the schools participating in the NSNP.

The findings are aimed at assisting in the development of applicable processes as well as cleaning and sanitation programmes, which would eventually lead to the formulation of a hygiene assessment document for the NSNP that would ensure that microbial limits are not exceeded, standards conformed to, and risks minimised.

1.4 LAYOUT OF THE CHAPTERS

The chapter layout is as follows:

CHAPTER 1: Introduction

This chapter will be outlining the overview of food security worldwide and in the South African context. Moreover, the gaps that exist, rationale, aims and objectives will be provided.

CHAPTER 2: Literature review

In this chapter extensive literature will be provided on the background of the National School Nutrition Programme (NSNP) which will outline the factors influencing food safety, overview of foodborne illnesses, microbial contamination as well as the significance of food safety and episodes of microbial contamination.

CHAPTER 3: Materials and methods

A synopsis of the study area and population size will be highlighted with features of the description of the schools, where the samples were collected from, what was sampled at each school and how it was measured.

CHAPTER 4: Results and discussion

The results and findings obtained from the various sample collections will be discussed in detail.

CHAPTER 5: Concluding remarks

The overall conclusions and recommendations of the study will be discussed as well as future research possibilities.

CHAPTER 2

Literature review

2.1 A synopsis of food safety challenges

The occurrence of microbial contamination of food is a major concern worldwide. A study by De Oliveira *et al.* (2014) showed that there are various simple and effective methods for assessing the hygienic conditions of the school kitchen, which could identify critical points of microbial multiplication, survival and contamination. These include the detection of microorganisms and the determination of residual organic matter after sanitising the food contact surfaces. According to the WHO (2014), when food becomes scarce, other factors including hygiene, safety and nutrition are neglected as people resort to less nutritious diets and reduced food quality, where chemical, microbiological, zoonotic and other hazards pose a health risk. As a result, some food-borne illnesses result from the lack of knowledge of the food handlers relating to how to avoid cross-contamination, proper hand washing, cleaning techniques, correct detergents and the safe handling temperature of the food. Hence, the knowledge, attitude and practices (KAP) of the food handlers are important in any food establishment to ensure food safety, hygiene and to prevent foodborne illness from occurring. A study by Saeed *et al.* (2021) had revealed that the food handlers were not the cause of the food-borne illnesses, but rather unsafe food sources, inadequate cooking and contaminated equipment.

Literature has previously indicated that food safety is not merely a microbiological issue but also includes a behavioural component (Griffith, 2010). Hence, it is imperative that meals prepared and served in schools should receive extra care due to the weakened immune system of the children who benefit from these meals. Al-Kandari *et al.* (2019) pointed out that food handlers often have little information about food contamination and how to minimize risk during food handling. While a study by Ovca *et al.* (2018) indicated that training in small and medium enterprises is often neglected due to the lack of time and knowledge of the food industry operators.

2.2 The National School Nutrition Programme (NSNP) of South Africa at a glance

In South Africa, the food served through the National School Nutrition Programme (NSNP) is prepared by voluntary food handlers (VFHs) who predominantly have very little training nor formal educational background in food safety and hygiene practices. It was discovered during the focus group discussions that the bulk of the voluntary food handlers had any formal training or formal education about food safety hazards or any condition that might lead to unsafe food before commencing. Regularly, the NSNP coordinator is the one who undergoes training on food safety and hygiene, which is organised by the Department of Basic Education (DBE), and thereafter would be expected to roll-out the information to the VFHs for implementation. However, this method is not feasible during the focus group discussions, as the information is sometimes distorted and not properly interpreted, which occasionally leads to contradicting facts. Furthermore, the information posters such as that of the five keys to safer foods and the correct hand washing techniques that ought to be on the kitchen walls for education purposes are often not put up, but rather are stored in the school storeroom. In an attempt to curb the fatalities and incidents caused by food-borne diseases, studies have been conducted previously to prove that effective sanitation and hygiene training programmes can be amongst others, the best prevention method for foodborne illnesses (Todd, 2020). Fleetwood *et al.* (2019) demonstrated that using visual food hygiene inspections conducted by trained inspectors to measure compliance with the food law is a useful tool in detecting illness-inducing microbiological contamination, and that the implementation of these inspections can lead to the reduction of foodborne outbreaks. Despite the existence of specific regulations, the safety measures taken during meal preparations are inadequate, as most schools do not consider specific sanitary requirements needed at various stages of food preparation (Soares *et al.* 2012). The association between food safety behaviours and food safety climate at an individual level should be investigated for better understanding (Clark *et al.* 2019).

2.2.1 Factors influencing food safety

The proliferation of possible harmful microbiota in food service environments, especially informal settings, have been well documented. According to Amare *et al.* (2019) apart from cross-contamination, suspect sources and improper preparation, ineffective cleaning and disinfection of the food contact surfaces have been shown to result in microbial contamination. Sibanyoni & Tabit (2019) pointed out that the accumulation of food debris and the formation of biofilms on the food contact surfaces enable the growth and multiplication of microorganisms. As a result, some of the food-borne pathogens have the potential to survive in such environments, with the potential to provoke cross-contamination between the food contact surfaces and the foodstuffs. In most situations the toxins responsible for inciting sickness in people are often produced, following the multiplication of the bacteria after its introduction into the food via contamination.

The Centre for Disease Control (CDC) (2010) reported that post-contamination with the toxins such as *Staphylococcus aureus* can endure and cause illness even after the bacteria is killed through cooking. Accordingly, foods such as sandwiches and sliced meats that are not cooked after handling are riskier if they are contaminated. The increased possibility of cross-contamination between the food contact surfaces and the foodstuffs within the food preparation facility is caused by the accumulation of food debris and the formation of biofilms on the food contact surfaces, thus facilitating the growth and multiplication of the microorganisms (Choi *et al.* 2016; Cortese *et al.* 2016).



(a) Milk placed next to a pot scourer.



(b) onions placed on the floor of the food preparation area.

Figure 2.1: Routes of cross-contamination

2.2.2 Foodborne illnesses

Literature has shown that most foodborne illnesses are acquired from public settings, where there is a large group of people that share a common meal, and these include schools, hospitals, funerals, and weddings. The WHO (2015) noted that approximately 600 million people became ill after consuming contaminated food. Hence, the provision of nutritionally dense foods that does not compromise the nutritional and health status is always important. Many factors contribute to food not being at an acceptable microbiological level and include cross contamination from utensils, equipment and in other instances from the hands of the food handlers to the food. According to Howes *et al.* (1996), food contamination and foodborne disease are caused by inappropriate handling practices, resulting in the consumer's health being vulnerable to diseases.

In recent times, with billions of people to be fed, the need to produce adequate quantities of safe food, unadulterated by bacterial, viral and protozoan pathogens as well as harmful pesticides and allergens, remains a major challenge (Charles *et al.* 2018; Greig *et al.* 2007). According to Cormier *et al.* (2007) and Doménech *et al.* (2008), food companies have emphasised that more efforts be given toward microbiological food safety, design and maintenance of their Food Safety Management Systems (FSMS). However, the

outcomes of these efforts were not a true reflection. Mostly, the consequences of a failing FSMS mainly originate from a lack of resources, even though the infrastructure, policies and legislation are in place. This often results in foodborne illnesses, outbreaks and even deaths. Nevertheless, taking into consideration all the prevention interventions, control measures, recommendations and implementations added to the outcomes arising from all the studies concerning food safety, there are still high levels of foodborne outbreaks occurring worldwide.

2.2.3 Significance of food safety and episodes of microbial contamination associated with the NSNP

In South Africa, many of the schools participating in the NSNP are specifically those in quintiles 1-3, living in rural communities that are poverty-stricken and lack access to basic services, including potable water supply, proper sanitation and electricity. The NSNP programme was devised in 1994 to alleviate poverty. It was specifically initiated to uphold the rights of children to basic foods and to contribute to learning in the school (NSNP report, 2014). Hence, serving nutritionally dense food which does not compromise the health status of the children is essential in the NSNP, as some of the children who are beneficiaries are between the ages of 5 – 8 making them more susceptible to foodborne illnesses as sometimes their immune system is still developing immunity. According to Kloc *et al.* (2020) during the first 7- 8 years of life a child's immune system and maturity is developed. Precisely, Tan *et al.* (2013) opined that hygienic food preparation and the education of those involved in the serving, processing, handling and preparation are vital in reducing the prevalence of foodborne illnesses. For example, *S. aureus* is an important risk factor in staphylococcal food poisoning among food handlers, especially through hand contamination (Ho *et al.* 2015a). The hands can act as mechanical vectors transferring the organism to the food, which in turn produces enterotoxins that result in acute gastroenteritis after consumption. As a result, it is imperative that the vulnerability of those who are to benefit be considered during the food chain.

Microbial contamination is associated with many foodborne outbreaks around the world. In 2017, a newspaper article from Egypt revealed that approximately 435 students from some public schools that benefited from the government issued meals got ill from suspected food poisoning after consuming the meals (News24, 2017). The authors of the abovementioned article emphasised the importance of those involved in the handling, processing and preparation of foodstuffs be equipped with the changing trends of information on hygiene and food safety to ensure compliance. Baert *et al.* (2011) defined food safety as the condition of the foodstuffs in all stages of production, processing and distribution that is required to guarantee the protection of the consumer's health.

Moreover, episodes of microbial contamination occur mostly via cross-contamination, where the microbes on the food contact surfaces get transmitted to the hands of a food handler and ultimately, to the food or vice versa. This triggers food-borne pathogens to multiply and cause illnesses, and in some instances may escalate to foodborne outbreaks. Microbiota may further be transferred amongst foodstuffs by using utensils or chopping boards without proper sanitation (CDC, 2013). Minimisation of the presence of food-borne pathogens is a major challenge in a setting involving the NSNP, where food is served by a variety of people with different hygiene practices, beliefs and to a large group of people. Moreover, food, water and food contact surfaces may be contaminated with large quantities of pathogenic microbes which could pose a risk of contamination and infection of the designated population. Studies carried out by Aycicek *et al.* (2004); Shojaei *et al.* (2006); Lues and Van Tonder (2007) and Nhlapo (2013) demonstrated that the presence of microorganisms on the hands of the food handler can become a source of contamination. This is due to poor personal hygiene, including hand hygiene practices. However, good personal hygiene and proper food handling practices can minimise the transfer of pathogenic microorganisms between the food, food contact surfaces and the consumers.

During walk-through inspections conducted it was observed that the majority of the schools, especially those in the rural areas, were not built with the prospect of feeding children as they did not have food preparation areas nor storage cabinet/ facilities. As a

result, it must be ensured that additional support in the form of education, training for the voluntary food handlers and monitoring is given to the schools that are beneficiaries of the NSNP. Nevertheless, Manyatsa (2007) opined that within the feeding programmes the provision of basic food storage facilities might be an option if schools are to continue feeding pupils. This act would aid in addressing the microbial contamination episodes and food safety behaviour as an important aspect in the management of food businesses and public policy stakeholders by identifying, engaging, and communicating with all individuals and groups that may be affected by these issues, regardless of the country's economic status, as most foodborne outbreaks occur due to inadequate food handling practices (Zanin *et al.*, 2017).

2.2.4 The role of food handler behaviour and culture in the NSNP

The systems and processes implemented in informal food trading facilities is different to those of the formal traders who are mostly managed through various systems such as HACCP, PRP's and FSMS. A study by Ungku Fatimah *et al.* (2013) highlighted that onsite food services are different from commercial retail food services, as this sector provides extensive service, serve a high volume of meals, form part of a public entity receiving a subsidy from taxpayers and have a fairly consistent work force. The above-mentioned study supports the current study as the NSNP is a government subsidized programme which serves food to a high volume of the public especially learners in quintile 1-3 schools. According to Griffith *et al.* (2010a) and Powell *et al.* (2011), poor food safety culture is increasingly recognised as a risk for foodborne illness outbreaks in the food industry. However, this can be altered over time especially in informal food trading facilities such as the NSNP whereby the food handler's due to the past regimes had a disadvantage of furthering their educational level to learn the principles that govern food safety and preventative measures to litigate foodborne illnesses which can lead to outbreaks. Furthermore, broadening of the scope of research into schools as opposed to just focusing on well-established food manufactures and formal food-trading facilities would contribute towards the promotion of food safety culture.

2.2.5 Impact of water supply in communities

Water is life and forms an essential part of livelihood; it is also one of the basic human rights of every citizen of South Africa to have access to safe, potable water supply and sanitation. Radif (1999) and Biswas (2004) indicated that though the availability of water is in abundance, the quality, quantity and availability of fresh water are limited and vulnerable. However, over the past years, the fulfilment of this human right has been a challenge due to increased population size, industrial growth, urbanisation, agricultural activities, as well as contaminated water catchment area and the piping water supply system (Mhlongo *et al.*, 2018). Furthermore, continuous migration to urban areas, including industrialised provinces, has placed an even greater demand on service delivery, infrastructure and resources. In South Africa, microbial water quality monitoring is the responsibility of environmental health practitioners in the different spheres of the government. The National Health Act, 2003 (Act 61 of 2003) defines the responsibilities of the local and the district municipalities by including water monitoring and environmental pollution monitoring among the municipal services. Chapter 14 of the National Water Act, 1998 (Act 36 of 1998) stipulates that the Minister is responsible for setting up a monitoring system for the microbial water quality of surface water.



