FOOD SAFETY AND QUALITY ASSURANCE MEASURES OF THE NATIONAL SCHOOL NUTRITION PROGRAMME IN MPUMALANGA PROVINCE, SOUTH AFRICA

By

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I declare that the above thesis is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references. I further declare that I have not previously submitted this work, or part of it, for any degree or examination in any other higher education institution.

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SIGNATURE DATE

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DEDICATION

This thesis is dedicated to my late parents; Christinah Bonani Sibanyoni and Daniel Chitheka Sibanyoni for most loving and encouraging believe in the importance of the education of a child and my daughter Mbali Amanda Sibanyoni whom I so dearly love.

ABSTRACT

Foodborne diseases are a major challenge to school feeding programmes because inadequate food safety knowledge and skills of staff can result in unsafe food handling practices and cross-contamination, thus causing foodborne disease outbreaks. The aim of this study was to investigate the food safety and quality assurance measures of the National School Nutrition Programme (NSNP) in Mpumalanga Province, South Africa. The research design was cross-sectional quantitative in nature. A total of 300 NSNP food service managers/coordinators and 440 food handlers were selected to participate in the study. Data collection was by means of a self-administered structured questionnaire and 192 food contact surface swap samples from 32 primary and secondary public schools.

The majority of schools offering NSNP meals were located in informal settlements and most were found to lack basic resources such as electricity and potable tap water in their kitchens. 93% of food handlers did not know about Hazard Analysis Critical Control Point (HACCP). The NSNP food service managers in some schools, especially in schools located in rural settlements, were found to have little knowledge or awareness of HACCP. No school was found to have implemented the HACCP, and only a few staff had received food safety training. Inadequate food safety knowledge was worst in schools located in informal settlements due to a lack of training. Up to 60% of food handlers did not know the correct procedure for washing a cutting board after it had been used. In addition, just over 95% of the food handlers did not know how to sanitise utensils and cutting surfaces after cutting up raw meat. The lack of hygiene was confirmed by the presence of *Listeria monocytogenes, Staphylococcus aureus, E.coli 015:H7, Salmonella* and *Shigella* species on food contact surfaces. A total of 22 different bacteria genera were identified. It is essential to monitor NSNP kitchen hygiene practice to ensure the minimal contamination of

food products and newly recruited food handlers should be trained on food handling practice and principles to ensure the safety of prepared food for school children.

Keywords: Food safety knowledge, Food safety awareness, Food handlers, School Feeding Programme, Contamination, Food contact surfaces.

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CHAPTER 1: INTRODUCTION

1.1 BACKGROUND INFORMATION

The World Food Programme (WFP) has reported that developed and developing countries' school feeding programmes have demonstrated the ability to raise and sustain school enrolment rates, as well as combat malnutrition among low-income families (WFP, 2013; Bukari, & Hajara, 2015). The use of school feeding programmes as a policy intervention with the objectives of addressing hunger, nutrition and long-term educational needs of school children is gaining popularity in many countries (Bundy, et al., 2009; WFP, 2012). The South African government has provided meals to school children through a government-sponsored programme called the National School Nutrition Programme (NSNP) with primary and secondary public schools as targets (Department of Basic Education (DBE), 2012). The NSNP targets schools of quantum 1 to 3(classification of schools from poor communities by DBE) as these schools are considered to be located in impoverished communities.

The importance of the NSNP is emphasised in the first two Millennium Development Goals (MDG) which included the eradication of hunger and the achievement of universal primary education (United Nations Department of Economic and Social Affairs, 2008). The WFP (2013) contends that school feeding programmes require significant institutional capacity to run and often governments tend to underestimate the resources required to run an efficient and effective food safety school feeding programme. The net result is that governments often experience challenges in ensuring food safety in school feeding programmes (WFP, 2013; Rendall-Mkosi et. al., 2013; Abushelaibi et al., 2016). In order to assure high quality meals for learners, school feeding programmes need to follow the regulations set by the Department of Health (DoH) of South Africa. These include the enforcement of the Foodstuffs, Cosmetics

and Disinfectants Act, 1972 (Act 54 of 1972) and the food hygiene and safety-related provisions of the Health Act, 1977 (Act 63 of 1977) (DoH, 2012b).

Foodborne diseases constitute an important health problem in both developed and developing countries (Nyenje et al., 2012; WHO, 2012). Although estimates of the number of outbreaks of foodborne diseases are available for developed countries (Mensah, & Julien, 2011; Singh, 2015; Quinlan, 2013), the lack of effective surveillance systems hampers the availability of similar estimates for developing countries (Malhotra et al., 2008). Cases of foodborne diseases are rarely reported since they can be mistaken for other illnesses and the exchange of information between regulatory bodies is virtually absent, meaning that the prevalence and magnitude of the problem cannot be accurately estimated (CDC, 2011a; Niehaus et al., 2011; Scallan et al., 2013).

Children are particularly susceptible to the effects of foodborne diseases during the first few years of life, because their immune systems are either not fully developed or may be compromised by other disease conditions (DoH, 2012a; Scallan et al., 2013). A small number of enteric pathogens that may be harmless to most healthy people can cause disease and even death in children, especially those who are immuno-compromised (Government Accountability Office [GAO], 2013; Mellou et al., 2013). Inappropriate food safety practices in food service establishments and at home play a crucial role in the occurrence of incidences of food-borne diseases (Tokuç et al., 2009; Assefa et al., 2015; Baluka et al., 2015). The prevention of foodborne diseases in school feeding programmes is essential, considering that schools have been identified as high food safety risk establishments (Da Cunha et al., 2012).

Efforts are being made worldwide to improve food safety at all levels of the food chain and legislation in many countries mandates that all food operators adhere to prescribed food safety standards such as Hazard Analysis and Critical Control Point (HACCP) (United States

Department of Agriculture (USDA), 2012; FAO/WHO, 2014). The Pew Charitable Trusts have reported that most schools offering food services in the United States of America are without adequate equipment or use equipment which is less-efficient, inadequate, expensive, inefficient, and unsustainable (The Pew Charitable Trusts, 2013). The lack of adequate equipment and resources can compromise the quality of food served to learners. To ensure food safety in South Africa's NSNP, proper kitchen infrastructure and facilities with storage, equipment and utensils for food preparation are needed in all schools (FAO/WHO, 2009; WFP, 2013; Sibanyoni et al., 2017). Previous studies have revealed that some food handlers in many food service establishments often lack basic food safety knowledge when it comes to temperature control, personal hygiene and the prevention of cross-contamination (Afolaranmi et al, 2015; Jianu & Chis, 2012; Martins et al., 2012). Hence this study aimed to investigate the quality assurance and food safety measures employed at schools implementing the NSNP in Mpumalanga Province.

1.2 PROBLEM STATEMENT

Billions of people are at risk every year and thousands die as a result of consuming unsafe food (WHO, 2012; Quinlan, 2013). Many outbreaks of foodborne diseases are due to cross contamination that occurs during food preparation within food service establishments (Smigic et al., 2016). This form of food poisoning is prevalent in schools (Sanlier & Konaklioglu, 2012). Outbreaks of foodborne diseases in school feeding programmes can result in life-threatening diseases, huge medical costs and the spread of infection to other children and staff, thereby leading to disruption of learning in schools (Scharff, 2012). In 2011 the South African National Department of Health (DoH) reported 2560 cases of foodborne diseases of which the majority (1700) were amongst learners in primary and secondary schools (Statistics South Africa [Stats SA], 2014). In 2014 three learners in Gauteng province (2) and Limpopo province (1) were reported to have died after consuming contaminated meals provided by the National

School Nutrition Programme (NSNP) (Nzimande, 2014). It should be noted that children with weakened immune systems are more at risk of contracting food poisoning compared to those who are in good health because their immune systems are not fully developed (WHO, 2012; Burke, Young, & Papadopoulos, 2016). The safety of food during transportation, storage, preparation, handling and serving is a priority for every school feeding programme (DBE, 2013). The World Food Programme (WFP) states that school feeding programmes require significant institutional capacity to run but they are often started without sufficient capacity to manage daily activities (WFP, 2013).

The South African NSNP is no different from other school feeding programmes when it comes to these challenges such as inadequate infrastructure, lack of proper equipment and utensils, and lack of skilled food handlers and monitors (Rendall-Mkosi et al., 2013; Sibanyoni et al., 2017). The lack of adequate resources in the NSNP can result in the provision of food with compromised safety and quality assurance (Garayoa et al., 2011; Lockis et al., 2011; DoH, 2012a; GAO, 2013; Sibanyoni et al., 2017). Furthermore, food safety and quality control inadequacies in the NSNP can result in foodborne disease outbreaks (Dimitrios & Katerina, 2014). In a school setting, where thousands of infants and children are served with food daily, a foodborne disease outbreak can cause sickness or the death of many learners with devastating legal and financial ramifications (WFP, 2013). Therefore, lapses in the food safety and quality assurance systems in the NSNP can pose a significant public health risk. Very little research or information is available on the food safety and quality assurance measures of the NSNP nor of the food safety awareness and hygiene practices of food handlers and managers of the NSNP in South Africa.

1.3 PURPOSE FOR THE STUDY

The purpose of this study was to investigate the food safety and quality assurance measures of the NSNP in Mpumalanga Province, South Africa. Food safety is an important issue in schools as it plays an important role in child health development and, consequently, in national economic development (Munthali et al., 2014; Sanfilippo et al., 2012). Thus, great effort should be made to improve food safety at all levels of the food chain. Notwithstanding the good record school feeding programmes have for serving safe meals to children, problems do exist relative to the food handling practices used by NSNP employees (Rendall-Mkosi et al., 2013; Nhlapo et al., 2014; Sibanyoni et al., 2017). By identifying the challenges to implementing food safety and quality assurance measures, food safety procedures and strategies can be developed to improve the safety of school meals served to children. Furthermore, by identifying the current levels of food safety knowledge and awareness in school kitchens, areas of deficiency can be determined and strategies developed to improve the food handling practices among employees. The results from this research can be used to enhance the food safety and quality assurance measures of the NSNP.

1.4 SIGNIFICANCE OF THE STUDY

This research study will benefit all learners, the Department of Basic Education, and the schools implementing the NSNP. Data will add to the body of knowledge about the NSNP's kitchen hygiene, food handlers and manager's food safety knowledge and awareness of quality assurance measures that are implemented in NSNP to ensure the safety of the learners. To date, little research has been conducted to assess the food safety and quality assurance measures implemented at schools implementing the NSNP in Mpumalanga province, South Africa.

1.5 ASSUMPTIONS OF THE STUDY

The researcher assumes that the NSNP's food handlers and managers/coordinators honestly and accurately reported information and returned complete questionnaires. The reliability and validity of the questionnaire instruments was tested in a pilot study with 8 schools. This exercise is done to ensure that the instruments are valid for their intended purpose and the contents are appropriate for measuring what it is supposed to measure (Ary et al., 2002).

1.6 LIMITATIONS OF THE STUDY

The sample of food handlers and managers/coordinators were limited to those from the population of public schools in Mpumalanga province implementing the NSNP. The schools in this sample represented schools from rural, suburban and urban areas. The survey response rate is reflective of the sampled school districts. Additional limitations include accuracy of self-reporting information and lack of cooperation from principals or managers/coordinators or food handlers. All communications and surveys were paper-and-pencil and were distributed using structured questionnaires unless the participants specifically requested self-reporting for the completion of the questionnaire using face to face interview.

1.7 LAYOUT OF THE THESIS

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

CHAPTER 1: INTRODUCTION

This first chapter is the introduction to the study. It provides an overview and background to the study. This section also outlines the problem statement, the purpose of the study, significance of the study, assumptions, limitations of the study, and explains the layout of the thesis.

CHAPTER 2: LITERATURE REVIEW

The literature review in chapter 2 provides an overview of existing literature on food safety in school feeding programmes, such as the management support for HACCP, the hygiene of kitchen food contact surfaces, and food handlers' knowledge.

CHAPTER 3: AIMS AND OBJECTIVES

In this chapter, the aim and objectives of the study were explained.

CHAPTER 4: METHODOLOGY

In this chapter, the research area, data collection methods and research instruments used were outlined.

CHAPTER 5: RESEARCH

Chapter 5 outlines the research outputs emanating from the different research objectives of which two were published and one submitted in a peer reviewed journal.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

In this chapter, conclusions on the research findings and recommendations for improvements are provided. A list of references and appendices then follows.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Foodborne diseases are a major concern for the foodservice industry as they are responsible for the bulk of mortality and morbidity worldwide with up to 30% of the population in industrialised countries suffering from foodborne illness annually (WHO, 2014). Foodborne illness is carried or transferred to people by food (Assefa et al., 2015; Baluka et al., 2015; Monney et al., 2014). The consumption of food and water contaminated with potential foodborne pathogens such as bacteria, viruses, parasites and toxins accounts for more than 250 different foodborne illnesses (Scallan et al., 2015; WHO, 2014; Woh et al., 2016).

The Centers for Disease Control and Prevention (CDC) estimates that 48 million people, or 1 in 6 individuals, in the United States fall sick, 128 000 are hospitalized, and 5000 die from foodborne related illness annually (CDC, 2014; Quinlan, 2013; Scallan et al., 2013). Therefore it is important to practise food safety and hygiene in order to prevent such illnesses. Anyone is at risk of developing a foodborne illness, but those at higher risk include the elderly, young children, pregnant women, transplant recipients and the immunocompromised, because their immune systems are either not fully developed or are compromised by a weakened condition (Bundy et al., 2009; Lund, & O'Brien, 2011). A single outbreak can affect many people. The food industry is regulated to ensure safe food supply; however, there is always some degree of risk. The importance of food safety and quality assurance has significantly grown in the food sector over the last few decades because of increasing consumer expectations, governmental regulations and expanding competition in the market (WHO, 2011; Fernando et al., 2014). However, millions of people become ill each year from eating contaminated food (CDC, 2014).

The implementation of food safety and quality assurance systems in school feeding programmes strengthens and improves the services of those programmes (Mensah et al., 2012). Food safety programmes are increasingly focusing on a farm-to-table approach as an effective means of reducing foodborne hazards (USDA, 2012). Empirical studies have shown that quality management practices can have several favourable impacts on operational variables such as productivity, quality, delivery, and customer as well as employee satisfaction (Arendt et al., 2013). The consumption of foods contaminated by foodborne pathogens and toxins produced by microorganisms can cause foodborne diseases, hospitalisation, economic losses and even death (Scharff, 2012; Hussain & Dawson, 2013; McLinden et al., 2014; Hoffmann et al., 2015). Foodborne diseases are often given little consideration as the symptoms are often moderate and self-limiting and many people do not even consult a doctor after falling sick (CDC, 2011b).

2.2 SCHOOL FEEDING PROGRAMMES

The South African government introduced a school feeding programme, (the NSNP), in 1994 as an anti-poverty policy intervention which declared that all primary school children should get fed a nutritional meal every day (Lund & O'Brien, 2009; Buhl, 2011; McLaren et al., 2015). Implementation of the NSNP gives effect to the legislative provisions contained in the White Paper on Reconstruction and Development (1994). These provisions may be summarised as: access to quality food and basic nutrition, as enshrined in the South African Constitution and part of the International Children's Charter; access to quality basic education and learner success, as stipulated in the National Educational Policy Act 27 of 1996 and South African Schools Act 84 of 1996; targeting schools for school feeding, as informed by the Norms and Standards for funding of Public Schools, according to the Department of Basic Education General Notice 2362 of 12 October 1998; provision of Grade R, as enshrined in the White Paper no 5 and the Cabinet Resolution of January 2002 in which the transfer of the school feeding programme was addressed; and caring for children affected by HIV/AIDS, orphans and

vulnerable children, as espoused in the strategic objectives of the Department of Basic Education (DBE, 2013).

The programme was initially provided by the Department of Health (DoH) but was subsequently taken over by the Department of Education (now the Department of Basic Education) in 2004. The programme increased its target from primary schools to secondary schools and changed its name from the Primary School Nutrition Programme (PSNP) to the National School Nutrition Programme (NSNP) (Public Service Commission, 2008; DBE, 2013). The NSNP aims to foster better quality education by enhancing children's learning capacity, encouraging regular attendance and punctuality, decreasing gender disparity, and addressing micronutrient deficiencies and alleviating short-term hunger by providing 30% of the daily energy requirements of the child (Global Child Nutrition Foundation, 2014; WFP, 2012). The South African Department of Basic Education administers the NSNP at national and provincial level (DBE, 2013).

2.3 FOOD SAFETY IN SCHOOL FEEDING PROGRAMMES

Millions of South Africans contract food poisoning every year (DoH, 2012a; Wright, 2009; Stats SA, 2014). Outbreaks of foodborne disease in humans are common in most countries worldwide and in South Africa in particular, but rarely reported (Smith et al., 2007; CDC, 2011a; Lund, & O'Brien, 2011). Any incidence of food poisoning involving two or more people is notifiable and should be reported to the relevant health authorities (WHO/FAO, 2010). Preventing foodborne illness is an important concern in school settings as outbreaks have personal, academic, financial and legal consequences for each school district (Scharff, 2012; Da Cunha et al., 2012; WFP, 2013). Children are at a higher risk of contracting foodborne illness from eating or drinking a contaminated substance (Lund, & O'Brien, 2011). As previously noted, foodborne diseases are often given little consideration as the symptoms are

often moderate and self-limiting and many people do not even consult a doctor after falling sick (CDC, 2011b; Mellou et al., 2013). The food safety systems such as FSSC/FS 22000 (Food Safety System Certification Standard), ISO 22000 and HACCP in developing countries and Africa in particular, are weak (WHO, 2009). Commitment and support from school management and administration are critical, as without this support the HACCP programme may not work in school feeding programmes.

2.4 HAZARDS IN FOODS

Any substance that is likely to cause harm, injury or illness when present above an established acceptable level is a food safety hazard. There are three recognised categories of food safety hazards; biological, chemical, and physical. Food safety hazards due to bacteria and other microbial agents result from improper food handling, environmental contaminants, and residues of substances used in agricultural production and processing, such as pesticides (FAO/WHO, 2009). Food hazards can arise from contamination of food during any stage of production, processing, storage and distribution (Dome´nech et al., 2008; Singh, 2015). Microbial contamination is common where there is poor hygiene and lack of access to clean water, both of which are major sources of foodborne illnesses, especially among children (WHO, 2014). Misuse and excessive use of pesticides sometimes lead to dangerously high residue levels in food (Djordjevic et al., 2011). In most countries regulatory bodies have established acceptable limits for all types of hazards (FAO/WHO, 2012). Moreover, the Codex Alimentarius has also established acceptable levels of certain hazards as part of its Food Standards Programme (Kok, 2009). The strategies used to address hazards in foods include the prevention or elimination of hazards or the reduction of hazards to acceptable levels. These strategies are employed in the HACCP system (Kok, 2009; Lockis et al., 2011; Liz Martins, & Rocha, 2014).

2.5 CAUSES OF FOODBORNE DISEASES

Foodborne diseases occur when foods containing infectious pathogens and/or toxigenic agents are eaten. Foodborne diseases are of two types, namely, disease due to infection (foodborne infection) and disease due to toxins (food poisoning). Foodborne diseases encompass a wide spectrum of illnesses that manifest after the ingestion of contaminated foods and food products. They can be caused by a variety of microbial pathogens, chemicals, and parasites that contaminate food at different points in the food production and preparation process (Hanson et al., 2012). Viruses account for half of all foodborne illnesses, while most hospitalisations and death related to foodborne infections are due to bacterial agents (Nyenje et al, 2012). Bacteria such as *Clostridium botulinum* and some strains of *Bacillus cereus* can multiply in certain foods and produce toxins which can cause food poisoning, unlike *Salmonella spp*. which causes foodborne infection due to growth of its vegetative cells (FAO/WHO, 2009).

Food preparation processes in catering establishments are often associated with increased food microbiological contamination risk (Melngaile & Karklina, 2013). Microbiological sources pose a greater risk to public health because of the severity of the clinical symptoms and the large number of foods and microorganisms that can be involved (WHO, 2008; Melngaile & Karklina, 2013). In the kitchen, microbes can be transferred from one food to another by means of using the same knife, cutting board, or other utensil to prepare both without washing the surface or the utensil with soapy warm water in between (Nyamari, 2013). The following have been described as the most common factors contributing to foodborne diseases: lack of basic sanitation; time and temperature abuse; poor personal hygiene and incorrect hand washing; cross contamination; lack of knowledge about food safety measures; lack of fuel for cooking; inappropriate food storage facilities; lack of education programmes for food handlers; failures/errors during food processing (Lockis et al., 2011; WHO, 2014; Baluka et al., 2015; Liz Martins, & Rocha, 2014).

2.6 EPIDEMIOLOGY OF FOODBORNE DISEASES

Food preparation processes and foodborne diseases affect millions of people each year both in developed and underdeveloped countries (CDC, 2011a). Globally, it seems that between one in three and one in four people gets food poisoning every year, so everyone is at risk because we have to eat. Most cases of food poisoning go unreported to health agencies as treatment may not be sought, diagnostic testing not done, or test results not forwarded for tabulation (Niehaus, et al., 2011; CDC, 2011a). In the United Kingdom (UK) it has been estimated that for every 136 cases of foodborne illness in the community, only 23 people will see a doctor, only six samples will be sent to a laboratory for identification of the organism causing the illness and just one case will be identified (Scharff, 2012). About 5,000 people die every year from food poisoning in the United States of America (USDA, 2012). South Africa is no different to this as the DoH reported 2560 cases of foodborne diseases in 2011 (Stats SA, 2014). The majority of foodborne disease incidences in South Africa occur in primary and secondary schools as well as in institutions of higher education (Stats SA, 2014). The bacteria most commonly involved in foodborne diseases are *Salmonella spp, Bacillus cereus, Staphylococcus aureus, Clostridium botulinum, Clostridium perfringens, Escherichia coli, Shigella spp., Campylobacter spp.* and *Vibrio cholerae* (WHO, 2008).

Food poisoning is much more serious in young children and in frail and immuno-compromised people (Lund, & O'Brien, 2011). Research shows that infants and toddlers attending childcare centres have higher rates of gastrointestinal infections than same-aged children cared for at home (Lund, & O'Brien, 2011; Mellou et al., 2013). Scharff (2012), Hussain and Dawson (2013) and Quinlan (2013) estimated that the total cost of foodborne illness in the United States of America is around $77 billion a year due to medical costs and lost productivity. Most of the cases of foodborne illness could be eliminated if people would follow food safety practices when preparing and handling food as these are one of the most effective means of preventing

the spread of bacteria (Scallan et al., 2015).

2.7 THE CHALLENGES OF THE NATIONAL SCHOOL NUTRITION PROGRAMME

The World Food Programme (WFP) states that school feeding programmes require significant institutional capacity to run but that, often, programmes are started without sufficient capacity to manage daily activities (WFP, 2013). Governments are experiencing challenges in providing the resources necessary to ensure food safety in school feeding programmes (WFP, 2013). The Pew Charitable Trusts report that most school food authorities in the United States of America are without adequate infrastructure and equipment, and utilise processes which are widely considered to be inadequate, expensive, inefficient and inadequate to deliver the expected quality of service delivery of the school feeding programme with regards to ensuring food safety (The Pew Charitable Trusts, 2013; Monakhova, 2014). The government of Ghana is struggling to fund the Ghana School Feeding Programme alone and is reported to be on the verge of collapse (Sulemana et al., 2013; Atta & Manu, 2015). A study conducted in Ghana reported that about 60% of the schools with the feeding programmes did not have well-built kitchen structures, access to regular and safe drinking water, facilities to cook food, or sanitary facilities (Sulemana et al., 2013; Atta & Manu, 2015). Furthermore, food handlers did not receive any kind of training in hygiene and nutrition (Oduro-Ofori & Adwoa- Yeboah, 2014).

South Africa is no different as, in spite of the impacts of the school feeding programme discussed thus far, it is faced with a number of challenges. These challenges are: lack of kitchens, storage, and dining halls; lack of training in hygiene and nutrition for school food handlers; lack of sanitation facilities and regular safe water at schools despite most menus requiring water for preparation; lack of basic equipment and utensils necessary for preparing and serving meals; poor food quality and poor food safety due to lack of hygiene; non delivery

of food, theft of food and corruption (Bundy et al, 2009; Education Training Unit, 2010; Rendall-Mkosi et al., 2013; WFP, 2013; Liz Martins, & Rocha, 2014; Atta & Manu, 2015; Da Cunha et al., 2012; Nhlapo et al., 2014; Sibanyoni, Tshabalala et al., 2017).

The lack of these resources increases the level of cross contamination which leads to food poisoning and foodborne illness (Wilcock et al., 2011; Liz Martins, & Rocha, 2014). This has a negative impact on children's health, teaching and learning. Effective implementation of the NSNP requires the provision of the necessary resources that will support the safety of food and thus prevent foodborne disease outbreaks in school (Rendall-Mkosi et al., 2013; Atta & Manu, 2015; Sibanyoni et al., 2017). While educational resources such as shortage of classrooms and other teaching aids may be viewed as more pressing challenges than the resources necessary for school feeding programmes, more attempts should nevertheless be made to create enabling conditions for the effective implementation of food safety in the NSNP (Rendall-Mkosi et al., 2013; Liz Martins, & Rocha, 2014). More attention to both personal hygiene and food hygiene and adherence to HACCP principles would prevent many outbreaks (Assefa et al., 2015; Liz Martins, & Rocha, 2014).

2.8 MICROBIAL QUALITY OF FOOD PREPARATION SURFACES

The contamination of surfaces can be a public health problem as some disease outbreaks are subsequently found to be due to surface contamination, such as inadequately cleaned equipment contributing to the contamination of meat by *Escherichia coli*, through the surface of that equipment being in contact with the meat (Brown et al., 2013). Cross contamination is one of the major factors responsible for foodborne disease outbreaks in various stages of food preparation (Greig, & Ravel, 2009). Although many cases of foodborne illness have been attributed to inadequate cooking, temperature abuse and the use of contaminated raw ingredients, and cross-contamination between raw and cooked foods, food contact surfaces

have also been identified as a significant risk factor (Boro et al., 2015; Nhlapo et al., 2014). Various types of food contact surfaces such as plastic, stainless steel, glass and wood are used in the food industry. These surfaces are subject to contamination by microorganisms, some of which are able to form biofilms.

Contamination of food contact surfaces depends on their characteristics, such as smooth, rough, porous, or irregular, and their state, such as before or after the cleaning process, new or old, dry or wet (Ismaïl et al., 2013). Cross-contamination is often associated with contamination of dishes or surfaces with washing water, contaminated cloths and sponges, or contaminated items placed in contact with them (Rossi et al., 2013). Several studies have revealed that cloths and sponges can be important disseminators of pathogens and can transfer bacteria to surfaces and utensils, leading to cross contamination of food (Kusumaningrum et al., 2003; Mattick et al., 2003).

Food contact surfaces in school feeding settings are prone to bacterial contamination where the lack of cleanliness and sanitation programmes pose a health risks to children due to their potential contribution to foodborne illness (Cremon et al., 2014; Choi et al., 2016). Food contact surfaces could become contaminated through contact with raw or cooked foods, equipment, workers, pests, waste, transfer from other unsanitary surfaces, and production practices (Bruhn, 2014; Baluka et al., 2015). According to Kusumaningrum et al. (2003), bacteria that were transferred from sponges to surfaces could survive for hours on stainless steel surfaces, thus increasing the risk of cross contamination. Contaminated hands of food handlers and moist sink faucets are reported as common areas of infection among children younger than 3 years of age (Monney et al., 2014). A study conducted by Assefa et al. (2015) indicated that various bacteria, including *Escherichia coli, Staphylococcus aureus* and *Salmonella* survive on hands for hours and days after initial contact with microorganisms. Therefore, cross

contamination and transmission of foodborne illness may be prevented through effective cleaning and sanitizing of food contact surfaces before, during, and after food preparation (Goncalves et al., 2013).

2.9 FOOD HANDLERS' KNOWLEDGE OF FOOD SAFETY IN A NSNP

Many studies have been conducted in different countries to assess food handlers' food safety knowledge on areas such as hand washing, temperature control, cross contamination, food storage, and microbial quality. Hislop and Shaw's (2009) study conducted in Canada found that training had a positive impact on food safety knowledge and that recertification was necessary periodically as knowledge retention decreased with the passage of time. Jianu and Chis (2012) study conducted in Romanian found food handler's knowledge levels were significantly greater based on educational levels, with food handlers with higher education achieving higher knowledge scores. However, a study by Martins, Hogg, & Otero (2012) in Portugal found that food handlers' knowledge levels were high for surface and utensils hygiene and food storage. Panchal, Liu, and Dworkin's (2012) study found that food safety knowledge levels of food handlers may be influenced by language barriers and the training methodologies used in training food handlers.