Figure 2.2: Communal hand washing bucket placed Infront of the classroom for learners to wash their hands before eating.

When water resources are not properly protected from harmful and various other activities such as illegal dumping of wastes and waste products, these often result in the degradation of the water sources and ultimately, water pollution. According to Northey *et al.* (2016), mining operations produce a negative impact on water quality, which may result in water pollution and the deterioration of the water quality in rivers, dams and groundwater. The microbiological quality of the water in South Africa has been a subject of interest over the years and poses various questions (Rasheed & Bezuidenhout, 2011). The Department of Water Affairs (DWA) (2009) mentioned that inadequate functional water infrastructure services, poorly maintained wastewater treatment works and the lack of appropriate sanitation infrastructure, including the issue of community development, pose serious economic and health implications to downstream users. When such infrastructure is not in place, community members resort to the use of open veld in remote locations, hence, resulting in faecal pollution of the water resources. It is therefore obvious that water quality monitoring is needed.

2.2.6 Water quality monitoring

Water quality monitoring is, amongst others, the core function of the Environmental Health Profession (EHP) in South Africa concerning collecting, reporting and monitoring the occurrence of microbial contamination of the water sources with *E. coli*, Total Coliform and total viable counts. The water samples collected are then submitted to accredited laboratories for analysis under the South African National Standard (SANS, 2015) for drinking water quality and reported as per the stipulations of the standards. However, water quality monitoring has been a major challenge over the past decade due to various water-polluting activities near the water catchment areas, the lack of resources for monitoring purposes as well as the chemicals that are used in various industries for production and everyday life (Mhlongo *et al.*, 2018). Also, the constant change of seasons, regions and changing times have been issues for consideration.

In addition, the Department of Water Affairs (DWA), as a custodian of South African water resources, devised a National Microbial Water Quality Monitoring Programme (NMMP) as an intervention to combat increasing health risks associated with faecal pollution to users and bridge the gap of information related to South Africa water quality (Kuhn *et al.*, 2000). After the implementation of the programme in the year 2000, the DWA released a report on the identification and prioritisation of areas with high health risks associated with faecal pollution of surface water.

The objective of the programme was to provide information necessary to assess and manage the potential health risks associated with faecal pollution of the water sources in South Africa. A study conducted by Xie (2006) identified Integrated Water Resource Management (IWRM) as one of the means which can be implemented in addressing the global water problems and working towards sustainable water management in the future.

2.2.7 Significance of water in the food supply

It is noteworthy to reiterate that water is a very important factor or a very needful/useful item during food production. Food production requires water for manufacturing purposes as well as throughout the food supply chain, be it in a household, formal or informal trading. Water has various uses which include but are not limited to rinsing, washing, cooking and cleaning. Yang and Cui (2014) opined that the major limiting factor in agricultural production is water. As a result, there have been many links between poverty and water pollution throughout the food supply chain. A study by Edokpayi *et al.* (2018) highlighted that an insufficient supply of safe drinking and domestic water often affects good hygiene practices. Precisely, with limited access to potable water, people often neglect hygiene and sanitary practices, resulting in illnesses.

Within the NSNP, it is empirical that the microbiological quality of the water used during food preparation is free from any contamination. Fawell *et al.* (2008) stated that pathogens that are important in foodborne illness might not necessarily be a threat to drinking water; also, the pathogens that are discharged into the water sources do not

multiply with a few exceptions. However, in food products, pathogen multiplication is the root cause of many foodborne diseases.

Furthermore, water used in industrial canning production and cooking often undergoes further processing to reduce the risk of pathogens, whereas water used for drinking does not have to undergo further processing. However, this is not the situation in the NSNP setting as the VFHs used water from the municipal water supply, assuming the water is safe for consumption and food preparation. This study sought to assess the microbiological quality of the water used in food preparation in the NSNP in the Welkom area. Ideally, the study would devise measures to ensure that the water used in the food preparation is of good microbiological quality, and where such water is not readily available, it would devise an alternative solution that is economical and applicable to the setting of the NSNP.

2.2.8 Importance of training and culture

Food safety culture can be viewed as how and what workers think about food safety. This includes the food safety behaviours they routinely practice and demonstrate (Yiannas, 2009). However, many researchers underestimate the role of food safety culture in influencing an employee's safe food handling practices. Figure 2.3 shows the food safety culture, a conceptual model, that is usually used to depict an interplay between the two ongoing processes or routes within the food processing organisations, wherein one factor might influence the final products. The question remains as to how a conducive culture can be instilled amongst voluntary, seasonal and contract workers that do not enjoy the group dynamics of the organisational environment.

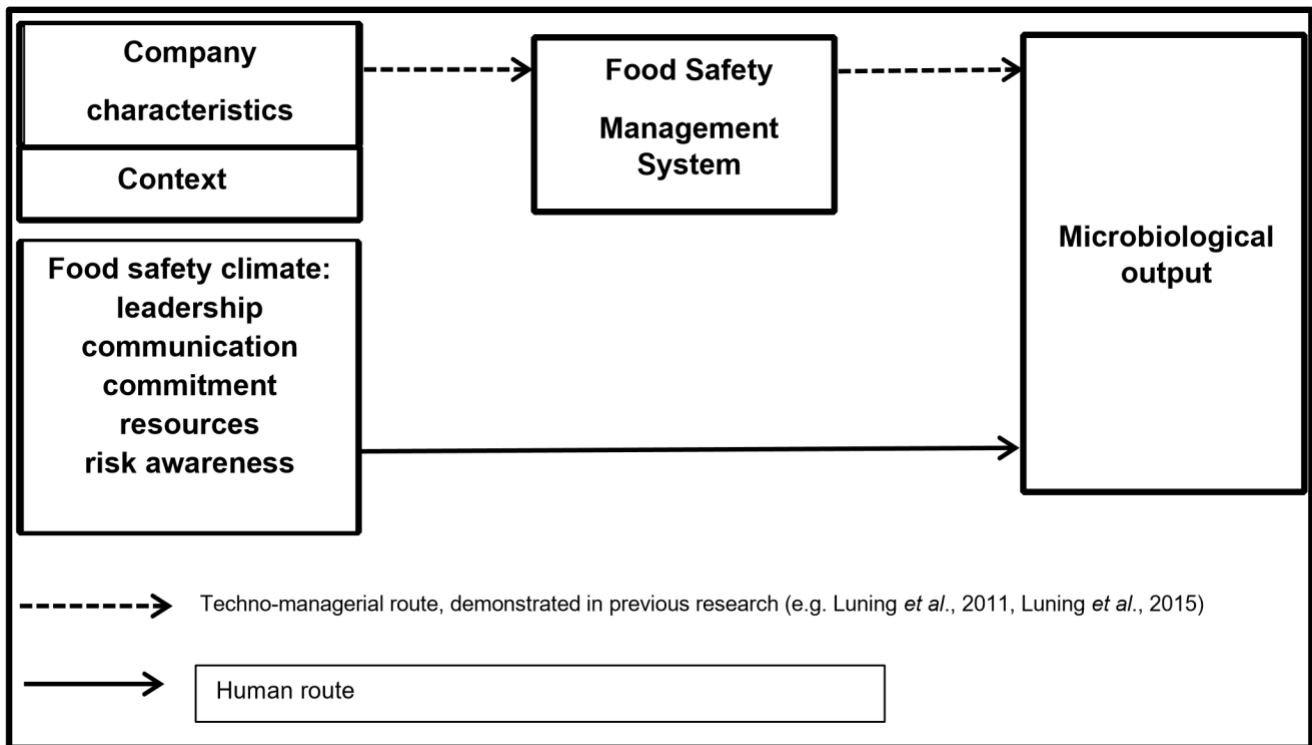


Figure 2.3: Food safety culture conceptual model (De Boeck *et al.*, 2015)

A study by Zanin *et al.* (2017) highlighted that there is a need to evaluate training from the point of view of the food handlers, taking into consideration their beliefs and behaviour, as there is an assumption that traditional training alone is not transformative. In the last decade, the food safety fraternity has evolved tremendously whereby authors have shifted their focus from a formal and technical-orientated FSMS to a more human dimension of food safety such as creating a food safety culture and a food safety climate (De Boeck *et al.*, 2015). This places more emphasis on the human aspect which includes people's beliefs, values, attitudes and perceptions.

While Harvey *et.al.* (2002) mentioned that most definitions of a food safety culture ignore the transfer of a safety culture from one context to the other, such as bringing values and practices from the driving or the domestic environments to the work environment. Sani & Siow (2014) attested that effective safety training from supporting organisations as well as adequate resources will strengthen food handling and workplace safety practices.

Furthermore, the right attitude of food handlers can reduce outbreaks of foodborne illnesses.

In addition, Stedefeldt *et al.* (2017) mentioned that despite the formal training, the educational approach should consider social relationships, perceptions, feelings and experiences, as these traits give shape to behaviour. Moreover, it is crucial to identify the training needs before designing the educational actions as a basis for filling the gaps. In recent years, organisational culture has been perceived as a significant factor in achieving desirable outcomes (Clark *et al.*, 2019). This may be supported by the fact that culture evolves with time, circumstances, organisations, technology and the generation of people. Furthermore, Griffith (2010a) and Nyarugwe *et al.* (2016) indicated that another critical factor influencing people's behaviour is the organisation's food safety culture, which is much broader than having knowledge, as it addresses the social context and experiences giving shape to food handlers' behaviour.

To date, there is still limited research on how a food safety culture could influence the behaviour of food handlers in school settings and informal food establishments; and on a course or training that was developed from the perspective of a food handler to assess whether it would be a feasible approach in the future. It is necessary that the schools should start operating as formal food service businesses by implementing basic programmes of good hygiene practice (GHP), pre-requisite programmes (PRPs), hazard analysis and critical control point principle (HACCP) systems as well as food safety management systems (FSMS).

CHAPTER 3

Materials and methods

3.1 Study area and population

Welkom is one of the biggest mining towns in the Free State, providing jobs for many South Africans, including those from neighbouring countries such as Lesotho, Zimbabwe, Swaziland and Botswana. Moreover, it provides massive support to the surrounding economy and the surrounding communities. Approximately 275 200 people were employed in the Welkom gold fields region in 1987. By 2010, that number had declined to just 84 700 (Vegter, 2019). In recent years, the economic status of Welkom has been deteriorating with mines being shut down, water being contaminated with mining effluent and service delivery not being rendered to the people. These have resulted in the town decaying and being regarded as the worst-performing urban area in South Africa, economically. According to Vegter (2019), the unemployment rate of the Lejweleputswa area has increased from 35 % in 1996 to 53 % in 2008. Furthermore, the poverty rate has increased from 36 % in 1996, (which was lower than the provincial average) to 61.3 % in 2006. According to the 2011 census, Welkom had a population of 211,011 people in an area of 212.7 square kilometres (km²) and with approximately sixteen (16) residential suburbs. The study populations included VFHs from the schools in Welkom which is the second largest city in the Free State, South Africa. The city is a popular area known for mining activities involving gold and uranium. Data was further collected using an inspection checklist which was conducted in the food preparation area.



Figure 3.1: Map showing the major residential areas of Welkom, South Africa

3.2 Description of the schools

The samples were collected from 32 schools in the Welkom area, South Africa. Of the 32 schools, three schools were located on the outskirts of the Welkom mining area. The schools involved a combination of primary, intermediate, special and technical schools, ranging between Q1 and Q3, whereby different assessments were performed for each school as per the discussion in the paragraphs following below. The samples collected were analysed for microbiological contamination of the food, the dominant hand of the food handler, food contact surfaces, water that was used for the food preparation as well as an observational survey of the food preparation areas.

3.3 Sampling protocol

Before the sample collection at each school, the principals, HOD and the NSNP coordinators were notified regarding the research project but not on the actual day of sampling, as a measure to avoid discrepancies and ensure validity and reliability. The samples were collected three times in a selected week between 08:00 and 11:00. In total 256 samples were collected which included 32 food samples, 192 food contact surface plates and hand contact plates of voluntary food handlers (VFHs). All the samples were

transported at 4°C to the laboratory for further analysis, within a 24-hour timeframe. The researcher looked for the absence and presence of colonies. Where there was one (1) to more than three hundred (300) colonies, it was considered as presence, whilst absence was considered when no growth was observed.

3.3.1 Laboratory analysis of food samples

The various food samples were screened for the presence/absence of pathogens and hygiene indicator organisms, including *Staphylococcus spp*, Total Coliforms and species of the Listeria Genus. The rationale for the selection was to assess the degree of possible contamination from human interaction and handling (*Staphylococcus spp* as common inhabitant of the human skin), faecal contamination and sanitary hygiene (Total Coliforms as indicator organism) and Listeria species (as commonly accepted environmental contaminants in food premises and indicator of facility cleanliness). The majority of the samples were analysed as per the method of Osimani *et al.* (2011). Considering the detection of *Staphylococcus* species and Total Coliforms in foods, the microbiological media used were weighed and prepared following the manufacturer's instructions.