Jevsnik et al. (2008) study on food safety knowledge and practices among food handlers in Slovenia found that there was an inadequate knowledge on the part of food handlers about microbiological hazards, correct temperature for hot holding, use of organoleptic methods to detect food contamination, and risks involved in handling food while experiencing health problem. Kunadu et al., (2016) study conducted in Accra, Ghana highlighted storage of food in the danger zone as a significant gap in knowledge, attitudes and practices of safe food handling. Elsewhere, Woh et al., (2016) and Onyeneho & Hedberg, (2016) identified a link between poor knowledge levels and poor participation in food training programmes, low

educational levels, and language barriers. Mishandling and the disregarding of hygienic measures by food handlers may enable pathogens to come into contact with food and multiply in sufficient numbers to cause illnesses to learners (Abdul-Mutalib et al., 2012). Human specific foodborne pathogens such as Hepatitis A, noroviruses, typhoidal *Salmonella*, *Staphylococcus aureus*, and *Shigella spp* can be transmitted by food handlers via their hands, cuts or sores, mouth, skin and hair (Labib et al., 2013). Furthermore, food handlers may also shed foodborne pathogens, such as *E. coli* O157:H7 and non-typhoidal *Salmonella* during the infectious period or, less likely, during the recovery period following gastrointestinal sickness (Goncalves *et al*., 2013).

It is essential that food hygiene principles are continuously applied by food handlers if children are to receive the protection they are entitled to. A study by Goncalves *et al*., (2013) conducted to evaluate the food safety knowledge, attitude and practice of food handlers in restaurants and food establishments in Brazil found unhygienic practice, negative attitudes, and lack of knowledge as identified risk factors in food poisoning. These gaps could be closed with risk-based training of food handlers in institutional catering facilities, using appropriate training aids to encourage understanding and appreciation of the application of food safety principles in their day-to-day operations. Training interventions should cover appropriate storage temperatures, thawing of frozen foods, and hand washing after coughing and sneezing during food preparation. Habits must be changed in order to obtain a sustained improvement in food safety practices and this can only be accomplished through gradual and continuous training, monitoring and resource improvement. Techniques employed in this process must also be tailored to accommodate the low education levels of the food handlers.

2.10 FOOD SAFETY TRAINING IN THE SCHOOL FEEDING PROGRAMME

Training of NSNP staff can influence the safety of food and thus reduce the unacceptably high

levels of food poisoning. Training of staff also leads to greater job satisfaction, builds programme loyalty, and may lower turnover and absenteeism (Arendt et al., 2013). According to Sprenger (2009), training is intended to modify or develop knowledge, skills and attitudes through learning experience and to achieve effective performance in an activity or range of activities. Staff development and professional training benefits the employee through improved morale and the employer by increasing productivity (Topliceanu et al., 2015). Many school feeding programme employees are not adequately trained to keep food safe and prevent foodborne illnesses (Egan et al., 2007; Fernando et al., 2014). Investing in staff, whether it is through funds for support of training or time for in-service training, will be returned by greater productivity, higher quality meals, and improved service to the learners (Buhl, 2012; Sulemana et al., 2013).

The management of school feeding programmes is responsible for encouraging staff to practise hygiene and food safety procedures. Commitment is essential to influence attitudes and actions of staff to ensure that the goals of the school foodservice programme are met. Although NSNP managers believe food safety is important, there is a need for additional training and improvement (Rendall-Mkosi et al., 2013). A study conducted by Webb and Morancie, (2015) on food safety of foodservice workers at a university campus reported employee training as the most significant barrier. Employee training has associated costs, including time away from the kitchen for training, trainer fees, and material and supply expenses. Training programmes for all staff, new and continuing, should be mandatory and provide the knowledge and skills needed to handle food safely in school feeding programmes. Current staff might know the correct procedures, but continual training and monitoring by management will reinforce the concept to ensure that these are followed. Managers should observe staff and provide feedback to close the gaps.

2.11 FOODBORNE DISEASE IN SOUTH AFRICA

The food industry has a responsibility to ensure that food provided to the consumer is safe and does not become a vehicle for a disease outbreak or the transmission of communicable diseases (DoH, 2012a). Millions of people worldwide, and in Africa in particular, contract foodborne diseases every year (CDC, 2011a; DoH, 2012a; Wright, 2009), yet these cases are rarely reported (Smith *et al.*, 2007). Any food poisoning incidence involving two or more people is notifiable and should be reported to the relevant health authorities. South Africa reports just a few hundred cases of food poisoning per year, whereas the incidences are more likely to be in the region of hundreds of thousands (Smith *et al*., 2007; Nyenje *et al*., 2012). Outbreaks of foodborne diseases should be thoroughly investigated. The national Department of Health (DoH) in 2011 reported 2560 cases of foodborne diseases, of which the majority (1700) were amongst learners in primary and secondary schools as well as in institutions of higher education (Stats SA, 2014). However, it should be noted that children with weakened immune systems are more at risk of contracting food poisoning compared to those who are in good health (Burke, Young, & Papadopoulos, 2016). In 2014, three learners in the Gauteng (2) and Limpopo (1) provinces in South Africa were reported to have died after consuming contaminated meals provided by the National School Nutrition Programme (NSNP) (Nzimande, 2014).These cases are estimated to represent less than 1% of the reality of the situation due to under reporting of the foodborne diseases (Niehaus *et al*., 2011).

2.12 FOOD SAFETY LAWS IN SOUTH AFRICA

There are three main governmental food control authorities in South Africa, namely, the Department of Health (DoH), the Department of Agriculture, Forestry and Fisheries (DAFF) and the Department of Trade and Industry (DTI) represented by the South African Bureau of Standards (SABS) which has various directorates controlling vegetable, meat and fish growing, processing and exporting issues (Gordon-Davis, 2011). The aim of more than two authorities

is to protect public health by: reducing the incidence of foodborne diseases; protecting consumers from unsanitary, unwholesome, contaminated, mislabeled or adulterated foods; supporting economic development by maintaining consumer confidence in the food system; and providing a sound regulatory foundation for domestic and international trade in food (Gordon-Davis, 2011). Food safety laws are in place to protect the consumer against any potential risk of contracting foodborne diseases and to protect the food industry from legal action by giving them rules within which to operate (DoH, 2012b).

2.12.1 The Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972)

This Act governs the manufacture, sale and importation of all foodstuffs from a food safety control point of view. The Act is supplemented by a comprehensive set of regulations published by the Department of Health (DoH) setting the minimum standards and requirements with which all foodstuffs should comply, including the correct labelling thereof (DoH, 2012b). This Act regulates the enforcement of the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972) and the food hygiene and safety-related provisions of the Health Act, 1977 (Act 63 of 1977) (DoH, 2012b). In order to assure high quality meals for learners, school feeding programmes need to follow the regulations set by the DoH of South Africa.

2.12.2 The Health Act, 1977 (Act 63 of 1977)

This Health Act, 1977 (Act 63 of 1977) has a Government amendment notice Number R.723 (2002) which regulates the general hygiene requirements for food premises and the transportation of food (DOH, 2012b). This regulations promulgated under this Act govern, among others, the hygiene aspects of food premises and food transport; milking sheds and the transport of fresh milk; and, the inspection of premises, stipulating for instance the powers and duties of inspectors authorised in terms of the Act which ensures the safety of food

supplied and provided to the consumer. These regulations are applicable to all food handling situations, including restaurants, cafés, shebeens, taverns, and caterers/suppliers at special events, and covers the following important aspects relating to the requirements for the handling of food (DoH, 2012b):

- Prohibition on the handling and transport of food
- Standards and requirements for food premises
- Standards and requirements for facilities on food premises

2.12.3 Standards Act 1993 (Act 29 of 1993) of the Department of Trade and Industry

The Department of Trade and Industry (DTI) regulates ration imports to South Africa in the national interest, but most goods may be imported into South Africa without any restrictions. The quality of the food products bought for food preparation should comply with the South African Bureau of Standards (SABS). The National Regulator for Compulsory Specifications (NRCS) falls under the portfolio of the Minister of Trade and Industry and is responsible for food safety issues related to canned meat products containing more than 10% meat, and frozen and canned fish and fishery products, through the Standards Act 1993 (Act 29 of 1993) (Government gazette, 2008). The NRCS ensures that fish products conform to the compulsory specifications (technical regulations) and is the appointed authority for certifying all fish exports to the European Union (EU) and Australia. The NRCS is also responsible for administering the Trade Metrology Act of 1973 (Act 77 of 1973) and the Trade Marks Act of 1963 (Act 62 of 1963), both of which are concerned with food labeling, which is referred to in Section IX of the Code of Practice: Product Information and Consumer Awareness (FOA/WHO, 2014).

2.13 MANAGEMENT SUPPORT OF FOOD SAFETY

School administrators need to have an understanding of the complexities of the school

foodservice programme and be supportive in providing adequate meal time periods, appropriate budget and assistance with effective payment methods, and providing sufficient staff members and training (Strohbehn et al., 2014). Furthermore, management should provide resources for the monitoring of children during mealtime and establishing and implementing food safety policies (Sneed et al., 2004). Financial shortages in the school feeding programme have led to school administrators looking at ways to balance the budget and focus on education rather than school feeding programme (Abdul-Mutalib et al., 2014). Learners meal programmes are part of the total educational and school environment and help promote healthy behaviour (Oduro-Ofori & Adwoa-Yeboah, 2014; Sulemana et al., 2013; Atta & Manu, 2015). School meal programmes need the support of the schools administration to operate as an integral part of the school day.

To ensure food safety and quality assurance, school feeding programmes should implement HACCP as a separate risk management system or FSSC 22 000 (ISO management system that includes ISO/TS 22001 and HACCP) which supports the managing of food safety (Kok, 2009; Tomasevic et al., 2016). The standard specifies the requirements for a food safety management system that involves interactive communication, system management, prerequisite programmes and HACCP principles. The successful application of HACCP requires the full commitment and involvement of management and the work force, along with the implementation of prerequisite programmes (WHO, 2008; FAO/WHO, 2009; Tomasevic et al., 2016). The ISO 22000 (ISO 2005) standard is a complete food safety management system incorporating the elements of prerequisite programmes for food safety, HACCP, and a quality management system, which, together, form an organisation's Total Quality Management (ISO, 2005; Escanciano & Santos-Vijande, 2014). HACCP comprises seven principles that guide the production and manufacturing of food. These are: conduct hazard analysis; determine critical control points; establish critical limits; establish monitoring procedures; identify

corrective actions; verify that the system works; and establish procedures for record keeping and documentation (ISO. 2011). HACCP provides organisations with a cost effective system for control of food safety, from ingredients right through to production, storage and distribution, to sale and service to the final consumer (Kok, 2009).

2.14 DEVELOPING A HAZARD ANALYSES CRITICAL CONTROL POINT (HACCP) PROGRAMME

The development of a HACCP programme will vary from facility to facility and is both product and process specific. Generic HACCP programmes may be used as a guideline for facilities to establish control measures, but the unique needs of each facility must be considered in the development of an effective HACCP programme (FAO/WHO, 2009; Tomasevic et al., 2016). In the development of a HACCP programme, five preliminary steps need to be taken before the actual HACCP principles are applied. The five steps concern "assembling a HACCP team, describing the food and its distribution, describing the intended use and the consumers of the food, developing a flow diagram that describes the process, and verifying the flow diagram" (FAO/WHO, 2009; Dimitrios & Katerina, 2014). After these five preliminary steps have been taken, the seven principles of HACCP (described above) can be applied.

CHAPTER 3: AIM AND OBJECTIVES

3.1 AIM

The aim of this study was to investigate the food safety and quality assurance measures of the NSNP in Mpumalanga Province, South Africa.

3.2 OBJECTIVES

This study's objectives were to:

1. investigate the implementation of food safety and quality assurance procedures of managers of the NSNP at different schools.
2. determine the food safety and quality assurance knowledge and awareness of food handlers of the NSNP at different schools.
3. evaluate the microbiological quality of food preparation surfaces of the NSNP at different schools.

3.3 CONCEPTUAL FRAMEWORK

Five major risk factors of foodborne diseases related to employee behaviours and preparation practices in retail and food service establishments are:

- Improper holding temperatures;
- Inadequate cooking, such as undercooking raw shell eggs;
- Contaminated equipment;
- Food from unsafe sources and
- Poor personal hygiene (CDC, 2011a).

In order to reduce these risk factors of foodborne diseases, this study was guided by the conceptual model in figure 3.1. The main factors identified as having an impact on food safety and quality assurance in NSNP services are management and administrator related factors, and

food handler related factors. Management and administrative support factors impacting on food safety and quality assurance are food safety policies and objectives, management commitment, and resource management (Karaman et al., 2012). Top management is required to provide evidence of commitment to the development and improvement of food safety measures in the NSNP and to communicate the importance of meeting food safety requirements through policies and objectives. Policies and objectives have to reflect the vision of the organisation and underpin every conscious thought and action. Furthermore, top management should ensure the availability of necessary resources. Physical resources are initiated through the purchasing process, human resources through the recruitment process, and financial resources through the funding process. The personnel performing work affecting product quality should be competent on the basis of appropriate education, training, skills and experience (Nyamari, 2013). Food safety is dependent on good hygiene practices and meeting the guidelines stipulated by the hazard analysis critical control points (HACCP) food safety management system (Bas et al., 2006).

Food handlers in the NSNP that can impact on food safety and quality assurance include food safety knowledge, accurate time and temperature control, prevention of cross contamination, good kitchen hygiene and good personal hygiene. In the catering industry it has been found that food safety is compromised due to. *inter alia*, lack of knowledge, lack of training, high staff turnover, large variety of products, change in potential demand, variability in workloads, and large numbers of part-time workers (Mensah, & Julien 2011). In addition to this, studies in hospital and school food services, catering establishments, hotels, kebab houses, takeaways and restaurants, have identified lack of knowledge about safety systems as the basic reason for not developing food safety applications (Karaman, et al., 2012).

There is strong statistical evidence that the incidence of food poisoning caused by caterers is greater than in any other food sector, accounting for 70% of all bacterial food poisoning outbreaks (Bas et al., 2006). Seventy per cent of these food poisoning outbreaks are due to the inadequate time and temperature control of food, while the remaining 30% are the result of cross-contamination (Melngaile & Karklina, 2013).

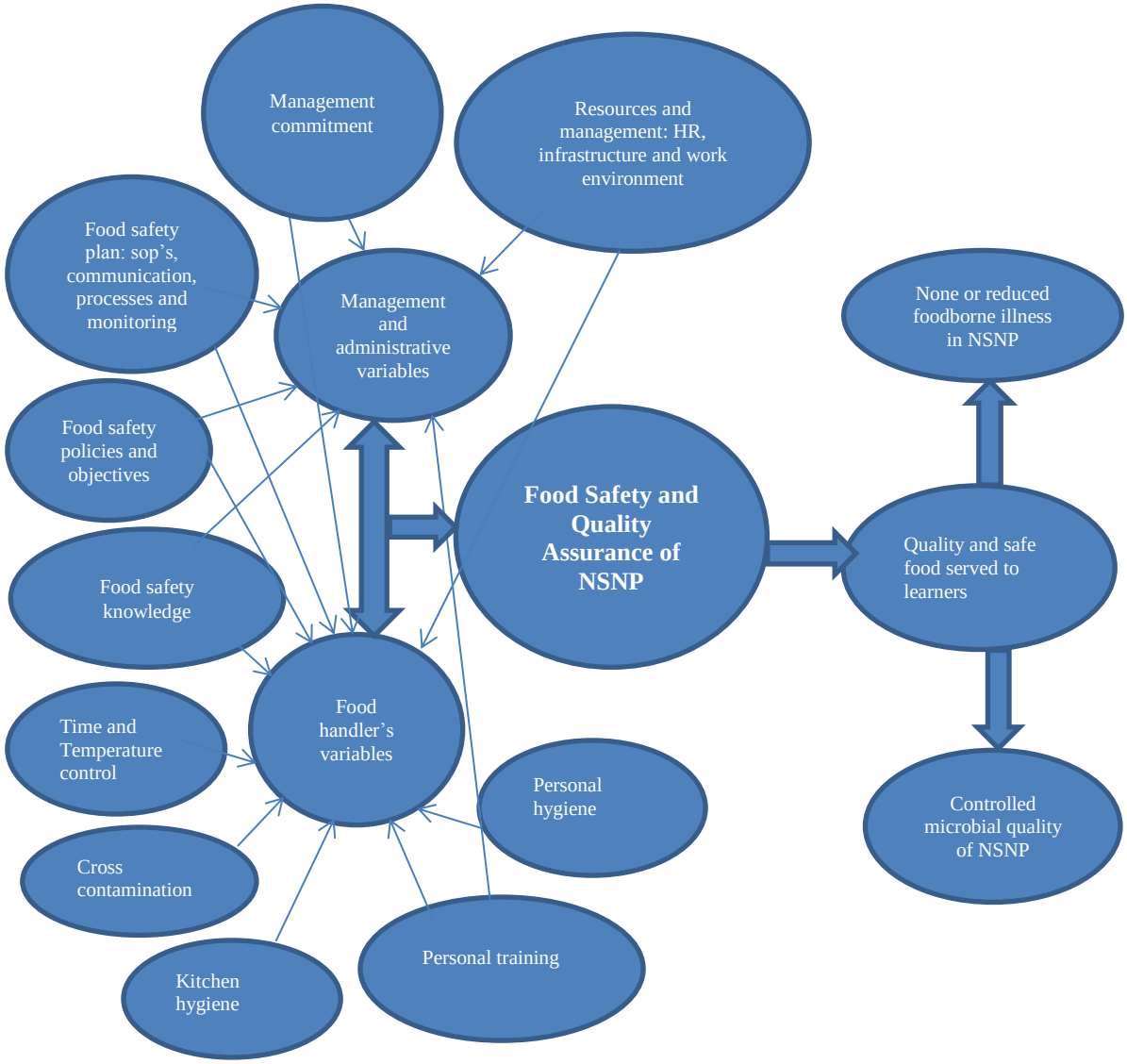

Figure 3.1: CONCEPTUAL FRAMEWORK: Food safety and quality assurance of the NSNP

CHAPTER 4: RESEARCH METHODOLOGY

4.1 RESEARCH DESIGN

The research design for this study was a descriptive one in which both qualitative and quantitative methods were used to analyse data that was obtained from a cross-sectional survey study.

4.2 MPUMALANGA POPULATION

Mpumalanga is one of the nine provinces of South Africa (Figure 4.1). It has a population of 3 657 200 persons, which comprises 7.2% of the South African population (Statistics South Africa [Stats SA], 2012a). The province is the second smallest province, after Gauteng, in terms of area with 76 495km2 of land (Figure 4.2). The province (Figure 4.2) has a very high unemployment rate of 29.8% as of the first quarter of 2016 (Stats SA, 2016).

The province has 1 021 722 learners in 1 966 public schools, of which 74% offer free meals provided by the NSNP (DBE, 2014). While the province has three administrative districts there are four educational districts – Ehlanzeni District, Gert Sibande District, Nkangala District and (Bushbuckridge) Bohlabela (Figure 4.3). This discrepancy in the district boundaries is problematic when trying to work with other departments who plan and work in accordance with the administrative boundaries (DBE, 2013).

4.3 RESEARCH AREA

The study targeted primary and secondary schools in Mpumalanga province implementing the NSNP. The entire province has four school districts: Ehlanzeni (Rural and has 13 circuits), Nkanganga (Urban/Rural and has 20 circuits), Gert Sibande (Urban/Rural and has 18 circuits) and Bohlabela (Bushbuckridge) (Rural and has 16 circuits).

Figure 4.1: Provinces of South Africa

Source: https://www.mycyberwall.co.za/get-smart/history/grade-5/provinces-south-africa

Figure 4.2: Mpumalanga Province

Source: http://www.rainbownation.com/

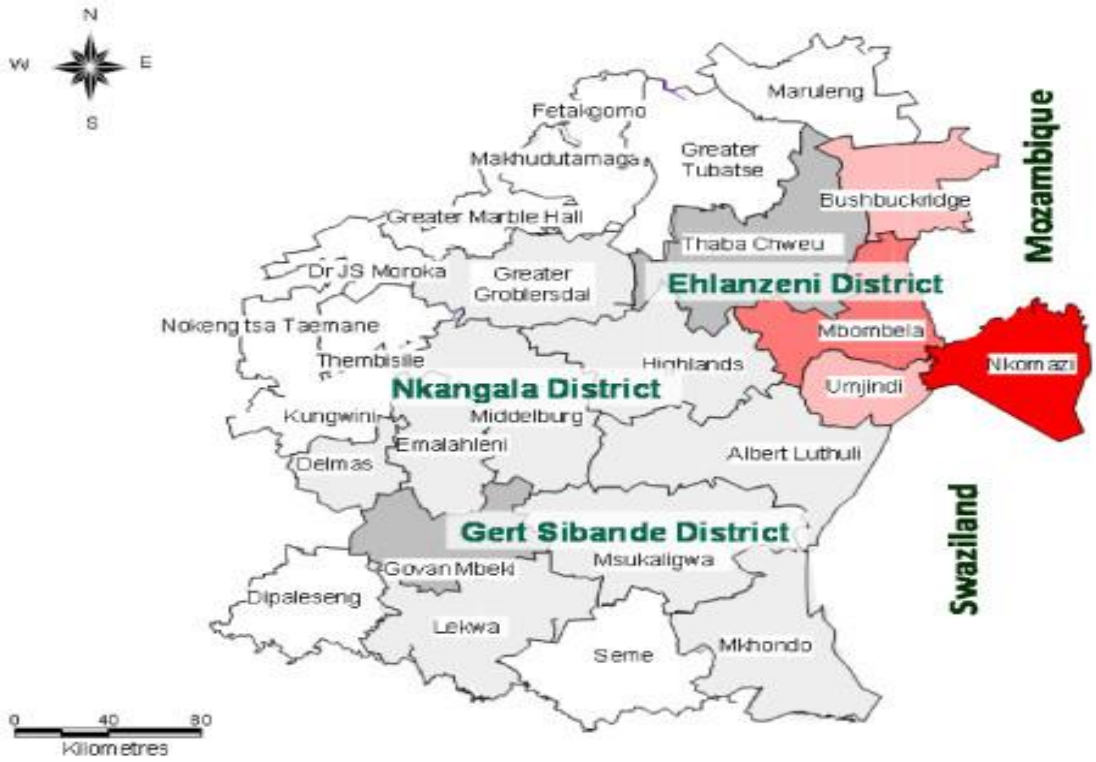

Figure 4.3:Mpumalanga provincial schools districts

Source: http://www.malariajournal.com/

4.4 SAMPLING OF RESPONDENTS

A combination of purposeful and stratified sampling methods was used to sample schools from the four school districts in Mpumalanga. Each district was divided into four geographical region (North, South, East and West). Fifty schools with at least 12 from each geographical region with a minimum of 6 primary and 6 secondary schools that offer NSNP were selected randomly from a list of school in each geographical region in each district. Primary and Secondary schools that do not offer NSNP were removed from the list prior to sampling to avoid bias. A total sample size of 300 schools (200 primary and 100 secondary) out of 1 966 in the four districts (DBE, 2012/2013 annual report) were used for data collection.

4.5 DATA COLLECTION INSTRUMENTS

Questionnaires were the instruments used to collect data from administrative staff and food handlers of the NSNP (Appendices A and B).

4.5.1 The questionnaire instrument

The food safety knowledge questionnaire was designed to obtain information about food handlers' knowledge of food poisoning, personal hygiene, cross contamination, cleaning, and temperature control. The questionnaire for the food-handlers (in Appendix B) comprised six sections: demographics, personal hygiene, kitchen hygiene, personnel training, cross contamination, time and temperature, and food safety practice. The other questionnaire, for administrators (Appendix A) comprised six sections, namely, demographics, management commitment to the NSNP, food safety policies, the food safety plan and standard operating procedures, HACCP knowledge, and the management of resources (human, infrastructure and the work environment). The questionnaires consisted mostly of questions to determine the participants' opinions on food safety knowledge and awareness and the administrative support of the NSNP.

The questionnaires consisted of various closed questions of various point scale such as 'agree', 'disagree' and 'not sure' for participants and an open questions to clarify participants purposes. To reduce the response bias, the multiple choice answers included ''not sure''. In addition, the questionnaires included questions relating to the demographic characteristics of NSNP staff (education level, age, gender, number of years in service in foodservice operations, food safety training).

4.6 DATA COLLECTION FROM RESPONDENTS

Data was collected by the primary researcher using a combination of self-administered questionnaire and face to face interview, based on the preference of respondents. Research assistants (fieldworkers) were recruited and trained for the purpose of the data collection. For microbial analysis, swabs of food preparation surfaces were collected from NSNP food preparation premises and transported chilled in cooler boxes to the UNISA Science Campus laboratory for analysis. Details regarding data collection will be explained in the relevant research (Chapter 5.1 and 5.2).

4.7 MICROBIAL SURVEY

A microbiological survey was conducted in one school district facilities of primary and secondary schools implementing the NSNP in Mpumalanga province. Each school facility was tested twice monthly over the course of a three-month period for a total of six ~~nine~~ sampling periods per school (32 schools) with a total number of 192 samples (2x3=6; 6x32=192). Specific broth agar media were used to culture microorganisms while specialize media were used for the detection of pathogens (Manufacturer's instruction manual was followed and the method is acceptable by regulatory authorities). Details regarding microbial analyses will be explained in the relevant research (Chapter 5.3).

4.8 DATA ANALYSIS

The questionnaire responses were coded and analysed using the social science software (SPSS). Descriptive statistics, ANOVA and regression analysis were applied to food safety and quality assurance variables such as kitchen and personal hygiene, cross contamination and time and temperature control. Pearson's chi-square test was performed to examine if there were any significant relationships between demographics, personal training, food safety knowledge, time and temperature control, cross contamination, kitchen hygiene and personal hygiene as well as

food safety practices. Correlation coefficient and variance analysis was conducted on microbiological counts. Statistical significance was set at $p < 0.05$. Further data analysis was explored using various tables and figures such as the frequency distribution.

4.9 PILOT TEST FOR THE SURVEY STUDY

Eight NSNP schools (4 primary and 4 secondary) from each district in Mpumalanga were selected randomly for the pilot study. This ensured the accuracy of the questionnaire instruments that it measured what it is supposed to measure (Ary et al., 2002). Pilot test responses from 8 schools were not included in the final data analysis to ensure the accurate reporting.

4.10 RELIABILITY AND VALIDITY OF THE QUESTIONNAIRE

The reliability of the questionnaire instruments was tested in a pilot study with 8 schools as described by conducting duplicate interviews with the same instrument. After which necessary adjustments was made to ensure reliability. The instruments were evaluated for face and content validity by a panel of experts with experience in food safety and quality assurance. This exercise is done to ensure that the instruments are valid for their intended purpose and the contents are appropriate for measuring what it is supposed to measure (Ary et al., 2002).

4.10.1 Reliability of the questionnaire

Cronbach's alpha was calculated to estimate internal consistency for each factor identified on the food safety knowledge and awareness scale as well as the quality assurance measures scale of the questionnaire. A total Cronbach's alpha (α) was performed to identify how well each item fitted into the total scale and to verify that there were no items that would increase the alpha if they were deleted.

4.10.2 Validity of the questionnaire

To establish content validity, the questionnaires were piloted in 8 schools. The random sample was chosen from schools implementing the NSNP in school district of Mpumalanga province. The questionnaire and a cover letter explaining the purpose of the study was taken physically to schools which were then asked to evaluate the questionnaire using a critique form. The questionnaire was evaluated for clarity, appropriateness of content, ease of completion, and appropriateness of questionnaire length. Feedback from the pilot test was used to make revisions to the questionnaire. School participating in the pilot test not included in the study.

4.11 ETHICAL ISSUES

Ethical clearance (2015/CAES/018) was granted by the College of Agriculture and Environmental Sciences (CAES), UNISA's research ethics committee, in order to ensure that the study complied with the rules of ethics as prescribed by the Medical Research Council of South Africa Regulations 1993. A formal letter describing the purpose of the study was sent to the Mpumalanga Department of Basic Education requesting permission to perform the study in their schools. An Informed Consent letter describing the purpose of the study, the role of the interviewees in the study, and their right to withdraw at any time during the study was signed by the participants prior to their entry into the study. Respondents participated in this study on a voluntary basis and they signed a consent form. Confidentiality of the respondents and the schools was maintained.