3.3.2 Analysis of hands and surfaces

A purposive sampling protocol was used to sample chopping boards, stainless steel and wooden tables used for preparing and serving the various foodstuffs for including *Staphylococcus spp*, Total Coliforms and species of the Listeria Genus. There was a discrepancy in that some schools did not have chopping boards, others chopped directly on the tables, while others had chopping boards but did not use them. The reason was that the chopping boards were stored in the staffroom /storeroom, and by the time the food handlers started the chopping process, none of the NSNP coordinators was around to open for the voluntary food handlers, as they usually started their shift around 06:00 am, depending on the meal of the day, since they are expected to serve the learners at 09:30 am. Surface plate samples were collected by pressing the agar surface of the various selective media firmly against a selected area for 10 seconds, followed by closing, marking and transporting it to the laboratory on ice, and then incubating it at 37°C for 24

hours. The hand contact plate samples were collected while employing the procedures described by Marzano and Balzaretto (2013). The samples were obtained from the fingertips of a dominant hand of a VFHs and constant pressure was applied using the index finger for 10 seconds.

3.3.3 Analysis of the water samples

Water samples were collected from 32 randomly selected schools in quintiles 1 to 3 participating in the NSNP, in Welkom, South Africa. Of the 32 schools, only three (3) schools were from the mining areas of Welkom. The water samples were collected from municipal tap water and water collected from the tap then stored in the buckets, specifically targeting the water that was used during food preparation which included tap water and water collected in buckets. The variance was because some of the food preparation areas were formerly used as classrooms, and in other cases, the former home economics or the hospitality classroom was converted into food preparation areas employed in the NSNP. It is worth mentioning that the quality of water can have an impact on the quality of food being prepared as well as on the consumers. In precise terms, water that is pumped out into communities is usually disinfected before being distributed. However, due to sewage spillage and some form of faults to the distribution system the water being distributed to the communities the water does sometimes get contaminated hence the water samples that were collected from the two sources mentioned above were analysed for Total Coliforms (TC's) using microbiological agar.

The water samples were collected following the quality of domestic water supplies Volume 2 Sampling Guide (Department of Water and Sanitation (DWS), 2000). Before the collection of the samples, where applicable, the mouth of the tap was sterilized with 70% alcohol and cotton wool. Thereafter, the tap was left to run for two (2) minutes before the water sample was collected. A water sample was collected from each school using a sterile 100 mL plastic bottle (Lasec, South Africa) while wearing latex gloves to avoid

contamination. Samples were placed in a cooler box, containing ice and transported to the laboratory at 4°C and analysed on the same day.

3.4 Social behavioural assessment

A mixed-method research approach utilizing checklists and focus group discussions was used. The sampling methodology utilised a cluster sample targeting a hundred per cent (100%) of the schools in quintiles 1 to 3 in the town of Welkom, Matjhabeng Local Municipality in the Free State Province of South Africa. At each school, respondents for the focus groups were selected using random sampling to ensure the representation of at least one (1) to three (3) volunteers per school, totalling a 57% participation rate.

3.4.1 Observational survey

An inspection checklist (*Appendix 2*) was used to assess the hygienic status of the food preparation area. The checklist was formulated using selected aspects of regulation R638, described as the regulations governing the general hygiene requirements for the food premises, the transport of the food and related matters (1979) as a guideline. The checklist was divided into the following categories: hygienic status of the food preparation area and equipment; food storage; food handling practices; personal hygiene; pest control; and waste management. The responses were based on “yes”, “no” and “not applicable” (n/a) answers. It is worth mentioning that where applicable, comments were made that would be used as a guideline for proper recommendations. However, not all the aspects of these regulations were applicable since the NSNP set-up is not similar to a formal trading facility, and most of the food preparation areas were once classrooms that have been converted into kitchens. Furthermore, some of the necessary facilities that needed to be in place as stipulated in R638 have become a luxury that most of the schools could not afford. However, that does not exempt the schools from preparing and handling the food in a hygienic manner. Failure to do so might result in negative health effects and cause health hazards.

3.4.2 Focus group

A focus group approach was followed to assess the self-reported behaviour of KAP of the VFHs in the food preparation area, during preparation, handling and serving of food, which comprised five questions. The focus group discussions were held in the school hall and lasted for approximately two (2) hours. Before the group discussions, an e-mail message was sent to the school principals to notify the VFHs about the dates of the focus group interviews. Consent was requested from the participants. Participation in the study was voluntary and all the participants remained anonymous. The discussions and responses of the focus group were audio recorded for reference purposes and manually transcribed. The thematic content analysis method was employed, whereby the transcribed texts were consequently verified using the audio recordings to ensure that the results were accurate and authentic as per the method of Flick (2002).

3.5 Method of analysis

Microbiological analyses for Total Coliforms were performed according to the method previously reported by Marzano and Balzaretto (2013). Briefly, 1 ml of water sample was inoculated into 9 ml of nutrient broth (Merck, South Africa) contained in a McCartney bottle (Lasec, South Africa) inoculated onto the selective agar plates by the spread plate technique. The plates were incubated at 37°C for 24 hours. The plates were observed for growth, but if there was no growth in the first twenty-four (24) hours, then the plates were subjected to a further twenty-four (24) hours. The results were recorded as present or absent followed by a percentage calculation. For *Listeria spp.* in food, 10 g of each food sample was weighed into a sterile stomacher bag together with 90 mL buffered peptone water (BPW) and homogenised using the STOMACHER-400 (Seward, United Kingdom) operated at 230 RPM for 30 seconds. Subsequently 1 ml of each original stock was transferred into a McCartney bottle containing 9 ml of nutrient broth and inoculated onto a selective agar. The inoculated plates were incubated at 37°C for 24 hours. As post-culture confirmation was not performed, results were recorded as presumptive only.

For the *Listeria spp* on food contact surfaces, one (1) food contact surface swab was collected per school by swabbing 100 cm² of the various surfaces (chopping boards, stainless steel and wooden tables) used for chopping different foodstuffs. The food contact surfaces were swabbed using moistened swabs (ISO, 18593, 2018) and labelled accordingly. Upon arrival at the laboratory, swabs were immersed in sterile test tubes filled with 100 mL One Broth-*Listeria* (OBL), agitated with a Vortex meter (Lasec, South Africa) for a minute and incubated for 24 hours at 30°C. Following the incubation, a sterile wire loop was used to dispense 10µL of each content onto sterile solidified Brilliance *Listeria* Agar plates, while observing aseptic conditions. Immediately, the inoculated agar plates were incubated between 24 and 48 hours at 37°C (ThermoFisher Scientific™, South Africa).

3.6 Statistical analysis

Checklist data were coded and processed using frequencies and percentages, whereas qualitative data from the focus group were categorised using thematic analysis (summative discussions of common denominators). In cases where statistical analyses were performed, these were done using the SPSS software, Windows, version 25.0 of 2017. The results obtained from the hygiene inspection checklist relating to the hygienic status of food preparation, food storage, food handling practices, personal hygiene, pest control and waste management were summarised using descriptive statistics, as shown in tables 4.6.1 to 4.6.6 respectively.

CHAPTER 4

Results and discussion

4.1 Food

Microbial contamination occurs in various conducts in the kitchen, whether directly from preparing, handling and eating or indirectly from surfaces that harbour microorganisms, including food, humans and the contact surfaces found in the kitchen. The areas used for food preparation in the NSNP meals consisted of various equipment, structural designs and apparatuses, which may or may not have contributed to the achievement of hygienic or unhygienic conditions. Also, the individuals that prepared these meals have varying knowledge, attitudes and practices relating to food safety.

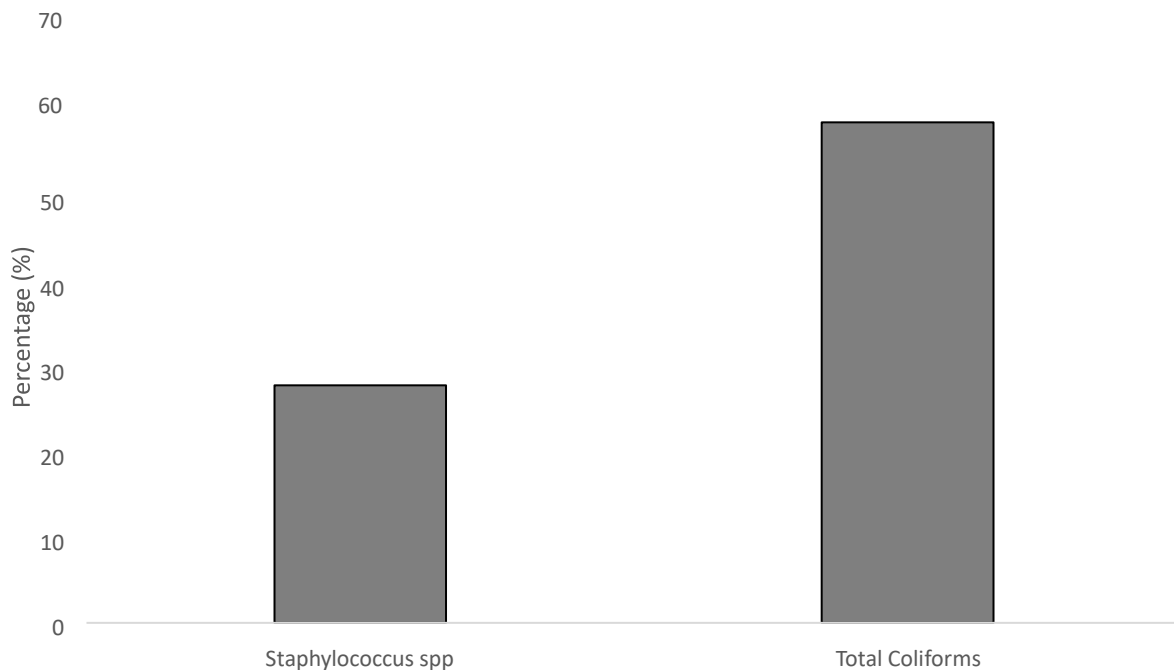


Figure 4.1: Detection of various microorganisms in food samples

Figure 4.1 above illustrates the percentages of *Staphylococcus spp* and Total Coliforms in the food samples that were collected from thirty-two (32) schools in the Welkom area. It can be depicted from Figure 3.2 that Total Coliforms were detected in over half of the food served to the learners. Coliforms give a general indication of the sanitary/ hygienic conditions of the food during food production or handling. Coliforms entail a diverse group of bacteria with the majority of the members being regarded as environmental

contaminants, while a few are of faecal origin (Martin *et al.*, 2016). Therefore, the data revealed the level of hygiene implemented by the voluntary food handlers during the processing of the food.

In addition, the results suggested that the foods were potentially contaminated, and even though some of the members of this group of bacteria are not harmful to humans, the level of the coliform counts indicates the presence of other potentially harmful faecal bacteria (e.g. *E. coli*). Furthermore, the findings seem not to be strange because generally, people are exposed to a wide variety of microorganisms, whether in their homes or communities. Based on the set-up of the kitchens, it was noted earlier that the majority of the kitchens were once classrooms converted into food preparation areas, and the food handlers hired to prepare the meals have limited knowledge of food safety and sanitation programmes. The above-mentioned results could be ascribed to the formation of biofilms, which are a continuous cross-contamination risk despite the disinfection treatment; as a result, some of the microorganisms can be pathogenically leading to infectious diseases. Notwithstanding, all the above factors should not be ignored, as there are ways of minimising the presence of these microorganisms on the food contact surfaces in the kitchens.



Figure 4.2: Waste rubble swept near a pot containing RTE (ready-to-eat) food

According to Nkere *et al.* (2011), a high level of contamination can be ascribed to poor environmental sanitation, and poor personal hygiene of the VFHs is the main cause of food contamination, but poor storage provokes microbial multiplication in food to reach infective doses that can cause infections. Much of the food contamination occurs through handling, especially raw food and the food encountering contaminated equipment and surfaces. According to Marcias-Rodriguez *et al.* (2013), food contamination is caused by microorganisms that are commonly present in kitchens and the household environment. The presence of Total Coliforms in food is often associated with poor personal hygiene and sanitary practices by the food handlers, mainly because the hands are the biggest harbours of microorganisms. Moreover, these foods are usually cooked by hand, and direct contact can result in an increased incidence of contamination with potential foodborne microbes or pathogens (Colombari *et al.*, 2007).

Several studies performed by Jumaa (2005); Lingaas and Fagernes (2009) as well as Dodrill *et al.* (2011) indicated that hands can gather dirt and microbial contaminants from

various contaminated sources directly or indirectly by touching surfaces, other humans and by using contaminated water. In this light, it is referred to as a food- or water-borne pathogen (Nurliyana *et al.*, 2018). The possible solution to reducing the presence of Total Coliforms in the food would be for the food handlers to be educated on the fundamentals of practising good personal hygiene and implementing effective sanitation programmes. As a result, hand hygiene is considered a leading measure for preventing the spread of pathogenic microorganisms, including infections associated with healthcare settings (Allegranzi & Pittet, 2009). Figure 4.2 suggests that food from most of the schools that served the NSNP might have been greatly affected by microbial contamination of Total Coliforms. This could be because of the lack of infrastructure in places, such as the improper storage facility, poor hygiene, improper handling of the food and poor sanitary practices. Worldwide, the occurrence of foodborne outbreaks has had a significant impact on public health systems. Subsequently, food handlers and food handling practices have played a prominent role in spreading microorganisms.