CHAPTER 5: RESEARCH

5.1 ASSESSING THE FOOD SAFETY ATTITUDES AND AWARENESS OF MANAGERS OF SCHOOL FEEDING PROGRAMMES IN MPUMALANGA, SOUTH AFRICA

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5.1.1 Abstract

The managers of school feeding programmes are responsible for ensuring the safety of the food which is provided to schoolchildren, but very few studies have been conducted on the food safety knowledge and awareness of these managers. The objective of this study was to evaluate the food safety attitudes and awareness of managers of the National School Nutrition Programme (NSNP) in schools in Mpumalanga, a province of South Africa. A cross-sectional survey study was conducted in which questionnaires were used to collect data from 300 managers. The majority of schools offering NSNP meals were located in informal settlements and most were found to lack basic resources such as electricity (power supplies to the food preparation facility) and potable tap water in their kitchens. No school was found to have implemented the hazard analysis and critical control points (HACCP) programme, and only a few staff had received food safety training. Food safety implementation was worst in informal schools in rural areas due to limited resources and infrastructure. The NSNP managers in some schools – especially those located in rural settlements – were found to have little knowledge or awareness of HACCP. These results indicate an urgent need to provide NSNP managers with

food safety training and resources (potable water supplies, electricity, dedicated food preparation facilities), particularly in schools in rural settlements.

Keyword: Food safety, Attitude, Awareness, Managers, School Feeding Programme

5.1.2 Introduction

School feeding programmes are powerful instruments for seeking to alleviate short-term hunger and improve nutrition and the cognitive abilities of schoolchildren by providing free meals in schools (Sanfilippo et al., 2012; World Food Programme (WFP), 2013; Munthali et al., 2014). A positive correlation has been found between the academic performance of schoolchildren and the provision of free school meals in schools located in poor communities (Taras, 2005). Endemic poverty in many communities in developing countries has necessitated the implementation of school feeding programmes (Bundy et al., 2009; WFP, 2013).

The implementation of food safety measures in school feeding programmes is important, considering that many schoolchildren are deemed vulnerable due to their weaker immune systems, when compared to healthy adults (Lund & O'Brien, 2011; Nyenje & Ndip, 2013, Monakhova, 2014). Foodborne disease outbreaks are becoming a frequent occurrence in school settings (Mellou et a., 2013), due to a lack of adequate infrastructure as well as inadequate food safety knowledge on the part of employees of school feeding programmes (Kibret & Abera, 2012; Baluka et al., 2015). Foodborne disease outbreaks in school feeding programmes can be caused by inadequate food preparation and food storage facilities in food preparation establishments which do not meet hygiene standards (Lockis et al., 2011). The absence of prerequisite programmes such as production control, raw material control, pest control, good manufacturing practices (GMP), good hygiene practices (GHP) together with the absence of standard food safety programmes such as hazard analysis and critical control points (HACCP)

in most food preparation facilities at schools constitute a food safety concern (Agyei-Baffour et al., 2013).

In 2012, the South African Department of Basic Education (DBE) reported that the majority of employees working for the National School Nutrition Programme (NSNP) had not received formal food safety training (Rendall-Mkosi et al., 2013). This means that many managers of NSNP food service facilities may not be knowledgeable about the establishment of food safety policies or the implementation of food safety standards (Arendt et al., 2013). Despite this, these managers are expected to commit monetary and material resources and to assume a leadership role in the implementation of food safety programmes (Mosadeghrad, 2014). These managers also have to make sure that staff undergo food safety training and oversee the consistent implementation of a comprehensive food safety programme within the food preparation facilities of school feeding programmes (Wilcock et al., 2011; Strohbehn et al., 2014).

In a school setting, where thousands of infants and children are served food daily, an outbreak of foodborne disease can lead to sickness which can result in death or the loss of school days due to illness amongst learners (Behravesh et al., 2012; WFP, 2013; Monakhova, 2014). Very few studies have been conducted on the food safety knowledge and awareness of school feeding programme managers who are responsible for ensuring the safety of the food which is provided to schoolchildren. Therefore, the objective of this study was to evaluate the food safety attitudes and awareness of NSNPs managers in schools in Mpumalanga, South Africa.

5.1.3 Materials and methods

The study area

The study was conducted in public primary and secondary schools that offer NSNPs in Mpumalanga, one of the nine provinces in South Africa and home to 7.2% of the South African population (Stats SA, 2012). The province has 1 966 public schools, of which 74% offer free meals provided by the NSNP (DBE, 2014).

Research design and Sampling

A cross-sectional survey study was conducted in which questionnaires were used to collect data from respondents. A total of 300 respondents were randomly selected from a list of 1 455 (74%) public schools that offer the NSNP in the province. Respondents were individuals 18 years and older, who have been designated by their respective school governing bodies to manage the NSNP in their schools.

Research instrument

The questionnaire instrument used for data collection comprised seven sections: socio-demographic details of respondents, details of NSNP food service facilities in schools, attitudes toward food safety assurance, food safety standard operating procedures (SOPs) and their implementation, empowerment of food handlers by NSNP food service managers, requisition practises and inventory management, and HACCP awareness. The questionnaire was piloted with 30 food handlers in eight schools, but these data were not included in the final sample. After the pilot study, the structure and wording of the questions were revised. The reliability and validity of the different sections of the research instrument were determined and the Cronbach's alpha (α) for the different constructs were found to range from 0.689 to 0.821.

Data collection

Prior to data collection, permission to conduct the study was obtained from the Mpumalanga Province's DBE and ethical clearance was granted by the ethics committee of the University of South Africa. Appointments to conduct interviews were made in advance with the relevant school principals. The questionnaires were distributed to each school NSNP manager/coordinator to complete. A consent form was signed by participants to affirm their voluntarily participation and their right to withdraw from the study if they so desired. The questionnaire of each respondent was coded to ensure anonymity.

Statistical analysis

The results were evaluated and analysed using the SPSS 20.0 software package. The data of all variables were presented as percentages. ANOVA was used to examine variations in response to food safety parameters.

5.1.4 Results

Socio-demographic details of respondents

Looking at the demographic characteristics of respondents, over 90% of the NSNP managers were female, with the majority (72%) older than 45 years. Similarly, the majority (88%) of respondents had obtained a post-high school qualification, while almost all (99.3%) of them were full-time employees of the DBE (Table 5.1).

Table 5.1: Biographic information of NSNP foods service staff (N=300)

Variables		Frequency (%)
	Male	26(8.7)
	Female	274(91.3)
	Under 25 years	0(0)
	25-35 years	4(2)
	36-45 years	78(26)
	46-55 years	164(54.7)
	56-65	50(16.7)
	Over 65 years	2(0.7)
	Less than high school	18(6)
	High school	18(6)
	Some college	104(34.7)
	University of Technology Diploma/ degree	48(16)
	University	112(37.3)
	Missing system	
	Full time	298(99.3)
	Part time	2(0.7)

Details of NSNP food service facilities in Schools

The majority (68%) of respondents' schools were located in rural areas and NSNP meals were prepared at all these schools (100%). The vast majority (92.7%) of the respondents were NSNP managers/coordinators in their respective schools. The majority (77%) of the respondents' schools had access to tap water, but only 17.3% used electricity as a source of power to prepare the food, compared to 82.7% which used gas, paraffin or wood. 43% of respondents' schools did not have a dedicated storage facility for the NSNP service (Table 5. 2).

Table 5.2: Details of NSNP food service facilities of Schools (N=300)

Variables		Frequency (%)
	Urban	96(32)
	Rural/Informal settlements	204(68)
	Yes	300(100)
	No	0(0)
	Volunteer	2(0.7)
	Food Handler	4(1.3)
	Manager/Coordinator	278(92.7)
	Others	16(5.3)
	Tap (i.e. running water)	234(77)
	Water tanker (mobile)	50(16.7)
	Communal water supply	16(5.3)
	River (collected)	0(0)
	Electricity	52(17.3)
	Gas/paraffin/wood	248(82.7)
	Designated kitchen	30(10)
	Classroom	62(20.7)
	Open area	206(68.7)
	Other, please specify	2(0.7)
	Yes	170(57)
	No	130(43)

Attitude toward food safety assurance

Up to 77% of respondents monitored their staff – as regards the implementation of food safety – at least once a week. Up to 73% of respondents indicated that the DBE representative visited the school to assess the NSNP's activities at least once a term. The majority (66.7%) of respondents indicated that their schools possessed hygiene policies and procedures for every person who enters the NSNP food preparation and food service areas, while more than 60% also had written policies and procedures for each of the following: receiving, storage, and serving of food and food products (Table 5.3).

Table 5.3: Attitude of NSNP managers towards food safety assurance (N=300)

Variables			Frequency (%)
	Daily		110(36.7)
	Weekly		124(41.3)
	Monthly		26(8.7)
	Once a term		14(4.7)
	Seldom		20(6.7)
	Never		4(1.3)
	Once a month		52(17.3)
	Once a term		168(56)
	Twice a year		62(20.7)
	Less than once a year		18(6)
	Never		0(0)
	Yes		200(66.7)
	No		100(33.3)
		Yes	208(69.3)
		No	92(30.7)
		Yes	200(66.7)
		No	100(33.3)
		Yes	198(66)
		No	102(34)

Implementation of food safety measures and training of food handlers

Most of the NSNP food service facilities had SOPs or guideline documents for food storage (78%), as well as the cleaning and disinfecting of food contact surfaces and equipment (54%). The majority of managers (84.7%) of school NSNP food service facilities carried out regular inspections of raw food materials. Furthermore, the majority (68%) of respondents' schools had more than three food handlers, yet only (39%) indicated that food handlers in their NSNP facilities had received food safety training courses on HACCP and food hygiene procedures (Table 5.4).

Table 5.4:The implementation of food safety measures and the training of food handler by managers of the NSNP (N=300)

Variables			Frequency (%)
		Yes	234(78)
		No	66(22)
		Yes	162(54)
		No	138(46)
		Yes	80(26.7)
		No	220(73.3)
		Yes	00 (0)
		No	300 (100)
		Yes	254(84.7)
		No	6(5.3)
		1	6(2)
		2	38(12.7)
		3	52(17.3)
		4	78(26)
		Above 4	126(42)
		Yes	118(39.3)
		No	182(60.7)

Food inventory requisition and management

A vast majority (89.3%) of respondents' NSNP food service facilities received their food supplies from commercial suppliers; the majority (76.7%) indicated that these suppliers are contracted to the DBE. Just over two thirds (68.7%) of respondents reported that their NSNP food service facilities did not have a planned delivery schedule with the suppliers of food items. The vast majority of respondents' NSNP food service facilities checked food items and invoices during delivery (99.3%), and performed stock rotation (72.7%). All the respondents' NSNP food service facilities had food storage areas that were always kept locked (Table 5.5).

Table 5.5: Requisition and inventory practices in NSNSP food service facilities (N=300)

Variables		Frequency (%)
Where do the food supplies come from?	Commercial supplier	264(89.3)
	Local community member	28(9.3)
	Both 1 & 2	0(0)
	Missing system	2(1.3)
	Yes	230(76.7)
	No	70(23.3)
	Yes	94(31.3)
	No	206(68.7)
	Yes	298(99.3)
	No	2(0.7)
	Yes	218(72.7)
	No	82(27.3)
	Yes	300(100)
	No	0(0)

HACCP and food safety audit awareness

As regards respondents' awareness of HACCP, the majority (60%) indicated they do not really know what HACCP is about. A significant majority (76.7%) believed that food safety is a priority in food service, while 74% stated that HACCP has benefits. A significant majority (80%) indicated that there should be more regular food safety audits on the part of the authorities (Table 5.6).

Table 5.6: HACCP awareness of NSNP food service managers (N=300)

Variables	Frequency (%)		
Could you please tick (x) whether you agree or disagree with each of the following:	Agree	Disagree	No idea
I am aware what HACCP is about	120(40)	128(42.7)	52(17.3)
Food safety is a major priority in NSNP food service	238(79.3)	44(14.7)	18(6)
I know that HACCP/food safety systems have benefits	222(74)	14(9.3)	100(16.7)
There should be more regular food safety audits by competent authorities in the NSNP	240(80)	60(20)	0(0)

Food safety parameters that are significantly affected by the location of schools

In terms of the location of schools, the responses of NSNP managers differed significantly ($p \leq 0.05$) only for the following food safety variables: where the school's water comes from, whether there are SOPs or guideline documents for monitoring the temperature of foods, whether HACCP is too complicated, and whether there should be more food safety audits by competent authorities in the NSNP.

As regards water sources, the cross-tab analysis showed that a higher proportion of schools located in informal settlements – unlike in urban settlements – do not have running tap water in their kitchens. Similarly, the responses indicated that a higher proportion of schools located in informal settlements, compared to urban settlements, depend on mobile water tankers as sources of water in their NSNP food service facilities. Similarly, as to whether there are SOPs or guideline documents for monitoring the temperature of foods, the cross-tab analysis revealed that a higher proportion of schools located in informal settlements do not have any guideline documents, when compared to urban settlements.

In their responses as to whether HACCP is too complicated, the cross-tab analysis revealed that a higher proportion of NSNP managers from schools in informal settlements indicated they do not know what HACCP is, compared to respondents in urban settlements. Furthermore, in their responses as to whether there should be more food safety audits by competent authorities in the NSNP, a higher proportion of NSNP managers from schools in urban settlements gave positive answers (Table 5.7).

Table 5.7: Food safety variables for which there was significant (p≤0.05) difference in the responses of NSNP managers due to the location of schools (N=300)

Food safety parameters		Percentage response within Food safety parameters based on the location of managers' schools		p value
		Urban (%)	Informal (%)	
	Kitchen tap (i.e. running water)	36 (37.5%)	38(18.45%)	
	Outside tap (i.e. running water)	48(50%)	112(54.37%)	
	Water tanker (mobile)	8(8.33%)	42(20.39)	
	Communal water supply (collected)	4(4.17%)	12(5.83%)	
	Total	96(100%)	206(100%)	
	Yes	40(41.67%)	40(19.42%)	
	No	56(58.33%)	164(79.61%)	
	Total	96(100%)	206(100%)	
	Agree	17(17.7%)	15(7.29%).	
	Disagree	51(53.13%)	56(27.18%)	
	Don't know	28(29.17%)	135(65.53%)	
	Total	96(100%)	206(100)	
	Agree	92(95.83%)	154(74.76)	
	Disagree	4(4.17%)	56(25.24%)	
	Total	95(100%)	205(100%)	

Food safety parameters that are significantly affected by NSNP managers' response to the monitoring of food safety implementation

In terms of how often the monitoring of food safety implementation is conducted, the responses of NSNP managers differed significantly (p≤0.05) only for the following food safety variables: whether the school is located in an urban or rural/informal settlement, whether there are written policies and procedures regarding receiving foodstuffs, and whether NSNP managers know what HACCP is.