However, kitchen sponges and dishcloths may also be reservoirs for microorganisms. Accordingly, Kusumaningrum *et al.* (2003) and Mattick *et al.* (2003) noted that enhanced cross-contamination between food-related environments can be stimulated by dishcloths as they are commonly used to clean surfaces, kitchen utensils and equipment as well as crockery. Moreover, Scott *et al.* (2008) demonstrated that microorganisms can be transferred from dish cloths and sponges to the hands, the surfaces as well as the food. From the above results and literature, it can be deduced that for food to become contaminated, there are quite a few factors to consider; only once they have been investigated and identified can viable control measures be introduced, implemented and monitored for efficiency. Despite the limited knowledge of the food handlers, the results indicated that most of the food served to the learners did not have excessive contamination with *Staphylococcus spp.* More elaborately, quite a high percentage of the schools (23/32; 71.88 %) had no indication of contamination with *Staphylococcus spp.* Figure 4.2 further illustrates that of the 32 schools, only 28% had foods contaminated with *Staphylococcus spp.*

The presence of this microorganism in food is obvious as the bacterium occurs as the normal flora of the skin and nasal passage of humans (Weidenmaier *et al.*, 2012; Raafat *et al.*, 2020). Therefore, through human contact (cooking), it can be transferred into the food due to poor personal hygiene and inadequate cleaning (Oranusi *et al.*, 2013). Moreover, Chessa *et al.* (2015) in their study noted that from the *Staphylococcus* species it is impossible to eradicate *S. aureus* from humans.

In addition, the results obtained may suggest that the schools which had a positive detection of *Staphylococcus spp* had limited resources that would reduce the chances of cross-contamination. According to Josephson *et al.* (1997); Chavette *et al.* (2014) and Yu *et al.* (2016) improper handling, preparation or storage of food encourages the growth of pathogenic microorganisms such as *Listeria spp.*, *E. coli*, *Salmonella spp.*, *S. aureus*, *Campylobacter jejuni* and *Bacillus cereus*.

The ingestion of food contaminated with *Staphylococcus* strains may lead to food poisoning if the strains present in the food produce enterotoxins. Studies carried out by Gorman *et al.* (2002) and Macias-Rodriguez *et al.* (2013) emphasised that most household environments and kitchens are favoured by moist conditions, availability of nutrients and the storage of food at room temperature, which creates an ideal atmosphere for the survival and the multiplication of microorganisms. Furthermore, approximately 97% of foodborne illnesses originate from the kitchen and the household environment, wherein the hands of the food handlers have been described as a vector in the spread of food borne illnesses due to inadequate personal hygiene practices (Lambrechts *et al.*, 2014; Faour-Klingbeil *et al.*, 2015). As a result, the implementation of good hygiene practices before, during and after food preparation may result in a significant reduction of potential food contamination by pathogenic bacteria. Moreover, a study by Chavatte *et al.* (2014) highlighted that routine hand washing can be the most effective control measure against the spread of foodborne illnesses. Contrarily, Anargh *et al.* (2013); Ataei *et al.* (2013) and FitzGerald *et al.* (2013) argued that in developing countries there is a lack of understanding of the role of hand hygiene and the spreading of infectious diseases. While a publication from WHO (2021) reported that Despite attempts to encourage hand

hygiene, the availability of hand hygiene facilities continues to persistently decline. If the present rate of improvement continues, by the conclusion of the Sustainable Development Goal (SDG) era in 2030, approximately 1.9 billion individuals will still be without access to home handwashing facilities.

4.2 Hands

The control of microorganisms is required at all stages in the food chain to prevent the multiplication of microbes in the final products and to ensure microbiological food safety. Figure 4.3 below indicates that 63% of the collected samples of hands tested positive for *S. aureus*, which is often associated with poor personal hygiene of the food handlers before and during food preparation. According to CDC (2010), *S. aureus* from the *Staphylococcus* species is an organism that can contaminate food through direct contact (touching the food) with those people harbouring it and who do not practice good personal hygiene.

According to Ho *et al.* (2015), contamination of food handlers' hands with *S. aureus* is an important risk factor for staphylococcal food poisoning, whereby the hands can become mechanical vectors transferring the microorganism to the food and producing enterotoxins that initiate sickness in people. The results obtained from the various microbiological analyses indicated poor sanitation programmes, lack of cleaning and poor personal hygiene.

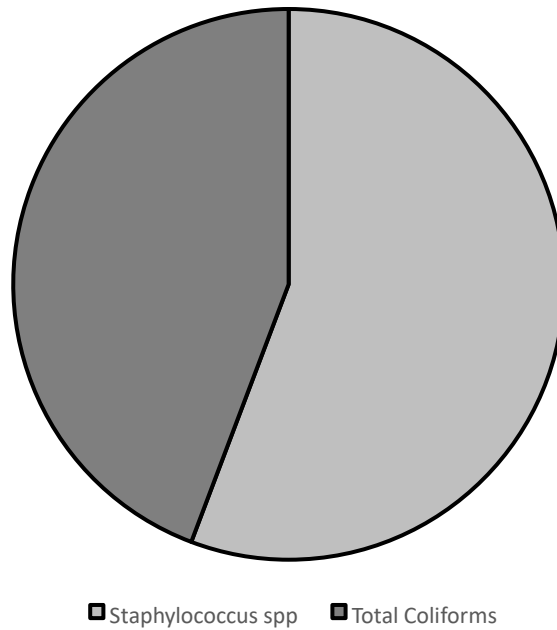


Figure 4.3: *Staphylococcus spp* and Total Coliforms on the hands of voluntary food handlers

Enterobacteriaceae is considered a food quality indicator where *E. coli* is the main contributor (Valero *et al.*, 2017). The possible reasons for the significant correlations might have been brought about by the structural design of the kitchen and the lack of resources, including a hand-washing basin equipped with hot and cold water, liquid soap and disposable towels. According to Soares *et al.* (2012), good personal hygiene and sanitary handling practices at work are essential parts of any prevention programme for food safety. The presence of a washbasin in the processing area is of primary importance to ensure adequate hygienic practices of the food handlers, as failures in hygienic procedures have been associated with foodborne disease outbreaks (Greig *et al.*, 2007; Todd *et al.*, 2010).

4.3 Food contact surfaces

Cross-contamination has been associated with many outbreaks worldwide. Total Coliform is often linked to the poor sanitation of the surfaces by the food handlers and the lack of knowledge. According to Setlhare *et al.* (2013), cross contaminations and the formation of biofilms could be caused by structural defects which may serve as harbouring places for microbial spread, as it tends to be difficult to clean.

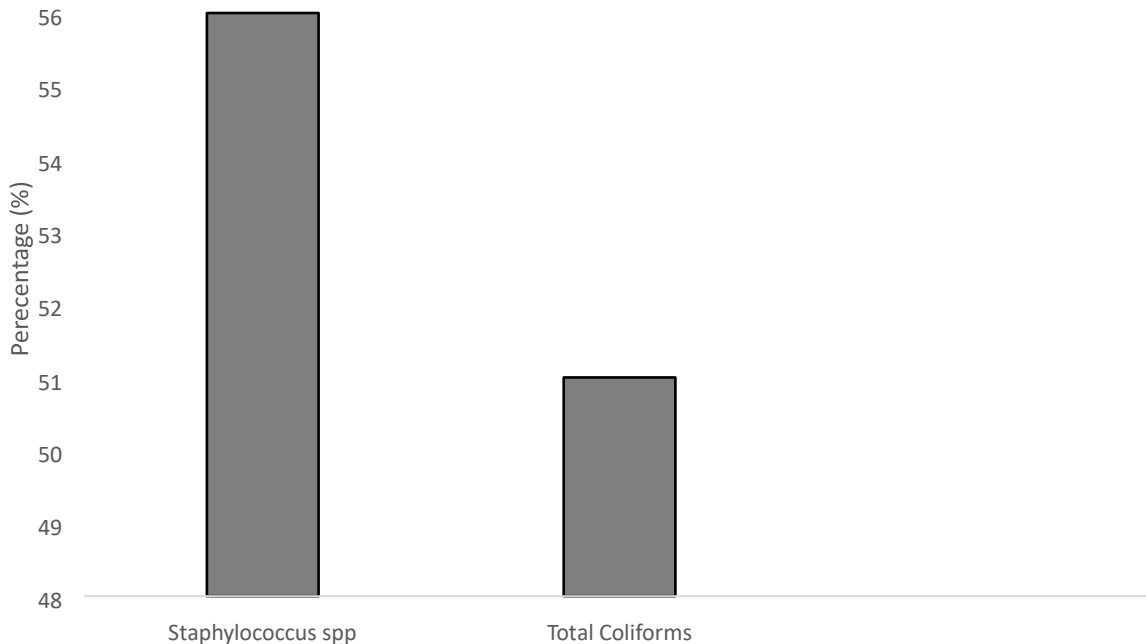


Figure 4.4: *Staphylococcus* spp, Total Coliforms and *Listeria* spp. on food contact surfaces

Furthermore, cleaning and sanitation of the food contact surfaces in the food preparation areas remain an important step in eliminating microbial hazards. Kampf and Kramer (2004) specified that though contaminated food contact surfaces may serve as possible reservoirs for microorganisms, the transmission of foodborne pathogens and microorganisms from one food contact surface to another is mostly due to the actions of the food handlers.

4.4 Water quality

Water samples were collected from the tap connected to the municipal water supply located inside the food preparation areas and in other cases from the buckets that were used to collect and store municipal water needed in the kitchen for preparing the food that is served within the NSNP. According to the WHO (2011a), the physical, chemical and microbial composition of water should be within acceptable health limits. Hence, water that is used for human consumption should not present any significant risk to consumers. Therefore, a study carried out by Pandey *et al.* (2014) indicated that the common

approach to quantifying the potential pathogen loads in ambient water bodies is by monitoring the levels of indicator organisms. The indicator organisms that are commonly used to assess the levels of pathogens in water resources include *E. coli*, Total Viable Counts and Total Coliforms. However, for the purpose of this study the 32 water samples were analysed for Total Coliforms found in either bucket water or tap water.

Figure 4.5 illustrates the results obtained from various schools concerning the tap water and bucket water investigated. The greatest presence of the microbiological indicator was observed with the Total Coliforms in both tap and bucket water, which in most cases signify faecal contamination. Various microorganisms from environmental sources have the potential to contaminate water, mostly groundwater, which may become contaminated through on-site sewage disposals, spillage as well as through run-off wastewater emanating from dairies, cattle farms as well as pig farms. Research by MOH (2007) revealed that contamination of groundwater occurs through direct infiltration of the groundwater.

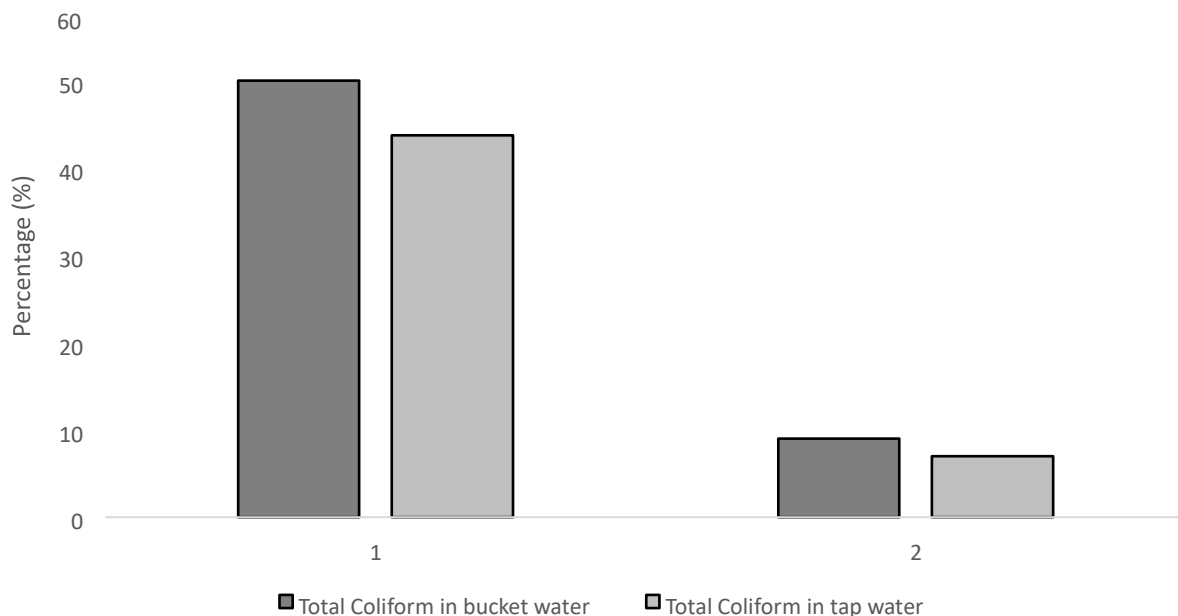


Figure 4.5: Microbiological results of Total Coliforms in bucket vs. tap water

The results relating to the water analysis were thought-provoking, as the water tested was collected from the treated water provided by the municipality, which had been treated and disinfected before being released to various distribution points. According to SANS:241 (SANS, 2015), the acceptable limit for Total Coliforms is ≤ 10 counts per 100 ml (Anargh *et al.* (2013); Ataei *et al.* 2013 & FitzGerald *et al.* 2013). Regarding the research data covered, it is clear that more schools detected Total Coliform counts in bucket water as opposed to tap water, indicating microbial contamination of the samples. Studies by Sartory (2004) & Li *et al.* (2020) have indicated that high levels of microbial growth can affect the taste and odour of drinking water and may insinuate the presence of nutrients and biofilms. Biofilms are defined as a collection of bacteria, which may be attached to living and non-living surfaces, interacting with each other to adapt themselves to environmental stressors compared to a planktonic existence (Mahapatra *et al.* 2006).

Given the knowledge of biofilms, how they are formed and how they survive, it may be reminiscent that the high levels of contamination found in the bucket and tap water were because of biofilm build-up, though one might argue that the buckets were regularly cleaned and disinfected using water mixed with soap and disinfectant (household bleach). In a study by Mahapatra *et al.* (2006) it was demonstrated that over time, the organisms in biofilms tend to become resistant to disinfectants and antibiotics. Subsequently, the biofilms become a reservoir permitting the spread of pathogenic organisms, and the increased virulence and resistance of biofilms potentially reduce the LD₅₀ (Lethal Dose) by increasing the viable organisms to survive and pass through the human stomach and reach the intestines, which may result in adverse health effects. Additionally, Jagals *et al.* (2003) and Nala *et al.* (2003) affirmed that stored water can become contaminated during the process of collection and storage in the containers, because the individuals who collect the water may sometimes introduce microorganisms through unsanitary hand hygiene practices.

In the NSNP setting, the containers used for water collection are buckets with wide openings, so that when the food handlers need water, they usually use a small can/pan or water jug to collect the water from the bucket to the pot. This method of collecting

water has the potential to introduce microorganisms into the water stored in the bucket. As illustrated in Figure 4.5 above, the Total Coliforms are the most detected microbiological indicator. According to Department of Water Affairs and Forestry (DWAF) (2001), the presence of microorganisms in drinking water can transmit infectious waterborne diseases to consumers. When such transmissions arise, outbreaks could occur and in severe cases, death may result.

The monitoring system for microbial water quality in South Africa is called the National Microbial Monitoring Programme (NMMP). It was developed to create a central hub for microbial water quality data. In addition, it ensures that the water that consumers receive is not contaminated by any means. Despite the degree of the development of the drinking water infrastructure that currently exists, meeting the demands of urbanisation and increased population growth has been challenging.

4.5 Statistical significance

The student t-test was done to determine a possible relationship between the microbial counts in the taps and buckets. The reason for this analysis was to assess whether there was significant contamination growth, or decline arising in the buckets, when compared with water collected from the taps. Statistical analysis was performed using the t-test, whereby the Total Coliform (bucket) vs. Total Coliform (tap) indicated no statistical significance difference of ($p = 0,425 > 0,05$). Thus, it was deduced that the bucket water transfers the same microbial content than the taps and does not introduce or limit microbial growth.

4.6 Profile of the kitchens

The inspections were conducted and observed during the food preparation, handling, and serving time each morning of the scheduled sampling days without prior notification of the activity. Hygiene inspections were conducted through a structured hygiene inspection checklist (see Appendix 2) which was divided into 6 (six) sections, namely 1) hygienic

status of the food preparation area; 2) food storage; 3) food handling practices; 4) personal hygiene; 5) pest control and 6) waste management. A similar study was conducted by Osimani *et al.* (2015b) wherein a checklist was used to assess compliance with the HACCP system. The structures of the kitchens varied with the schools and included mobile kitchens, corrugated iron structures (shacks), former home economics classrooms and in some instances, a former classroom which has since been converted and utilised as a food preparation area. The categories of hygiene inspections were classified according to the hygiene status of the food premises, food storage, food handling practices, personal hygiene, pest control and waste management. Tables 4.6.1 to 4.6.6 show the results obtained in various categories of the hygiene inspection checklist.



Figure 4.6: The interior of the food preparation area indicating how perishable foodstuffs are stored.

4.6.1 Hygiene checklist of the premises

The results of the overall hygiene inspection checklist indicated that the hygienic status of the food preparation areas did not entirely comply with the stipulations of R638, but that they were in satisfactorily fair condition. There is minimal infrastructure and resources in place to aid in achieving compliance as stipulated in the regulations. Surprisingly, from the thirty-two schools included in this study, only one school (3.13%) displayed untidiness in the food preparation area as the structure was made from old, corrugated iron and was placed on the old concrete floor that had cracks and crevices. It can also be deduced from Table 4.6.1 that forty per cent (40%) of the schools appeared not to be regularly washing and disinfecting their kitchen cloths, as the dishcloths were stained and discoloured.

Table 4.6.1: Hygiene status of food preparation areas

	YES		NO		N/A	
	PER (%)	FREQ	PER (%)	FREQ	PER (%)	FREQ
Are food preparation areas clean and tidy?	97	31	3	1	-	0
Do staff clean as they go?	56	18	44	14	-	0
Are all food contact surfaces in a good condition?	84	27	16	5	-	0
Are food contact surfaces disinfected regularly?	75	24	25	8	-	0
Are suitable cleaning chemicals provided?	59	19	41	13	-	0
Are proper cleaning techniques used?	80	26	20	6	-	0
Are there cleaning cloths provided?	100	32	-	0	-	0

Are cloths/kitchen swabs regularly washed and disinfected?	60	19	40	13	-	0
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PER (%), percentage; *FREQ*, frequency; *N/A*, Not applicable

However, it seemed that VFHs do not let these challenges deter them from ensuring that the food served within the NSNP is of good quality and that learners do not get sick. Therefore, they commonly disinfected their food contact surfaces with warm water containing soap and bleach, provided to all the schools from the NSNP budget before and after food preparation, though the cleaning chemicals varied based on the different suppliers. Furthermore, it is assumed that the VFHs applied their indigenous knowledge in the kitchens to ensure cleanliness.

According to Mattick *et al.* (2003), water temperature, detergent concentration and drying play an important role in the survival of microorganisms. Microbial indicators can be used to assess the level of hygiene of the equipment and the food contact surfaces and indicate the efficiency of the disinfectants as well as the sanitation programmes. Also, none of the kitchens that had running water were equipped with hot water. Cogan *et al* (2002) noted that washing with cooler water is not effective. Despite the structural challenges, the implementation of good hygiene practices before, during and after food preparation can potentially reduce food contamination.

4.6.2 Food storage

Food storage is an issue throughout the NSNP set up, as many of the schools were never designed to prepare or store food on their premises. Despite this, it was evident during the investigation as indicated in Table 4.6.2 that seventy-eight per cent (78%) of the schools had means of ensuring that ready-to-eat food was stored above raw foods and kept separately. Though there was insufficient space in the schools, the School Management Team (SMT) and coordinators had to improvise and complied with proper practices such as not storing food directly on the floor, thus ensuring that the food was

not contaminated. Ninety-four per cent (94%) of the schools practised stock rotation and implemented the First-in-first-out (FIFO) system with caution.

Table 4.6.2: Food storage

	YES		NO		N/A	
	PER (%)	FREQ	PER (%)	FREQ	PER (%)	FREQ
Is ready-to-eat food stored above/separately from raw food?	78	25	22	7	-	0
Is the food in the fridge/ refrigerator covered?	100	32	-	0	-	0
Is stock rotated regularly and dates checked?	94	30	6	2	-	0
Are dry ingredients stored directly on the floor?	22	7	78	25	-	0
Is the refrigerator/ freezer working properly?	-	0	-	0	100	32

PER (%), Percentage; FREQ, frequency; N/A, not applicable

The strategies developed and executed by the schools were to store all the dry ingredients on top of a pellet away from the floor and to ensure that raw food is separate from the cooked food. According to Daniels *et al.* (2002); Lee and Greig (2010) and Panisello *et al.* (2000), avoiding cross-contamination, and ensuring that raw and cooked food are stored separately, are some of the most common contributing factors to reducing foodborne outbreaks. Taking into consideration that most of the schools seemed to have mechanisms for food storage in place, the recommendation would be that they should continue with the available mechanisms yet ensure that their storage facilities are cleaned regularly, and that food contamination does not occur.

4.6.3 Food handling practices

Table 4.6.3 shows the different food handling practices that the various schools implemented. The most common practice demonstrated by all the schools was the use

of the same food contact surfaces to chop and wash where applicable both the raw and the cooked foods in tandem, as not all the schools have colour-coded chopping boards. This could be due to the lack of knowledge by the SMT, coordinators and food handlers, or it could be attributed to mere ignorance because, where there was a provision of such, it was kept away and not used. In other cases, it was observed that the food handlers chopped and cut their vegetables directly on the table without using the chopping board. The reasons were that some of the schools were economically challenged and reported the inaccessibility to the storeroom where the equipment is stored, since there was no individual to open the staffroom on time before the meals were being prepared. This can lead to food-borne illnesses. Moreover, sixty-six per cent (66%) of the schools seemed not to sanitise their food contact surfaces during the preparation, claiming that the smell and the taste of the detergent used would be transferred to the food. Hence, they thought it would be better to clean at the end of the shift.

Table 4.6.3: Food handling practices

	YES		NO		N/A	
	PER (%)	FREQ	PER (%)	FREQ	PER (%)	FREQ
Are raw and ready-to-eat food handled on the same food contact surface?	100	32	-	0	-	0
Are food contact surfaces cleaned and disinfected between uses?	34	11	66	21	-	0
Is there colour-coded equipment used?	-	0	-	0	100	32
Is the colour-coded equipment used accordingly?	-	0	-	0	100	32
Is high-risk food returned to the refrigerator immediately after use?	-	0	-	0	100	32
Is food cooled quickly and away from sources of contamination?	100	32	-	0	-	0

Are fruits and vegetables trimmed and washed thoroughly before use?	66	21	34	11	-	0
Are frozen foods defrosted safely?	6	2	-	0	94	30
Are there control measures in place to prevent contamination?	78	25	22	7	-	0

PER (%), percentage; FREQ, frequency; N/A, Not applicable

It can be deduced that contamination of food occurs through handling particularly raw food, and through food that is being exposed to contaminated surfaces and equipment in the kitchen. In this study, different food handling practices were observed that involved different food handling techniques as practised by VFHs.

Sibanyoni and Tabit (2019) alluded that food pathogens can survive in moist organic debris on the food contact surfaces and proceed to contaminate the food and other food contact surfaces in the food preparation facilities of the schools. However, Giaouris *et al.* (2014) argued that the most relevant cross-contamination vehicle between the food contact surfaces and the food products is biofilms. Muhammad *et al.* (2020) described biofilms as complex surface-attached bacterial communities that are held together by self produced polymer matrices, constituting polysaccharides, secreted proteins and extracellular DNAs. The biofilms can eventually cause food spoilage leading to foodborne outbreaks. Similarly, the aforementioned studies by suggested that surface sampling is essential for the evaluation and control of contamination of food contact surfaces.

With regards to the high-risk foods such as cooked meat, poultry, sauces and pasta being returned to the refrigerator, the data indicated that this was not applicable as the set menu did not include such foodstuffs (refer to *appendix 1*). Also, because of the set-up of the NSNP, the food is cooled quickly by dishing the food into smaller serving containers placed away from the sources of contamination. Furthermore, such control acts may become useful tools in the prevention of toxin production in case of contamination.

4.6.4 Personal hygiene

The hands are regarded as the primary sources that harbour microorganisms in humans, depending on the individual's location, occupation and hand hygiene habits. In this study it was discovered that all the schools included in the study had no access to change rooms. This is a major concern as it challenges the hygiene of the staff and may be a contributing factor to cross-contamination as well as a transmission of non-food particles, making its way into the food. Furthermore, from Table 4.6.4, it can be deduced that the food preparation areas were not equipped with adequate basin facilities which are essential for hand washing. Despite the above challenge, the VFHs ensured that their hands were washed under running water.

Table 4.6.4: Personal hygiene

	YES		NO		N/A	
	PER (%)	FREQ	PER (%)	FREQ	PER (%)	FREQ
Are the staff free from open wounds, cuts, and sores?	91	29	9	3	-	0
Do the staff wear clean and suitable personal protective equipment (PPE)?	56	18	44	14	-	0
Is there a hand washbasin with hot and cold water, soap and hand towels?	-	0	-	0	100	32
Is the hand washbasin used for hand washing only?	-	0	-	0	100	32
Is jewellery limited to a plain ring?	44	14	56	18	-	0
Are there changing rooms available?	-	0	-	0	100	32
Are the toilets clean and tidy?	86	28	14	4	-	0

PER (%), percentage; *FREQ*, frequency; *N/A*, Not applicable

According to Akabanda *et al.* (2017), Ehiri and Morris (1996), Greig *et al.* (2007) and Howes *et al.* (1996), though most food handlers have the knowledge and skills to handle food safely, human handling errors have been implicated in many food poisoning cases. A good example of behavioural errors occurs in circumstances where the food handlers had a washbasin their food preparation areas, but washed their hands in the same sink that was used for the cleaning and washing of utensils. Also, the majority of the employed food handlers were married individuals who wore wedding bands and jewellery, further compounding the problem of contamination and transmission of contaminants.

A study by Jumaa (2005) highlighted that people who often wear jewellery demonstrate greater numbers of microorganisms on the skin, and that the number of microorganisms increases with the number of rings worn. Similarly, Al-Allak *et al.* (2008) affirmed that there is evidence that microorganisms found under the rings may be persistent for many months. Furthermore, fifty-six per cent (56%) of the food handlers did not have Personal Protective Equipment (PPE) and in cases where a uniform was provided, each food handler received one set of PPEs for a period of two years. From the findings of this study, it is obvious that fully equipped infrastructure alone will not guarantee the safety of the food served within the NSNP, but equipping the food handlers with the necessary knowledge and training can significantly improve the environment.