Regarding the location of the school, the cross-tab analysis showed that a significantly higher proportion ($p \leq 0.05$) of NSNP managers in schools located in urban settlements conducted daily monitoring. In terms of the availability of written policies and procedures on the receiving of foodstuffs, the cross-tab analysis showed that a significantly higher proportion ($p \leq 0.05$) of NSNP managers in schools with written policies and procedures conducted daily or weekly monitoring. As to whether NSNP managers know what HACCP is, the cross-tab analysis showed that a significantly higher proportion ($p \leq 0.05$) of schools in which NSNP managers know what HACCP is conducted daily monitoring (Table 5.8).

Table 5.8: Food safety variables for which there was significant ($p \leq 0.05$) difference in the response of NSNP managers regarding how often monitoring of food safety implementation is conducted by NSNP managers (N=300)

Food safety parameters		Percentage response within Food safety parameters on how often monitoring is conducted						p value
		Daily	Weekly	Monthly	Once a term	Seldom	Never	
	Urban	50(52.1)	28(29.2)	4(4.2)	2(2.1%)	8(8.3%)	4(4.2)	
	Informal	60(29.7)	96(47.5)	22(10.9)	12(5.9%)	12(5.9%)	0(0.00)	
	Yes	86(41.7)	94(45.6)	10(4.9)	8(3.9)	8(3.9)	0(0.00)	
	No	24(26.1)	30(32.6)	16(17.4)	6(6.5)	12(13.0)	4(4.3)	
	Agree	56(32.6)	88(51.2)	20(11.6)	6(3.5)	0(0.00)	2(1.2)	
	Disagree	54(42.9)	36(28.6)	6(4,8)	8(6.3)	20(15.9)	2(1.6)	

5.1.5 Discussion

Demographic information

The fact that the vast majority of NSNP managers were female, and that over 72% were older than 45 years, can be attributed to the fact that female educators are often nominated to coordinate the NSNP since they have cooking experience acquired as a result of preparing meals for their families (Allen & Sachs, 2007). The reason why the majority of NSNP managers have obtained post-high school qualifications and are permanently employed can be attributed to the fact that most of them are qualified educators, with at least a post-high school teaching qualification. These managers have been nominated by their respective schools to manage the NSNP and to serve on the nutrition committee of the NSNP in their respective schools (DBE, 2014). Schools are required to nominate a member of the school governing body (comprising parents, educators, non-educators, learners and co-opted members of the community) to manage the NSNP, and teachers are often nominated to perform this duty in addition to their normal teaching responsibilities (DBE 2011b). NSNP managers are expected to ensure the safety of the food which is served to learners benefiting from the programme by ensuring that employees implement safe food-handling practices (Arendt et al., 2013).

Details of NSNP food service facilities of schools

The reason why the majority of schools offering NSNP meals are located in rural areas can be attributed to the fact that households in these communities are more likely to be poor. Learners in these schools are thus more likely to require free meals from the NSNP to reduce hunger during school periods (DBE, 2011b). School feeding programmes are a convenient means by which important nutrients can be provided to needy children in schools located in poor communities; the programme ensures that schoolchildren have food to eat, thereby helping them to concentrate better during lessons (Buhl, 2011). All South African public schools are

categorised according to five quintiles, with quintile one comprising schools located in the poorest communities in the country. The quintile ranking is important because it determines the amount of financial support that each school receives annually from the South African DBE, and whether or not free NSNP is available to learners at a particular school (DBE, 2014).

It is encouraging that the majority of schools in the survey had access to tap water, since it ensures that clean water is available for the preparation of food – an important requirement for food safety implementation (Baluka et al., 2015). Without running tap water in schools, food handlers would be forced to fetch water from distant places to prepare NSNP meals, which could lead to water contamination and, concomitantly, food contamination (Assefa et al., 2015).

The fact that only a few schools used electricity as a source of power in their food preparation facilities is cause for concern, because the lack of electricity limits the use of important electrical equipment (e.g., refrigerators, freezers) at NSNP food service facilities (Sawicka et al., 2012). The lack of electricity supply also limits the ability to store food at high or low temperatures respectively (Lee & Greig, 2010). Time-temperature control measures are vital in preventing the growth and multiplication of microorganisms in food (Liz Martins & Rocha, 2014). Furthermore, up to 43% of schools did not have a dedicated food storage facility for use by the NSNP service – something which can lead to improper food storage practices and concomitant cross-contamination between foods during storage (Lockis et al., 2011; Topliceanu et al., 2015).The proper storage of food is important in maintaining both nutritional value and safety (Baluka et al., 2015; Boro, et al., 2015).

The majority of schools had more than three food handlers at their NSNP food service facilities. This is in line with the requirements of the DBE, which states that each school should appoint one food handler for every 200 learners – and most schools have more than 600 learners (DBE,

2011a). This ratio, which is clearly insufficient for most schools, constitutes a food safety concern, considering that the poorly managed workload of food handlers can result in lapses in the implementation of safe food handling practices Lund, & O'Brien, 2011). The workload of food handlers needs to be moderated to ensure optimum working conditions which will allow them to provide safe food in terms of the programme (Machado et al., 2014; Samapundo et al., 2015).

Attitudes toward food safety implementation

The fact that more than three-quarters of NSNP managers monitored their staff at least once a week on the application of food safety in their food service facilities is encouraging for the NSNP, because this practice ensures that food handlers consistently and correctly implement the proper measures (Monney et al., 2014). Frequent monitoring of food handlers ensures that food safety implementation lapses are corrected to prevent the contamination of food (McLaren et al., 2015). NSNP managers must ensure that food handlers comply with food safety procedures (Wilcock et al., 2011). Monitoring should form part of the food safety management process of any food service establishment, to ensure the consistent and effective implementation of food safety measures (Mensah, & Julien, 2011; Al-Kandari, & Jukes, 2011). More than 70% of NSNP managers in the survey indicated that the DBE frequently sends a representative (at least once a term) to assess NSNP activities at their schools. These monitoring activities ensure that the schools' food preparation facilities conform to stipulated food safety measures, in addition to ascertaining the safety and quality of the food served to the schoolchildren (Al-Kandari, & Jukes, 2011).

The majority of managers indicated that their schools possess SOPs for food storage (78%) and for cleaning and disinfecting food contact surfaces (54%). This is important for the NSNP, because it ensures that standard procedures in implementing food safety measures are followed

by everyone (Wilcock et al., 2011; Topliceanu et al., 2015; Al-Kandari, & Jukes, 2011). Food safety SOPs are important food safety assurance instruments in any food service establishment (Nyenje, & Ndip, 2013; Lockis et al., 2011). The fact that a significant majority of NSNP managers did not monitor the temperature of food items constitutes a safety hazard, considering that this could lead to food being stored at improper holding and cooking temperatures, with the result that the food can spoil and foodborne disease outbreaks may follow due to the growth and multiplication of microorganisms (Baluka et al., 2015; Sawicka et al., 2012). The continuous monitoring of temperatures ensures that food products are safe during storage (Nyenje, & Ndip, 2013). Lower storage temperatures decrease the reproduction rate of bacteria and reduce the rate of food product spoilage during storage (Sawicka et al., 2012).

The vast majority of NSNP managers carry out regular inspections of raw food materials in their NSNP food service establishments. This is encouraging, as it ensures that supplied raw food materials are of good quality and are suitable for use in preparing NSNP meals (Toth et al., 2016). Fewer than 40% of food handlers at the NSNP food service facilities have received on-the-job food safety training. This is a concern given that the guidelines on hygiene and food safety, as issued by the South African DBE, state that a series of food safety workshops should be conducted throughout the year to train NSNP staff (Baluka et al., 2015). The continuous training of food service staff will ensure that they remain aware of food safety measures at all times, thereby preventing lapses in the implementation of food safety measures (Toth et al., 2016).

Food inventory requisition management

The vast majority of NSNP food service facilities received their foodstuffs and ingredients/ supplies from commercial suppliers, most of whom were contracted by the DBE. This is a good practice in terms of food safety management, because it ensures traceability and consistency in terms of the quality of the food products delivered (Ko, 2015; Kafetzopoulos, & Gotzamani, 2014). However, despite having contracted suppliers of raw food materials, more than two-thirds of the food service facilities had no pre-determined delivery schedule with the suppliers. The unplanned delivery of food items can lead to the receipt of poor-quality foodstuffs, as products can be received without proper inspection, given that the NSNP managers are also involved in teaching activities (Wilcock et al., 2011; Khalid, 2015). A planned delivery schedule with suppliers should be in place to ensure that food items are received at an agreed time, to enable proper checks during the receiving process (Duan et al., 2011). Furthermore, the price, quality and quantity of food materials delivered should match the information supplied on the invoice and quotation list (Duan et al., 2011).

The fact that over 70% of NSNP food service facilities practised stock rotation is beneficial in terms of food safety management, considering that it ensures that food items are not kept beyond their required storage duration (use-by date), thereby preventing microbial growth and product deterioration on the shelves during storage (Baluka et al., 2015). The storage areas of all NSNP food service facilities were kept locked at all times. It is recommended that food storage facilities be locked at all time, thus preventing any attempt at intentional contamination or bioterrorism (Spink et al., 2016).

HACCP programme implementation and food safety audit awareness

The reason why up to 60% of NSNP food service managers did not know what a HACCP programme is, could be attributed to the fact that respondents are qualified classroom teachers with little or no prior food safety training (DBE, 2014). The fact that HACCP is not known to most NSNP managers implies that it is not being implemented in their NSNP food service facilities, which may compromise the safety of the meals offered in these schools (Garayoa et al., 2011). The HACCP programme enables the identification, analysis and control of food safety hazards in food service establishments (Spink et al., 2016; Fernando, Ng, & Yusoff, 2014). Despite the fact that the majority of NSNP managers did not know what HCCP is, 74% of them believed that food safety is a priority in food service establishments, and that HACCP has food safety benefits. The advantage of this view is that NSNP managers can start to take the necessary measures to implement HACCP by advocating for food safety training programmes: trained employees have been found to significantly outperform untrained employees with respect to perceptions and practices associated with food safety (Ko, 2015). Effective training on food safety reinforces food handlers' knowledge, awareness and attitudes towards food safety implementation (Sani & Siow, 2014).

A significant majority of the NSNP managers were of the view that more regular audits of food safety practices at NSNP food service facilities should be conducted by competent government authorities, to ensure the regular and consistent implementation of food safety measures (Topliceanu et al., 2015). Food safety audits play a fundamental role in certifying that proper food safety practices are being adhered to, while ensuring the safe production of food at food service facilities (Kafetzopoulos, & Gotzamani, 2014; Hoffmann et al., 2015).

Food safety parameters affected by the location and food safety monitoring in schools

The reason why a significantly higher proportion of schools located in informal settlements do not have running tap water in their kitchens can partly be attributed to the legacy of apartheid in South Africa, during which informal settlements were neglected and not supplied with sufficient potable water compared to urban areas (DBE, 2008). Schools in urban areas have access to better water resources from municipal authorities than schools in informal settlements (Daniels et al., 2002; Department of Water Affairs, (2012). The lack of potable water can compromise the safety of the food produced, given that a supply of clean water is required to practise food hygiene in food service establishments (Kariuki et al., 2012). Access to clean, potable water will enable the implementation of basic food safety measures such as hand washing, the washing of equipment and food contact surfaces, as well as raw food materials, thereby contributing to preventing food contamination (Wenhold, & Faber, 2009).

The reason why more schools located in informal settlements do not have a standard operating procedure for monitoring temperatures on a daily basis is the non-implementation of food safety programmes such as HACCP. As a result, food safety implementation lapses occur and there is an increased likelihood of foodborne disease outbreaks in schools (Nyenje, & Ndip, 2013; McLinden et al., 2014; Neal et al., 2012). Worryingly, most NSNP managers from schools in informal settlements did not know what HACCP is, due to a lack of related training (Lockis et al., 2011). It is important for NSNP managers to be knowledgeable about HACCP and other food safety measures, considering that they form the basis of any integrated food safety management system within a food service establishment (Agyei-Baffour et al., 2013).

A significantly higher proportion of NSNP managers who knew what HACCP is about were found to conduct daily monitoring compared to those who did not know. Therefore, greater support in terms of HACCP and food safety training in general should be provided to NSNP

managers in schools in informal settlements, to enhance their ability to monitor and enforce food safety programmes (Rendall-Mkosi et al., 2013). Resources such as guideline documents are vital to schools in informal settlements: the greater proportion of schools with written policies and procedures on the receiving of foodstuffs were found to conduct daily or weekly food safety monitoring, and were hence more likely to ensure food safety implementation (Henderson et al., 2013). Similarly, a significantly higher proportion of NSNP managers from schools in urban settlements responded in the affirmative as to whether there should be more frequent food safety audits by competent authorities in their schools. These discrepancies can be attributed to greater knowledge and awareness of food safety programmes on the part of managers in urban areas (Arendt et al., 2013).

5.1.6 Conclusions

Most NSNP managers were female, older than 45 years, in possession of a post-high school qualification and employed full time as educators by the DBE. The majority of schools offering NSNP meals were located in informal settlements, where most schools lack basic resources such as electricity (power supply to the food preparation facility) and potable tap water (in kitchens). Despite regular visits by DBE monitors, and the availability of hygiene policies and procedures, no school was found to be implementing the HACCP programme and only a few food handlers in select schools had received food safety training. Food safety implementation was found to be worst in informal settlement schools, mainly due to resource and infrastructural constraints, as well as relatively more limited knowledge and awareness of HACCP on the part of NSNP managers in those schools. The development of food safety knowledge, attitudes and awareness of managers in the NSNP will improve food safety implementation and compliance in schools.