4.6.5 Pest control

Integrated pest management (IPM) is an approach that primarily involves the improvement of the sanitary and structural conditions to deny pests of food, water, harbourage, and movement, and includes the judicious use of pesticides after an evaluation of the need and the hazard to human occupants (Kass *et al.*, 2009). As indicated in Table 4.6.5, none of the schools included in this study was pest-proofed nor had fly screens. Furthermore, pest control that depends solely on chemical approaches tends to fail to address the conditions that sustain pest populations. Also, the ability of pests such as flies, ants and mice to move within and between residences, and the presence of food and water sources in the kitchens and the bathrooms, added to the ability of the pests to find and create shelter, resulting in a failed pest management system.

Table 4.6.5: Pest control

	YES		NO		N/A	
	PER (%)	FREQ	PER (%)	FREQ	PER (%)	FREQ
Are the premises pest proofed?	-	0	100	32	-	0
Are there any signs of pests?	47	15	53	17	-	0
Are doors and windows fitted with suitable fly screens where necessary?	-	0	100	32	-	0
Are there bait stations?	3	1	97	31	-	0
Are the bait stations properly maintained?	-	0	3	1	97	31
Is food properly protected from the risks of contamination by pests?	78	25	22	7	-	0

PER (%), percentage; *FREQ*, frequency; *N/A*, Not applicable

Comprehensive pest control in the schools is not considered an important factor, as most of the schools had no measures in place except the use of rat poison that would be placed in a hidden corner to minimise the infestations of rodents. However, one school had a bait station, but the bait station was shown not to be properly maintained, as it seemed that the food handlers did not even know that it existed. Even though the schools and the kitchens were not having proper pest control programmes, the data showed that seventy-eight per cent (78%) of the food presented with lesser risks of contamination by pests, and the schools had no signs of pests. However, considering the flies, none of the schools had fly screens or control measures to control the flies that were found in the food premises. This is a major concern, especially because the flies can be carriers of food poisoning microorganisms and viruses that may pose major hazards to consumer health. Furthermore, it was observed that some of the kitchens had broken windows, which allow pests access to the food premises.

4.6.6 Waste management

Waste management practices in many of the schools appeared to be a challenge which could be associated with the issues related to municipal service delivery. The results indicated that sixty-six per cent (66%) of the schools properly stored their waste on the food premises and only discarded the waste at the end of the shift because they had no waste bins outside the food premises. Some schools were located close to an illegal dumping site, which was adjacent to the kitchen. This arrangement misrepresented the schools to be the ones dumping waste illegally. However, eighty-one per cent (81%) of those schools which had a secured refuse storage area did not keep it clean, therefore, facilitating a major health hazard serving as a breeding site for pests and rodents that might cause cross-contamination in the food preparation areas.

Table 4.6.6: Waste management

	YES		NO		N/A	
	PER (%)	FREQ	PER (%)	FREQ	PER (%)	FREQ
Is waste inside the food premises stored correctly?	66	21	34	11	-	0
Is food waste stored correctly outside?	31	10	69	22	-	0
Is the refuse storage area kept clean?	19	6	81	26	-	0
Is unsound food properly labelled?	-	0	100	32	-	0
Is unsound food stored separately from other foods?	100	32	-	0	-	0

PER (%), percentage; *FREQ*, frequency; *N/A*, Not applicable

Studies performed by Henroid and Sneed (2004) and Martins and Rocha (2011) highlighted that incorrect handling of waste was found in all the food services, and that awareness should be communicated to the employees on the hazards that may arise from improper disposal and the handling of waste. Furthermore, it was evident during the

inspections that 100% of the sampled schools did not label unsound food and just dumped all the food deemed unsound with the rest of the garbage generated from the kitchen. It was, however, observed that the food handlers stored the unsound food separately from the sound food. This demonstrated that the food handlers equally have good practices relating to waste management, as indicated in Table 4.6.6 above. To support the practices, food handlers must be equipped with the necessary equipment to improve on the current waste management strategies in a bid to ensure that possible episodes of cross-contamination that may emanate from the improper handling of waste are minimised.



Figure 4.7: Waste management inside one of the school premises

4.7 Assessment of the focus group

4.7.1 Profiles of the participants

The focus group consisted of 85 (47% of the total) voluntary food handlers from all the schools participating in the NSNP, particularly from Quintile 1– Quintile 3 (Q1-Q3). They were female participants and the interview lasted for two (2) hours. Before the themed

interview questions, there was an ice breaker session during which each food handler had the opportunity to share an encounter with the learners whether hilarious, heartbreaking or emotional. Consequently, the knowledge, attitude and practices (KAPs) of the food handlers were assessed through a focus group utilising standard questions, and content analysis was used to process and summarise common denominators.

4.7.2 Focus group responses

Question 1: How do you prepare food daily when you arrive at work?

- One participant had the following to share [sic]: *“When I get here the first thing I do I wash my hands before I touch anything and then depending on the meal for the day, I put the pots on the stove and start cooking because at 09:25 Me Respondent 1 wants the food ready and if they are not ready, she shouts so we have to be fast. She further alluded that after all the pots are on the stove, she starts to clean and clear away the things that are not going to be used. The facilitator cross-examined the participant regarding the PPE by stated that she did not hear the participant say anything about changing from personal clothes into her work clothes. The participant responded with the following [sic]: “No, we don’t change when we come here, we come readily dressed from our homes and then we start to work”.*
- Another participant had the following to say [sic]: *“I also come dressed in the uniform that was issued to me when I started working here and for example, if our meal for that day is samp, we usually boil it halfway the previous day and leave it on the stove so that the next day we can just finish it up and add salts and so forth. Also, with the vegetables for the day we usually prefer to peel them the day before, so that the next day we don’t struggle, we just quickly chop and put it on the stove and this method saves us time”.* The facilitator further asked whether the participant has any PPE, and if indeed, how many sets of PPE she has; who washes the PPE, and how often. The participant responded with the following [sic]: *“Yes, we do have overall that we must wear daily to work with closed-toe shoes like a “reef”. However, it is just one set. Every day when I knock it off, I must wash*

it for the next day and now that it is winter, it is hard as sometimes it does not dry properly because the days are shorter”.

- Another participant stated the following [sic]: *“With us, we prepare the food the same way as the other two schools and with regards to the uniform, we do not have. We have been waiting for it since we started working. Whenever we ask, we are told that the money from the department of education for buying us uniforms is not yet paid in. So, we work in our clothes and we bring our aprons to work with them just so that when we knock off our clothes are not dirty and to prevent our clothes from having stains”.*
- The other participant indicated the following [sic]: *“When we know that we have, say, for instance, tripe to prepare as the meal of the day we know that we have to come in very early around 5 because it takes time for it to be soft and cooked. So, while we wait for the pots to be ready, we boil water so that we can have tea and eat the food we came with from home as we leave home very early and there is no time to eat. We also take turns cooking and checking on the pots because we are a team, and we work together. This means when Respondent 2 has gone to the toilet, I cannot let the pot get burned I must look after it because when the food is burned, Me Respondent 1 shouts at us because then the learners do not eat the food and a lot of food would go to waste”.*

Question 2: Do you think it is important to wash your hands; how often do you wash your hands; and with what, since you do not have hand washbasins in your food preparation areas?

- One participant shared the following [sic]: *“Yes, it is very important to wash your hands before you touch food. Even at home for my family before I cook, I wash my hands with soap and water and also after I had visited the toilet, I wash my hands”.*

- The other participant stated *[sic]*: “Yes when we arrive, we help each other wash our hands by using a jug to rinse outside and then we can begin working because if we do not wash our hands, it means that we will be cooking for the learners with hands full of germs and then they will get sick. Also, after I visit the toilet, I do wash my hands even though there is no soap in the toilets”.
- One participant responded as follows *[sic]*: “Yes, we also wash our hands before we touch food and after visiting the toilet but what do you mean how often? Because with me if I am busy with the dishes and in constant contact with water, I am washing my hands as well”.
- The other participant elaborated further *[sic]*: “Our kitchen has a sink, so I wash my hands in the sink before I commence with my duties with the dish washing liquid soap”.
- Another responded made the following statement *[sic]*: “I boil water and, in the bowl, mixes the hot and cold water, pours the liquid soap to her hands and then I wash my hands in that bowl and thereafter, I throw out the water and commence with my duties”.

The common theme with regards to the importance of hand washing and frequency were quite similar amongst the majority of the VFHs, and they agreed without exception that it is important to wash your hands before you touch food and after you have been to the toilet/bathroom. However, in terms of the frequency, they seemed not to be sure, as some indicated that they are always in contact with water, and therefore do not see any need to wash their hands. In terms of what they use to wash their hands with, the common response was to use the same liquid soap that they use to wash the dishes, equipment and pots. In terms of where they wash their hands, the responses varied, as some had the luxury of kitchen “sinks”, while others use a bowl and others wash their hands with the help of an individual pouring water over their hands by way of a jug.

Question 3: What is food safety, who is responsible for ensuring food safety, and why?

- One participant indicated that [sic]: *“I think food safety has to do with thorough cooking of food and that as a food handler I have the key responsibility to ensure the above so that kids don’t get sick”*.
- Another participant responded as follows [sic]: *“Food safety is when food is cooked the right way with clean pots and in a clean kitchen and the people responsible for that is every woman in the kitchen because they are a team”*.
- Another participant elaborated further and said [sic]: *“Is when food does not have germs, and if I don’t wash my hands before I touch food then that would mean I cook with those germs and the kids will get sick”*.

Subsequently, all the other participants seemed to be in harmony with what the other three participants highlighted in terms of what food safety is, who is responsible for it, and why.

Question 4: How should a food handler be dressed when coming to work daily?

- One participant said [sic]: *“We must always be clean and tidy, wear clean clothes and have short nails”*.
- Another participant indicated the following [sic]: *“They must also cover their hair to ensure that hair does not fall into the pot and that at their school they have to put on hair nets under their hats”*.
- The facilitator further cross-examined the participant on how often they change the hair net.

- The participant elaborated further and said [sic]: *“Well, it depends on the availability, If we have them, we would use one hair net every 2 days and in other instances, 1 per week”*.
- Another participant shared the following [sic]: *“Because we do not have a uniform (PPE) yet we are still waiting, we use a “doek” known as a head scarf to cover our hair”*.
- One participant stated the following: *“They are not allowed to wear any earrings or necklace and chains except for a wedding ring because for some, they had been married for many years and so the ring no longer comes off”*.

Question 5: Have you ever received complaints that the learners were having diarrhoea and vomiting etc. after having eaten your food? What happened?

- One participant said [sic]: *“We have never encountered such ever since we started with our contracts”*.
- Another participant elaborated further [sic]: *“We had one incident with 3 learners, but we are not sure what was the reason, though the learners implied that they ate food from the school and that could have been the cause of their diarrhoea. As far as we know no investigation was done and it just ended there”*.
- Another participant stated the following: *“One participant recalled an incident where the mother of one of the learners confronted them in the kitchen and asked if they wanted to kill her child. As it turned out the child had an allergic reaction to something in the food and as a result, the child was admitted”*.

Despite the two incidents mentioned above, participants had never encountered incidents where the learners were reported sick as a result of the food from the NSNP kitchen/service area.

4.7.3 Discussion of the focus group results

The focus group was insightful and produced considerable content which contextualised the inspection checklist information. The results obtained from the focus group interview provided qualitative information, providing an understanding of why the VFHs behaved the way they did, their beliefs and their practices.

Seeing that knowledge is a key determinant of positive behaviour, it is proposed that the food handlers in the schools and informal trading must be trained in the fundamentals of food safety.

4.7.4 Significance of sanitary practices and hand hygiene during food preparation

As observed from the results of the food contact surfaces, food contamination from either physical, chemical, or even microbial agents has been a major concern for decades, as contaminants can originate from various sources. One of the issues that contribute to contamination is environmental factors, including dust, contaminated water, and humans, as they act as vectors of microorganisms. As highlighted by the participants, they come to work dressed in their PPE as there is no provision for changing rooms in the schools. It was also reported that in other cases, the food handlers walk across areas that are sometimes infested with sewage spills. Some of them are provided with one overall. When these food handlers come into the food preparation areas, it is easy for their clothing to shed some of the microorganisms they might have picked up from the outside environments and cross-contaminate the surfaces.

Another contributing factor is the use of fertilisers and pesticides on fruits and vegetables, which might result in the contamination of the surfaces, especially if they are not properly

washed and cleaned. Food contamination must be eliminated if it cannot be minimised. With the changing times and the new technological developments, costs and efforts have been devoted to developing products that would be effective in detecting these contaminants. As described in the results above, the food handlers performed Good Hygiene Practices (GHP) even when there was a lack of infrastructure in place. They make provisions to eliminate potential threats and risks. A good example is that during hand washing they used a jug as a tap to provide “running water” to avoid using a communal bowl, though some still resorted to using a communal bowl as they believed they were saving water and that nothing will go wrong.

In African culture, when the bereaved family returns from the graveyard, they are expected to wash their hands in a communal bowl by having three (3) or more of the family members dip their hands in the bowl at the same time. According to Moabi (2016), washing hands in a communal hand-washing bowl can be a potential source for the transmission of harmful microorganisms such as faecal and coliform bacteria as well as other pathogenic microorganisms. The dirt that accumulates in the hands and underneath the nails of people may also be a pathway that introduces harmful microorganisms into the communal hand-washing bowl. This act of using a hand-wash communal bowl poses a risk to microbial food safety, as food handlers do not wash their hands for sanitation purposes but continue to prepare food. Hence, food handlers must adhere to good personal hygiene and sanitary handling practices to prevent foodborne infections.

4.7.5 Food handler’s knowledge, attitude and practices concerning food safety

Food handlers play a pivotal role in ensuring food safety and the prevention of food poisoning. Most food-borne illnesses are caused by episodes of cross-contamination, cooking and storing of food at incorrect temperatures and sometimes, by the use of contaminated equipment and utensils.

A study by Al-Kandari and Jukes (2009) indicated that food handlers often have limited information relating to food contamination risks and how to prevent them. Additionally,

Rebouças *et al.* (2017) highlighted that the improper handling of food and the exploitation of time and temperature accounted for most of the foodborne disease outbreaks. Previous findings suggested that to effectively decrease the occurrence of foodborne illnesses, food handlers must be exposed to the various routes in which humans come into contact with the bacteria that cause foodborne illnesses.

The need to train VFHs on the mastering of skills and equipping them with knowledge of food safety forms an important aspect in ensuring that the food prepared under the NSNP is safe for consumption and does not result in the occurrence of food-borne illnesses. Adesokan *et al.* (2015) indicated that though training might be one of the effective strategies which can ensure food safety and offer long-term benefits to the food industry, the outcome of increased knowledge might not necessarily lead to a change in behaviour, but should be supported by a culture of commitment and care.

4.7.6 Foodborne illnesses

The occurrence of foodborne outbreaks is still affecting consumers' health, globally. According to Ovca *et al.* (2018), education and training in basic food safety principles form an integral part of the reduction of foodborne illnesses in the food industry and among consumers. However, the emphasis should be directed on having tailored and task-specific training relating to the target group. During the focus group, it was evident that the VFHs were simply instructed to implement certain practices in the food preparation areas, and as a result did not see the relevance since they were not informed of the significance and importance of implementing certain activities. Furthermore, when they omitted certain practices, they did not regard it as having a negative impact on the final product, consumers and safety. Given the above responses, it is fundamental that the microbiological content in the food is assessed to inform the sources of contamination.

CHAPTER 5

GENERAL CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL CONCLUSIONS

Poor nutrition is a challenge that casts a shadow because its consequences are evident throughout the life cycle and continue through the generation affecting everyone, especially adolescent girls and women (Mhongera & Lombard, 2018). Therefore, nutrition must become a module embedded within the curriculum from primary school to university level. Also, this will ensure that the children will grow up to be responsible adults who will make good nutritional decisions that can lead to the reduction of micro-nutrient deficiency, stunting and wasting in the next generation. WHO (2015) indicated that using kids as health agents inside their homes leads to behavioural change amongst their fathers, mothers and siblings, and slowly but surely the entire community begins to change. Bain *et al.* (2013) indicated that improving the educational status of parents, especially mothers regarding nutrition, sanitation and common disease prevention strategies should logically reduce malnutrition-related mortality and morbidity.

According to Devereux *et al.* (2018) the three pillars of the NSNP provide a holistic set of instruments for improving the nutritional status of school children and their families as follows:

- 1) School feeding can improve the consumption of nutritious food by the children if the menu is well designed (by nutritionists) and especially if both breakfast and lunch are provided at the school.
- 2) Nutrition education can inform learners, their families and the community at large about good nutrition practices such as dietary diversity and exclusive breastfeeding for up to six months after delivery.
- 3) School food gardens can produce food such as fresh vegetables for consumption at school or home, as well as learning opportunities (e.g. kitchen gardens and backyard farming). This initiative has the potential to alleviate poverty. It would be holistic, focusing on the community and not only on the learner.

With this in mind, it is important that care must be taken to ensure that resources, including soil and water, are of good quality, because using unsafe resources could constitute unhealthy foodstuff being produced. When foodstuffs are not of good quality and are contaminated with microorganisms, it can result in foodborne outbreaks and people becoming ill. However, in previous years, the “one-health initiative” emerged, stating that we have to start at the farm level by ensuring that there is healthy livestock and pathogen-controlled feed.



Figure 5.1: Ideal storage conditions in some schools

According to Fawell and Bartram (2008), formalising quality assurance programmes for drinking water supplies as with the HACCP identifies the hazards and risks at each stage of the process, and ensures that significant risks are mitigated by preventive actions that include planning for emergencies. There is a need for monitoring of the water processes to ensure that they are working properly, all the time. The development of a water quality detection system that is handy, cheap and readily available which will indicate high levels of dangerous microbial contamination is necessary (Adeleke & Bezuidenhout, 2011).

From the data obtained in this study, it is worth concluding that great discrepancies were observed in the number of food samples (Total Coliforms, *Staphylococcus spp*, *Listeria spp*), depending on the schools that were involved. The level of counts connoted contamination of the samples and therefore emphasised the need for environmental sanitation and good personal hygiene. In addition, the findings provide evidence that microbial contamination poses a health risk to consumers both directly and indirectly; thus necessitating public health interventions. However, the major challenge of having effective control measures that can reduce microbiological contamination within the NSNP set-up is that VFHs are changed yearly. As a result, with the introduction of every new batch of VFHs, bridging the knowledge gap on food safety becomes a challenge, as some VFHs come from the era where the education system limited the food handlers to advance their educational level beyond a certain grade. The old apartheid regime posed a disadvantaged to them in terms of advancing their educational level hence it is a challenge for some of them to understand certain food safety principles apart from the knowledge they have gained over the years of becoming a wife, a mother and managing their households. Also, renovating the current food preparation areas and transforming them into proper kitchens that are equipped with hand washbasins separately from the basins used for cleaning the equipment that has hot and cold running water will have huge financial implications.

Furthermore, many of the schools in Quintiles 1-3 exclusively rely on the subsidy received from the government for the smooth running of the NSNP; thus, raising capital for these renovations might not be feasible, as some schools are still attending to issues of having proper classrooms. Stangarlin *et al.* (2013); Zhao *et al.* (2014) and Zwietering *et al.* (2016) indicated that an important aspect of reducing the risk of outbreaks of foodborne diseases in schools is the cleaning and sanitising of food contact surfaces in the food preparation areas. According to Havelaar *et al.* (2010), microbial risk management requires one to have a thorough understanding of the entire food production chain, since contamination may occur at any point during production. Also, monitoring should not be left only to the final product as it is inefficient for hazard control.

Hence, correct cleaning techniques must be a permanent topic as part of the intervention strategies in ensuring good practice. Van Der Spiegel *et al.* (2004) and Arvanitoyannis and Traikou (2005) noted that the Hazard Analysis Critical Control Point (HACCP) and Good Hygiene Practices (GHP) systems are proven to be highly effective in controlling food safety. However, the challenges with GHP and HACCP systems arise when a new, unknown hazard occurs, which is likely to question the development and the effectiveness thereof. These systems were not designed to expand when new technology and information emerge. According to Anthony & Taner (2003); Dora *et al.* (2013) and Walker *et al.* (2003), the lack of resources, competencies and the increased average cost of production in small-scale enterprises hamper the implementation of FSMS in small and medium-sized enterprises, therefore, making it more challenging. Nevertheless, having such systems implemented within the NSNP might be a possible solution to reduce health risks and microbiological contamination, as current monitoring is minimal or none. Furthermore, knowing the source of contamination will determine the correct hygiene intervention that would be more applicable.

The water results indicated that providing access to safe water is one of the most effective instruments in promoting health and reducing poverty, in alignment with the WHO's water safety and quality guidelines (WHO, 2013). Without water, there is no life, as water is needed in everyday life for many purposes such as cooking, cleaning, hygiene and ensuring proper sanitary practices. The results also indicated that though water from the water service provider complies with <10 CFU/mL for Total Coliforms at the water treatment plant, that does not guarantee the water complies at the point of use. Clearly, a statement by the UN (2018) emphasised that many serious diseases in the developing world are directly related to unsafe drinking water, poor sanitation and insufficient hygiene practices. Consequently, potable water must be made available throughout the food production chain and the vulnerability of the elderly, immune-compromised persons and children should be taken into consideration. Furthermore, it is salient to ensure that the microbial water quality is protected from the source to the point of use and is screened for microorganisms using MPN (Most Probable Number).

The observational survey indicated that the food preparation areas that were used in the food preparation for the NSNP did not meet certain standards stipulated in regulation R638. It was further noted that the food handlers often had to devise their own control measures that aided in reducing cross contamination, even though they had no prior formal training on food safety. This was likely possible owing to the experience gained over years from running their own households. Also, it was noted that most of the schools lacked basic Pre-Requisite Programmes (PRPs), Hazard Analysis Critical Control Points (HACCP) and food safety management systems, which would aid the further implementation of a food safety management system (FSMS). A practical suggestion could be that food handlers be trained in the application of the WHO's five keys to safer foods – a universally accepted systems aimed at developing food safety knowledge amongst primarily unskilled individuals.

Another observation raised by the study is the level of commitment from the SMT and SGB when dealing with the NSNP, and whether these bodies grasp the importance of proper nutrition in the learning process. Jespersen and Bedard (2015) indicated that culture and attitude influences how individuals think about safety, their attitude toward safety, their willingness to openly discuss safety concerns and share differing opinions with peers. Opportunities have been rendered by the FSMS, indigenous knowledge, cultural beliefs as well as food safety attitudes and practices toward finding ways into merging all to achieve a food safety culture in the NSNP.

5.2 RECOMMENDATIONS

From the chronicles of information and data studied which added to the findings unravelled in this study, the following is recommended:

- 1) Hands-on training should be implemented as a measure to educate the food handlers on the implementation of the five keys to safer foods (see Appendix 5) to achieve good hygiene standards, also taking into consideration their food safety culture and beliefs. The five keys to safer food by the WHO is widely accepted as

the standard for creating awareness and skills about food safety, especially in developing and vulnerable economies and environments.

- 2) A tool should be developed/designed that can be utilised by the food handlers and coordinators for surveillance of malpractices.
- 3) The current food preparation areas should be renovated by equipping them with basic apparatus, including hand washbasins with soap, hot and cold water and disposable towels.
- 4) Owing to the educational background of some of the VFHs, it is salient to provide education and training utilising posters harbouring information on the proper cleaning techniques and ways to avoid and reduce cross-contamination in the food preparation areas. De Oliveira *et al.* (2014) indicated that bioluminescence can be used to estimate surface cleanliness in real-time, including the presence of organic wastes and the risk of microorganisms.
- 5) Installation of an on-site microbiological detection system that would ensure that microbial contamination is detected immediately as shown in Figure 5.2, instead of sending off the water samples to the laboratory and awaiting results only to implement remedial actions at a later stage. This type of system will result in decreased manual labour and transportation costs, as the verifications will be done on-site and no one would have to go and collect the samples and then transport them to the laboratory. Furthermore, this method would ensure that water is safe and free from any microbial contamination before being used for food preparation purposes.

Decision tree for assessing the suitability of water for its intended use (1)

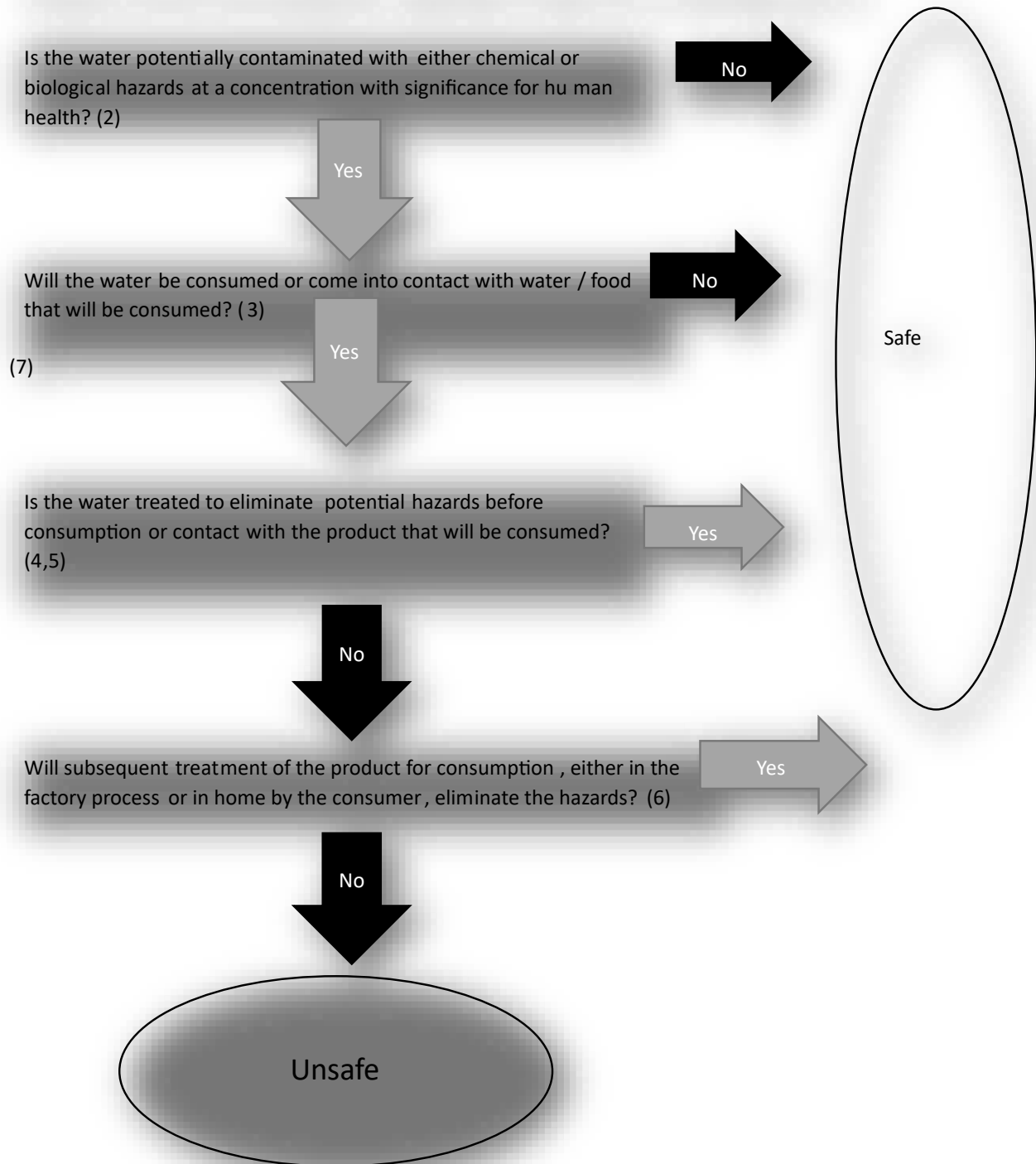


Figure 5.2: Suitability of water for the intended use (Fawell & Bartram, 2008).