5.2 FOOD SAFETY KNOWLEDGE AND AWARENESS OF FOOD HANDLERS IN SCHOOL FEEDING PROGRAMMES IN MPUMALANGA, SOUTH AFRICA

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5.2.1 Abstract

Food handlers working in school feeding programmes can play an important role in the prevention of outbreaks of foodborne diseases in schools. This research aimed to investigate the food safety knowledge and awareness of food handlers working for the National School Nutrition Programme (NSNP), Mpumalanga, South Africa. A cross-sectional, quantitative research method was used and food handlers were interviewed using a structured questionnaire. A total of 440 food handlers from 147 randomly selected public schools participated in this survey. The vast majority (98.9%) of the respondents were females of 36 years and older with a high school education. More than 90% of NSNP food preparation facilities did not have a hazard analysis and critical control points (HACCP) programme in place and just over 90% of food handlers did not know about HACCP. Sixty per cent (60%) of food handlers did not know the correct procedure for washing a cutting board after it had been used. In addition, 95.5% of the food handlers had never sanitised utensils and cutting surfaces after cutting up raw meat. Most food handlers of the NSNP were lacking in knowledge, awareness and attitudes on many important aspects of microbial food safety hazards.

Key words: food safety, knowledge, awareness, food handling practices, school feeding programme

5.2.2 Introduction

Inadequate food safety knowledge and skills of food handlers can result in unsafe food handling practices and cross-contamination in food service establishments (McGill et al., 2015; Rahman et al., 2012). Previous studies have revealed that some food handlers in many food service establishments often lack basic food safety knowledge when it comes to temperature control, personal hygiene and the prevention of cross-contamination (Afolaranmi et al., 2015; Jianu & Chis, 2012; Martins et al., 2012). The urgency of the matter is stressed by the findings of the World Health Organisation (WHO) that human actions are the leading cause of food contamination during food preparation in food service establishments as a result of non-adherence to good hygiene practices (WHO, 2013).

Ensuring the safe handling of food in school feeding programmes remains a big challenge in many countries, considering that many of these school feeding schemes are often regarded as poverty and hunger alleviation initiatives (Jomaa et al., 2011; WHO/FAO, 2010). Furthermore, the available resources of most schools involved in school feeding programmes are sometimes inadequate to support the proper implementation of food safety systems (Bas et al., 2006; Fotopoulos et al., 2011; WFP, 2012). Food safety assurance in food service establishments depends heavily on the availability of adequate infrastructure, appropriate management support and commitment, as well as knowledgeable and skilled food handlers (Rendall-Mkosi et al., 2013).

Outbreaks of many foodborne diseases are due to contamination that occurs during food preparation within food service establishments (Smigic et al., 2016). Cases of food poisoning are prevalent in schools as a result of cross-contamination during food preparation (Sanlier & Konaklioglu, 2012). The outbreaks of foodborne diseases in school feeding programmes can result in life-threatening diseases, huge medical costs and the spread of infection to other

children and staff, thereby leading to disruption of learning in schools (Scharff, 2012). In 2011 in South Africa 2,560 outbreaks of foodborne diseases were reported, of which the majority (1700) were among learners of primary and secondary schools (Stats SA, 2014). It should be noted that children with weakened immune systems are more at risk of contracting food poisoning compared to those who are in good health (Burke, Young, & Papadopoulos, 2016). In 2014, three learners in the Gauteng (2) and Limpopo (1) provinces in South Africa were reported to have died after consuming contaminated meals provided by the National School Nutrition Programme (NSNP) (Nzimande, 2014).

With the increased number of public schools offering NSNP meals to learners in South Africa, it is important that relevant food safety and quality assurance measures are put in place to prevent or reduce the incidence of foodborne diseases in "from farm to fork" food chains in schools (Asiegbu et al., 2016; Losasso et al., 2012). Areas of lapses can be identified for redress by studying the food safety knowledge and safe food handling practices of food handlers in school feeding programme. Therefore, the objective of this study was to assess the food safety knowledge and awareness of food handlers in the NSNP in the Mpumalanga Province, South Africa.

5.2.3 Materials and methods

The study area

The study population consisted of NSNP food handlers in various primary and secondary public schools in Mpumalanga Province, South Africa. Mpumalanga is one of the nine provinces in South Africa with 7.2% of the South African population (Stats SA, 2012). The province has 1 966 public schools out of which nearly three quarters (74%) offer a food programme, the NSNP (Department of Basic Education, 2015).

Research design and sampling

A cross-sectional survey was conducted in which questionnaires were utilised to obtain data from respondents. A total of 440 respondents were randomly selected from a list of the 241 public schools in the province that use the NSNP. Respondents were individuals of 18 years and older who were involved in the preparation of NSNP meals.

Research instrument

Data was collected by means of a questionnaire, designed purposefully for this study using information from literature, which consisted of six sections: socio-demographic characteristics, details of NSNP food service facilities at schools, training information of NSNP food service staff, microbial food safety hazard knowledge of the staff of the NSNP, food safety awareness of NSNP food handlers, and food safety attitudes of NSNP food service staff. The questionnaire was piloted in eight schools using thirty food handlers but the information gained was not included in the final sample. After the pilot study, the structure and wording of the questions were revised. The reliability and validity of the different sections of the research instrument were determined using Cronbach's α for the different constructs ranged from 0.689 to 0.821.

Data collection

Prior to data collection, permission to conduct the study was obtained from the Mpumalanga provincial Department of Basic Education, and ethical clearance was given by the University of South Africa. Data collection was carried out by means of interviews with NSNP food handlers after appointments to conduct the interviews had been made with individual school principals. The interviews were conducted on a one-on-one basis and the questionnaire was filled in either by the respondents themselves or with the assistance of the principal researcher depending on the respondent's level of literacy. If they were willing to participate in the study,

respondents were asked to sign a consent form to confirm their voluntary participation as well as their right to withdraw from the study at any time if they so desired. The questionnaire of each respondent was coded to ensure anonymity and each interview session lasted about 20 minutes.

Statistical analysis

The data collected were statistically analysed using SPSS software version 23. Descriptive statistics were used to summarise the variables, while the Spearman correlation and analysis of variance (ANOVA) was used to determine the relation between selected variables. Statistical significance was identified at a 95% confidence level ($P \leq 0.05$).

5.2.4 Results and discussions

Socio-demographic details of respondents

The vast majority of the respondents were females (98.9%) who were 36 years and older (83.7%), had at least attended high school (59.9%) and had been working for the NSNP for at least a year (63.7%) (Table 5.9). Women in rural and suburban communities in South Africa, who are often unemployed (Stats SA, 2013), are usually responsible for cooking meals for their families (Allen & Sachs, 2007). The fact that most of the respondents were literate was beneficial for the NSNP, given that it is easy for literate food handlers to improve their food safety knowledge through text-based training (Bas et al., 2006; Martins et al., 2012; Osaili, Obeidat et al., 2011). It is likely to be more difficult for food handlers who are not literate to acquire adequate knowledge and the skill required to deal with microbiological food safety hazards such as temperature control, cross-contamination and personal hygiene (Bas et al., 2006; Ko, 2013; Sani & Siow, 2014). The fact that the majority of the respondents had been working as food handlers in their current food preparation facilities for at least a year was good for the NSNP, considering that a longer term of employment provides a base for the continuous

improvement of safe food handling practices, given that there is a significant positive correlation between the food safety knowledge of food handlers and their years of working experience (Farahat et al., 2015; Siow & Sani, 2011).

Less than half of the respondents (46.4%) had had previous food handling experience or training when they started working in their current NSNP food preparation facilities (Table 5. 9). This can be attributed to the absence of food safety programmes in the curricula of high schools in South Africa (Department of Basic Education, 2014; Smith & de Zwart, 2010). The lack of prior training of food handlers translates into lower levels of food safety knowledge and skills (Egan et al., 2007). Education and training programmes which include aspects of safe food handling are effective tools to increase food safety knowledge and awareness of hygiene among food handlers prior to employment in food service establishments (Gillespie et al., 2000; Sani & Siow 2014).

Table 5.9: Biographic information of National School Nutrition Programme (NSNP) food service staff (N=440)

Variables		Frequency (%)
	Female	435(98.9)
	Male	5(1.1)
	Under 25 years	4(0.9)
	25-35 years	66(15)
	36-45 years	195(44.3)
	46-55 years	138(31.4)
	56-65	29(6.6)
	Over 65 years	6(1.4)
	Missing system	2(0.5)
	Less than high school	179(40.7)
	High school	258(58.6)
	Some college	1(0.2)
	University of Technology Diploma/ degree	1(0.2)
	Missing system	1(0.2)
	Less than a year	157(35.7
	One (1) to (2) years	101(23)
	More than (2) two years	179(40.7)
	Missing system	3(0.7)
	Yes	204(46.4)
	No	228(51.8)
	Missing system	8(1.8)

Details of National School Nutrition Programme food service facilities of Schools

A huge majority (98.69) of the respondents indicated that their schools had a menu presenting what was on offer (Table 5.10). Having a menu is important because it is one of the pre-requisite documents required in the planning phase for any food safety management programme, as it provides guidance on the types of food stuffs to be purchased, storage requirements, equipment needed, specific steps for preparation as well as food safety critical limits such as final cooking temperatures that need to be monitored and verified (Food and Drug Administration, 2006). The vast majority (98%) of respondents indicated that they had not previously attended any food safety training courses (Table 5.10). Newly recruited food handlers should not work immediately in food service establishments without prior training or experience in the safe handling of food (Ababio & Lovatt, 2015; Ko, 2013). The possession of

experience in the safe handling of food is an important prerequisite for the effective implementation of food safety programmes in food service establishments (Altekruse et al., 1996). Up to 91.4% of respondents indicated that their respective NSNP food preparation facilities did not have a hazard analysis and critical control points (HACCP) programme in place (Table 5.10). It is a cause for some concern that so many schools are not using this important tool to alleviate the risk of food-borne disease infection to learners (Tomasevic et al., 2016), considering that it is mandatory for any food handling enterprise to do so in South Africa (Department of Health, 2003). HACCP is an effective and economically efficient approach to food safety control and a requisite in the global food supply chain to minimise the occurrence of negative effects for consumers (Herath & Henson, 2010; Wilcock et al., 2011). Furthermore, 82.7% of respondents indicated that there were no dedicated food safety assurance personnel in their respective food preparation facilities (Table 5.10). This is because the Department of Basic Education often nominates teachers without qualifications or skills in food safety management to manage the NSNP in schools (Department of Basic Education, 2009).

The lack of qualified food safety personnel to manage the NSNP could lead to improper application and monitoring of safe food handling practices (Rendall-Mkosi et al., 2013) considering that lack of knowledge about HACCP is a barrier to its successful implementation (Karaman et al., 2012). 84.5% of respondents indicated that NSNP meals are prepared in a designated kitchen out of which 52% used a permanent kitchen while 32.7% make used of a temporary kitchen (Table 5.10). The fact that a considerable number of schools are not preparing meals in a designated kitchen constitutes a food safety hazard because the lack of basic food preparation infrastructure can contribute to the outbreak of foodborne diseases (Kibret & Abera, 2012). Furthermore, the lack of appropriate infrastructure and equipment, and incorrect layout in food service establishments have been found to be the most important

obstacles in the implementation of food safety programmes (Department of Health, 2015; Garayoa et al., 2011; Lockis et al., 2011). Most NSNP food preparation facilities clearly do not meet the prescribed pre-requisite requirements for the proper implementation of the HACCP programme which is essential to maintain food safety (Boro et al., 2015). It is reassuring that the vast majority of NSNP food preparation facilities had big enough food preparation space (81.6%), clean portable water for food preparation (79.3%) and enough cleaning equipment (88.9%), because these are important requirements for the implementation of food safety procedures (Sun, 2005) (Table 5.10).

Table 5.10: Details of National School Nutrition Programme (NSNP) food service facilities of Schools (N=440)

Variables		Frequency (%)
	Yes	434(98.6)
	No	6(1.4)
	Yes	9(2)
	No	431(98)
	Yes	32 (7.3)
	No	402 (91.4)
	Missing system	6(1.3)
	Yes	364(82.7)
	No	76(17.3)
	Permanent Kitchen	229(52)
	Temporary Kitchen	144(32.7)
	Classroom	24(5.5)
	Outside in the open	43(9.8)
	Yes	359(81.6)
	No	81(18.4)
	Yes	349(79.3)
	No	91(20.7)
	Yes	385(87.5)
	No	55(12.5)
	Yes	391(88.9)
	No	15(3.4)

Food safety training knowledge of National School Nutrition Programme food service staff

Nearly 70% (69.8%) of respondents indicated that in-service training for safe food handling had been provided to food handlers in their current NSNP food preparation facilities and just over two-thirds (67.01%) of the respondents indicated that they received such training at least once a year (Table 5.11). This is beneficial because training on the job has been found to significantly improve the safe food handling practices and attitudes of food handlers compared to those that are untrained (McIntyre et al., 2013). Food handlers who have never attended any training related to food safety have been found to possess poor food safety knowledge (Sani & Siow, 2014) and unsafe food handling skills (Gould et al., 2013; Shinbaum et al., 2016). Even though most of the respondents (71.7%) in the study had received training on good personal hygiene, the majority had not received training in chemical storage (77.5%), purchasing and receiving procedures (73%), pest control (63.3%), equipment cleaning procedures (64.8%), kitchen operating procedures (65.5), equipment care and maintenance (68.7%) and food allergy safety precautions (82.4%) (Table 5.11). The in-service food safety training provided for NSNP food handlers is therefore insufficient and should include procedures to prevent food contamination and the risk of foodborne pathogens. Food handlers need to be kept updated about the required procedures in maintaining the quality and safety of the food produced (Kibret & Abera, 2012).

Table 5.11: Training information of National School Nutrition Programme (NSNP) food service staff (N=440)

Variables			Frequency (%)
	Yes		307(69.8)
	No		130(29.5)
	Missing system		3(0.7)
	At least once every term		12(2.73)
	At least once every year		295(67.01)
	At least once every two years		133(30.2)
		Yes	220(71.7)
		No	87(28.3)
		Yes	69(22.5)
		No	228(77.5)
		Yes	83(27)
		No	224(73)
		Yes	97(31.7)
		No	194(63.3)
		Yes	108(35.2)
		No	199(64.8)
		Yes	106(34.5)
		No	201(65.5)
		Yes	96(31.3)
		No	211(68.7)
		Yes	54(17.6)
		No	253(82.4)

Microbial food safety hazard knowledge of National School Nutrition Programme food service staff

A vast majority (93.2%) of respondents had not heard of HACCP while 96.6% indicated they needed more information and training on HACCP principles (Table 5.12). As mentioned earlier, this state of affairs can be attributed to the fact that HACCP training is not part of the curricula in most primary, secondary and high schools in South Africa (DBE, 2014) as well as to the fact that most of the NSNP food handlers interviewed were working in a food service establishment for the first time (Cloete et al., 2009). The lack of HACCP knowledge by food

handlers can hamper their ability to implement food safety measures in food service establishments (Webb & Morancie, 2015). Elsewhere, studies conducted in Spain (Garayoa et al., 2011) and Malaysia (Sani & Siow, 2014) also revealed that the majority of food handlers in food service establishments were not knowledgeable about the HACCP system.