1. Also, understanding the pathogen occurrence in water sources is essential, as it facilitates the selection of the highest quality source for drinking water supply by determining pathogen loads and concentrations in water sources.

This will provide a basis for establishing treatment requirements to meet health-based targets within WSP guidelines for drinking water quality.

2. Disinfect the water in the buckets overnight before use by adding one (1) teaspoon of bleach to 20 litres of water and letting it stand overnight.
3. Intense monitoring should be a pre-requisite amongst the schools participating in the NSNP, as well as the proper implementation of all the relevant policies related to food safety.
4. Ensure that resources are made available to the schools that would facilitate the achievement of food safety in its highest form, and that those are properly maintained.
5. Design a pre-requisite programme for the schools which will form a baseline for the implementation of simpler HACCP approaches within the schools.

The NSNP should implement programmes and initiatives that are compulsory for food safety training of all the food handlers, including the coordinators.

5.3 FUTURE RESEARCH

Cross-contamination remains the biggest contributing factor to food-borne illnesses. As a result, it is vital that those involved in the food industry be equipped with the necessary knowledge that would aid in the reduction of foodborne outbreaks. Additionally, the establishment of a pre-requisite programme and simpler HACCP systems can assist in identifying CCPs (critical control points) and having control measures in place as a means to prevent hazards from happening rather than dealing with the consequences of a foodborne outbreak that might occur.

Acknowledging that food safety is not merely about microbiological compliance, but also the human aspect thereof. Furthermore, it is essential to develop a monitoring tool that the schools can use to check the microbiological counts on the food contact surfaces, equipment and food. Several studies have been conducted previously investigating various aspects of the NSNP with similar results. However, there is not much change within the NSNP, and as a result it is presumed that the present study sought to change the perspective of the school Management and the DBE. Particularly based on the results of this study and the *listeriosis* pandemic that recently hit our country, more especially, because of the vulnerability of those who benefit from the NSNP, there is a need to expand such research into all the other provinces to obtain the general stance of the NSNP.

5.4 APPENDICES

5.4.1 APPENDIX 1: Menu of the meals served

FREE STATE PROVINCE: PRIMARY SCHOOLS MENU

DAYS	MEAL PLAN	MENU (FOOD ITEM)	DRY PORTION SIZE
1 Monday	LUNCH		
	Protein	Soya Mince Stew	45g
	Starch	Maize Pap	60g
	Vegetable/fruit	Cooked Fresh Green Vegetable	70g
2 Tuesday	LUNCH		
	Protein	Cooked Beans	40g
	Starch	Cooked Samp	60g
	Vegetable/fruit	Boiled Yellow Vegetables	70g
3 Wednesday	LUNCH		
	Protein	Pilchard Stew	40g
	Starch	Maize Pap	60g
	Vegetable/fruit	Boiled Green Vegetable	70g
4 Thursday	LUNCH		
	Protein	Split Peas/Lentils Stew	100g
	Starch	Rice/Maize Rice	60g
	Vegetable/fruit	Boiled Yellow Vegetable	70g
5 Friday	LUNCH		
	Protein	Sour Milk/Full Cream Milk	200ml
	Starch	Phuthu Pap	60g
	Vegetable/fruit	Whole Fruit	1 medium sized



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FREE STATE PROVINCE: SECONDARY SCHOOLS MENU

DAYS	MEAL PLAN	MENU (FOOD ITEM)	DRY PORTION SIZE
1 Monday	LUNCH		
	Protein	Soya Mince Stew	60g
	Starch	Maize Pap	90g
	Vegetable/fruit	Boiled Green Vegetable	90g
2 Tuesday	LUNCH		
	Protein	Cooked Beans	40g
	Starch	Cooked Samp	60g
	Vegetable/fruit	Boiled Yellow Vegetable	90g
3 Wednesday	LUNCH		
	Protein	Pilchard Stew	60g
	Starch	Maize Pap	90g
	Vegetable/fruit	Boiled Green Vegetable	90g
4 Thursday	LUNCH		
	Protein	Split Peas/Lentils Stew	100g
	Starch	Rice/Maize Rice	90g
	Vegetable/fruit	Boiled Yellow Vegetable	90g
5 Friday	LUNCH		
	Protein	Sour Milk/Full Cream Milk	250ml
	Starch	Phuthu Pap	90g
	Vegetable/fruit	Whole Fruit	1 medium sized



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5.4.2 APPENDIX 2: Inspection checklist

HYGIENE INSPECTION CHECKLIST

NAME OF SCHOOL: _____

DATE: _____

	Satisfactory			Comment
	Yes	No	N/A	
Hygiene of food rooms & equipment				
Are food rooms clean and tidy?				
Do staff clean as they go?				
Is equipment easy to clean and kept in a clean condition?				
Are all food and hand contact surfaces e.g. work surfaces, chopping boards in a good condition?				
Are food contact surfaces and chopping boards disinfected regularly?				

Are suitable cleaning chemicals available and stored correctly, and are proper cleaning methods used?				
Are proper cleaning techniques used?				
Are provided cleaning cloths suitable for use?				
Are the cleaning cloths regularly disinfected?				
Food storage				
Is ready-to-eat food stored above/separately from raw food?				
Is food in fridges/freezers covered?				
Are high-risk foods date coded, codes checked daily and stock rotated?				
Are dried goods stored correctly e.g. off the floor, in covered containers?				
Are freezers or fridges working properly?				
Food handling practices				
Are raw and ready-to-eat foods prepared in separate areas or are the work surfaces cleaned and disinfected between uses?				

If colour coded equipment is provided (e.g. chopping boards), are they used correctly?				
Are high-risk foods returned to the fridge immediately after handling/preparation?				

Is food cooled as quickly as possible away from raw food and other sources of contamination?				
Are ready-to-eat fruit/salads/vegetables trimmed and washed thoroughly?				
Are frozen foods defrosted safely?				
Are controls in place to prevent contamination by chemicals/foreign bodies, e.g. glass, packaging materials, bolts, rust, cleaning chemicals?				
Personal hygiene				
Are staff fit to work, and do they wear clean, suitable, protective clothing and follow personal hygiene rules?				
Do hand washbasins have cold and hot water, soap and hygienic hand towels?				
Are hand washbasins used for hand washing only and used regularly by staff?				

Is jewellery limited to a plain ring?				
Are staff's toilets and changing facilities clean and tidy?				
Pest control				
Are premises pest proofed and free from any signs of pests?				

Where necessary, are external doors/windows fitted with suitable fly screens?				
Are bate stations (if provided) properly maintained?				
Is food properly protected from risk of contamination by pests?				
Waste management				
Is waste inside food premises stored correctly?				
Is food waste stored correctly outside the food preparation area?				
Is the refuse area kept clean?				
Is unsound food clearly labelled?				
Is unsound food stored separately from other foods?				

5.4.3 APPENDIX 3: Focus group agenda questions

Questions

-
- 1. How do you prepare food daily when you arrive at work?**
 - 2. Do you think it is important to wash your hands? How often do you wash your hands, and with what, since you do not have a hand washbasin in your food preparation areas?**
 - 3. What is food safety, who is responsible for ensuring food safety, and why?**
 - 4. How should a food handler be dressed when coming to work?**
 - 5. Have you ever received complaints that the learners were having diarrhoea and vomiting etc. after having eaten your food? What do you think happened?**
-

5.4.4 APPENDIX 4: WHO five keys to safer foods tool

Five keys to safer food



Keep clean

- ✓ Wash your hands before handling food and often during food preparation
- ✓ Wash and sanitize all surfaces and equipment used for food preparation
- ✓ Protect kitchen areas and food from insects, pests and other animals

Why?
While most microorganisms do not cause disease, dangerous microorganisms are widely found in soil, water, animals and people. These microorganisms are carried on hands, wiping cloths and utensils, especially cutting boards and the slightest contact can transfer them to food and cause foodborne diseases.



Separate raw and cooked

- ✓ Separate raw meat, poultry and seafood from other foods
- ✓ Use separate equipment and utensils such as knives and cutting boards for handling raw foods
- ✓ Store food in containers to avoid contact between raw and prepared foods

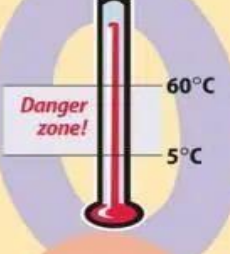
Why?
Raw food, especially meat, poultry and seafood, and their juices, can contain dangerous microorganisms which may be transferred onto other foods during food preparation and storage.



Cook thoroughly

- ✓ Cook food thoroughly, especially meat, poultry, eggs and seafood
- ✓ Bring foods like soups and stews to boiling to make sure that they have reached 70°C. For meat and poultry, make sure that juices are clear, not pink. Ideally, use a thermometer
- ✓ Reheat cooked food thoroughly

Why?
Proper cooking kills almost all dangerous microorganisms. Studies have shown that cooking food to a temperature of 70°C can help ensure it is safe for consumption. Foods that require special attention include minced meats, rolled roasts, large joints of meat and whole poultry.



Keep food at safe temperatures

- ✓ Do not leave cooked food at room temperature for more than 2 hours
- ✓ Refrigerate promptly all cooked and perishable food (preferably below 5°C)
- ✓ Keep cooked food piping hot (more than 60°C) prior to serving
- ✓ Do not store food too long even in the refrigerator
- ✓ Do not thaw frozen food at room temperature

Why?
Microorganisms can multiply very quickly if food is stored at room temperature. By holding at temperatures below 5°C or above 60°C, the growth of microorganisms is slowed down or stopped. Some dangerous microorganisms still grow below 5°C.



Use safe water and raw materials

- ✓ Use safe water or treat it to make it safe
- ✓ Select fresh and wholesome foods
- ✓ Choose foods processed for safety, such as pasteurized milk
- ✓ Wash fruits and vegetables, especially if eaten raw
- ✓ Do not use food beyond its expiry date

Why?
Raw materials, including water and ice, may be contaminated with dangerous microorganisms and chemicals. Toxic chemicals may be formed in damaged and mouldy foods. Care in selection of raw materials and simple measures such as washing and peeling may reduce the risk.

Knowledge = Prevention

 Food Safety
World Health Organization

WHO/SEI/PIH/PO/01/1
Illustration: General
Original: English

5.4.5 APPENDIX 5: Detected microbiological images



Figure 2: Listeria spp



Figure 3: Staphylococcus spp

5.4.6 APPENDIX 6: SANS 241:2015 standards

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SANS 241-1:2015
Edition 2

Table 1 — Microbiological determinands

1	2	3	4
Determinand	Risk	Unit	Standard limits
<i>E. coli</i> ^a or faecal coliforms ^b	Acute health	Count per 100 mL	Not detected
Protozoan parasites ^c <i>Cryptosporidium</i> species <i>Giardia</i> species	Acute health ^g Acute health ^g	Count per 10 L Count per 10 L	Not detected Not detected
Total coliforms ^d	Operational	Count per 100 mL	≤ 10
Heterotrophic plate count ^e	Operational	Count per mL	≤ 1 000
Somatic coliphages ^f	Operational	Count per 10 mL	Not detected
^a Definitive, preferred indicator of faecal pollution. ^b Indicator of unacceptable microbial water quality, could be tested instead of <i>E. coli</i> , but is not the preferred indicator of faecal pollution. Also provides information on treatment efficiency and aftergrowth in distribution networks. ^c Confirms a risk of infection and faecal pollution, and also provides information on treatment efficiency. The detection of selected protozoan parasites confirms a human health risk. ^d Provides information on treatment efficiency and aftergrowth. ^e Process indicator that provides information on treatment efficiency, aftergrowth in distribution networks and adequacy of disinfectant residuals. ^f Process indicator that provides information on treatment efficiency. ^g Determinand that is presently not easily quantifiable and lacks information pertaining to viability and human infectivity, which, however, does pose immediate unacceptable health risks if present in drinking water.			

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