A considerable number of respondents did not know the following: that an outbreak of foodborne disease due to *Escherichia coli* 015:H7 may lead to kidney failure in children (43.6%), that undercooked chicken and raw eggs could carry food-borne pathogens such as *Salmonella* (35.7%), that it is unsafe to use raw eggs as an ingredient in uncooked food and salads (49.3%), the correct procedure for washing a cutting board after it has been used for the preparation of raw meat (69.3%), the correct way of handling accidentally thawed meat (62%), the safest way to cool a large pot of hot soup (32.3%), and the correct duration for storing ground beef and hamburger patties in the refrigerator (86.4%)(Table 5.12). The principal reason for the lack of adequate knowledge on some these food safety hazards by NSNP food handlers could be the lack of prior training about microbial food safety hazards before they were recruited (Quinlan, 2013). This should be a concern, because NSNP meals are served to children who could easily contract foodborne diseases due to their weak immune systems (Scallan et al., 2013). The fact that the majority of respondents did not know the correct procedure in cleaning a cutting board after it has been used for raw meat preparation means that cross-contamination between is likely to occur between the cutting board and raw or cooked foods (Bruhn, 2014). NSNP food handlers should be trained in the proper procedure for washing and disinfecting cutting boards so as to eliminate the possibility of transmitting foodborne pathogens from one food to another (Farahat et al., 2015).

NSNP food handlers should know that uncontrolled thawed or cooled food products could easily reach temperatures at which bacteria can multiply to dangerous levels and hence should

be disposed of (Sani & Siow, 2014; Abdul-Mutalib et al., 2012). Furthermore, NSNP food handlers should know the appropriate duration to store foods, especially beef hamburger patties in the refrigerator to prevent high levels of microbial growth and, in some instances, the accumulation of toxins (Bruhn, 2014). This lack of knowledge on the correct temperature regimes for food storage is not unique to South Africa: Smigic et al., (2016) in a study conducted in three European countries (Serbia, Portugal and Greece) also found that many food handlers lack adequate knowledge on temperature regimes during storage.

Table 5.12: Microbial food safety hazard knowledge NSNP food service staff (N=440)

Questions and answer options			Frequency (%)
Have you ever heard of HACCP?		Yes	30(6.8)
		No	410(93.2)
		Yes	425(96.6)
		No	15(3.4)
The presence of E. coli015:H7 in undercooked hamburgers may result in kidney failure complications in children after an outbreak of disease.		**True**	**248(56.4)**
		False	192(43.6)
		True	**283(64.3%)**
		False	157(35.7)
		True	217(49.3)
		False	**223(50.7)**
	Wash with hot soapy water and rinse with water		220(50)
	Wash with hot soapy water, rinse with a kitchen sanitiser.		**135(30.7)**
	Clean with a disinfectant such as Lysol, Clorox or bleach.		95(21.6)
	Wash cutting board in a dishwasher		85(19.3)
	Throw them away		**167(38)**
	Cook them right away		272(61.8)
	See how they smell or look before deciding what to do		1(0.2)
	Immediately re-freeze until solidly frozen, then cook it		0
	Put the soup in a clean shallow pan and refrigerate right away		**298(67.7)**
	Keep the soup in the cooking pot and refrigerate right away		68(15.5)
	Put the soup in a clean, deep pot and refrigerate right away		39(8.9)
	Cool the soup to room temperature on the counter, then refrigerate it		35(8)
	1-2 days		**60(13.6)**
	3-4 days		160(36.4)
	5-7 days		147(33.4)
	More than a week		72(16.4)

NB: Correct answers have been written in bold

Analysis of variance (ANOVA) of microbial food safety hazard knowledge of National School Nutrition Programme (NSNP) food service staff

The age factor was the only factor to significantly ($p \leq 0.05$) influence whether or not respondents had heard of HACCP. The partial cross tabulation result (PCT1) indicates that the older the respondent was the more likely it was that they had not heard about HACCP while working for the NSNP (Table 5.13). This could be attributed to a lack of education and fewer training opportunities for older respondents compared to younger ones (Webb & Morancie, 2015). Furthermore, older NSNP food handlers were less likely to have formal qualifications than their younger counterparts because, prior to 1994 when South Africa became a democracy, access to formal higher education was not readily available to the disadvantaged sector of the population (McNair, 2011). Also, older NSNP food handlers are more likely to have more family commitments which may be a hindrance in furthering their education and training (Sanlier, 2009).

Respondents in the different subgroups within "duration worked in NSNP" differed significantly ($p \leq 0.05$) in their response to whether or not undercooked chicken and raw eggs can transmit *Salmonella*. The partial cross tabulation (PCT) analysis (PCT2) indicates that food handlers who are more experienced are more aware of the fact that undercooked chicken and raw eggs can transmit *Salmonella* (Table 5.13). This may be due to the fact that NSNP food handlers probably gain safety food handling knowledge and skill over time through in-house training (Roberts et al., 2008). It is crucial that food handlers are trained on a continuous basis to increase their knowledge and awareness of food safety aspects (Sharif et al., 2013).

Respondents in the different subgroups within the "level of education" and the "duration food handlers have worked in the NSNP" differed significantly ($p \leq 0.05$) in their response to the following: whether or not it is safe to use raw eggs in recipes that will not be cooked, the

acceptable way to clean a cutting board or counter after it has been used for handling raw meat, and the safest way to cool a large pot of hot soup. The PCT analyses (PCT3, PCT4, PCT5 and PCT6) indicate that the higher the level of education and the longer the term food handlers have worked for the NSNP, the better their food safety knowledge is (Table 5.2.5). Even though the level of education of food handlers does not automatically translate to food safety knowledge (Webb & Morancie, 2015), individuals with higher qualifications are more likely to quickly acquire improved attitudes and behaviours towards food safety with an increase in knowledge after training (Young et al., 2015), because of their relatively high academic aptitude (Blanch & Aluja, 2013).

Table 5.13: Analysis of variance (ANOVA) of microbial food safety hazard knowledge of NSNP food service staff (N=440)

Food safety hazards knowledge	ANOVA between groups (p-value)		
	Age	**Level of education**	**The duration you have worked in your current food preparation facility**
Have you ever heard of HACCP?	0.002¥ PCT 1	0.113	0.139
Do you think you need more information about HACCP and food hygiene in NSNP?	0.093	0.569	0.163
E. coli (a harmful germ) in undercooked hamburger can cause kidney failure in children.	0.999	0.490	0.422
Undercooked chicken and raw eggs can carry Salmonella (a harmful germ).	0.655	0.098	0.002¥PCT 2
It is safe to use raw eggs in recipes that will not be cooked.	0.234	0.016¥PCT 3	0.000¥ PCT 4
It is safe to give an infant a bottle of baby formula that has been out of the refrigerator for longer than 2 hours.	0.407	0.104	0.452
Refrigeration eliminates harmful germs in food.	0.379	0.109	0.423
Which is an acceptable way to clean a cutting board or counter after it is used for raw meat?	0.205	0.000¥PCT 5	0.000¥ PCT 6
Your electricity went off in your freezer and the meat, chicken, and fish thawed. What should you do to prevent the growth of microorganisms?	0.258	0.482	0.516
What will be the safest way to cool a large pot of hot soup?	0.115	0.006¥PCT 7	0.039¥ PCT 8
What is the appropriate duration to store beef hamburger patties in the refrigerator?	0.813	0.859	0.317
If you want to keep a prepared meal for 2 hours, how will you store it?	0.075	0.996	0.859
¥ : Significance at p≤0.05, PCT: Partial Cross Tabulation			
PCT 1: Under 25 (No: 50%), 25-35 years (No: 89%), 36-45 (No: 91%), 46-55(No: 96%), 56-65 (No: 100%) and Over 65 (No: 100%)			
PCT 2: Less than a year (True: 73.2%), One to two years (64.4%) More than two years (57%)			
PCT 3: Less than high school (True: 42.5%), High school (True: 53.3%), College (True 100%)			
PCT 4: Less than a year (False: 38.2%), One to two years (55.4%) More than two years (58.7%)			
PCT 5: Less than high school (Correct response: 13.4%), High school (correct response: 27.1%), College (Correct response: 100%)			
PCT 6: Less than a year (False: 33.8%), One to two years (15.8%) More than two years (14.5%)			
PCT 7: Less than high school (Correct response: 60.9%), High school (Correct: 72.5%), College (Correct: 90%)			
PCT 8: Less than a year (Incorrect response: 75.2%), One to two years (66.3%) More than two years (62%)			

Food Safety awareness and attitudes of National School Nutrition Programme food service staff

Most of the respondents indicated that they were not doing the following: using gloves (97.5%), covering their mouths with masks (97.7%) or wearing chef's hats (79.1%) when touching or distributing food to learners (Table 5.14). Gloves, when used properly, prevent direct contact between bare hands and food and food contact surfaces, thereby reducing opportunities for food contamination. However, the use of gloves remains a contentious issue. In order to be effective, they must be used correctly and this implies understanding that gloves are an extension of one's hands, and therefore not a substitute for good hand washing practices. Furthermore, gloves can also become a source of contamination through contact with raw food material and other food contact surfaces if they are not used properly (Todd et al., 2010). The usage of gloves is not mandatory in many food service establishments (Tan et al., 2013). However, most of the respondents indicated that they always washed their hands before (75.9%) and after (97%) touching unwrapped raw foods as well as before (98.9%) and after (99.5%) touching unwrapped cooked foods (Table 5.14). This is an important food safety measure for NSNP food handlers. Given that they have been found not to wear gloves, it is imperative for them to practise hand washing, considering that it is an important step in the prevention of cross-contamination in a food service establishment (Scallan et al., 2013). Incorrect hand washing practice during the handling of food is one of the major contributing factors to cross-contamination, which can put consumers of NSNP foods at risk for various food safety hazards (Bas et al., 2006; Choi et al., 2016). The non-covering of mouths or hair by food handlers can render them potential sources of food contamination (Samapundo et al., 2015; Sani & Siow, 2014). The consequence of this practice could be disastrous for learners as their food could become contaminated by hair strands or microorganisms from the mouths of food handlers, especially those who are sick with airborne diseases (McLinden et al., 2014;

Parra et al., 2014). However, this food safety concern can be mitigated by effective professional training on personal hygiene practices (Jianu & Golet, 2014).

Almost all the respondents (99.1%) indicated they always checked the use-by date of food products before using them (Table 5.14). This is a good food safety practice which enables food handlers to determine how long to keep food products without compromising safety and quality (O'Connell et al., 2016). Keeping food products longer than they have been designed to be stored can lead to degradation and the growth of micro-organisms which can cause foodborne diseases (Evans & Redmond, 2014).

Table 5.14: Food safety awareness of National School Nutrition Programme (NSNP) food service staff (N=440)

Questions and answer options		Frequency (%)
	Yes	11(2.5)
	No	429(97.5)
	Yes	10(2.3)
	No	430(97.7)
	Yes	92(20.9)
	No	348(79.1)
	Yes	334(75.9)
	No	106(24.1)
	Yes	427(97)
	No	13(3)
	Yes	435(98.9)
	No	5(1.1)
	Yes	437(99.5)
	No	2(0.5)
	Yes	435(99.1)
	No	6(0.9)

In terms of attitudes to cleaning and washing the majority of respondents indicated they had never done the following: cleaned by washing in hot soapy water and then sanitised meat cutting surfaces after usage (95.5%), cleaned by washing in hot soapy water and then sanitised cooking utensils after each use (80.7) (Table 5.15). This is a rather unfortunate practice and

may be attributed to a general lack of adequate knowledge by food handlers about the microbial hazard of cross-contamination due to inappropriate food handling practices (Woh et al., 2016). Food handlers with limited microbial hazard awareness would be unlikely to understand why and how to use sanitisers or would not use them all (Crandall et al., 2016).

However, over 86% of respondents indicated that they did the following: always washed their hands before and after the handling of raw and cooked foods, always washed fruits and vegetables under running water prior to usage, always or most of the time stored raw meat below ready-to-eat foods in the refrigerator and always or most of the time used older food products first (Table 5.15). It is good practice for NSNP food handlers to always wash their hands as well as fruit and vegetables because it is an important step in the prevention of cross-contamination by foodborne pathogens (Abadias et al., 2012; Lynch et al., 2009). Hand washing must always precede the washing of food stuffs and utensils so as to avoid cross-contamination (Rasool Hassan, 2012). The storage of raw meat below ready-to-eat foods in the refrigerator by food handlers is an important step in the prevention of cross-contamination between raw food and cooked food via liquid dripping from the raw food (Kibret & Abera, 2012). Using older products first, according to the first-in-first-out (FIFO) principle, can aid in preventing the growth of bacteria in food products because they have been kept in storage too long (Grunow & Piramuthu, 2013).

When it comes to temperature control and storage practices, only a few respondents did the following: always or most of the time reheated leftovers (26%) and always or most of the time used a calibrated food thermometer when checking food temperatures (3%) (Table 5.15). The vast majority of respondents had never reheated leftover food (food that remained after lunch had been served). This may be attributed to the usage of power sources such as wood, coal, gas and even paraffin which are not convenient for keeping food at a high temperature for a few

hours after lunch has been served (Sugru & Lebelo, 2009). Leftover cooked food should be kept piping hot above 60°C or promptly cooled and refrigerated below 5°C. The keeping of cooked food at temperatures ranging from 5°C to 60°C must be avoided (WHO, 2006). Leftover food can be reheated at a temperature above 60°C to eliminate harmful micro-organisms before it is served to learners who eat after school before they go home (Abdul-Mutalib et al., 2012). It is disappointing that only a small proportion of the food handlers always or most of the time use a calibrated food thermometer to check food temperatures. It is important to use a thermometer and check the food temperatures in food service facilities when testing if food has been cooked at the correct temperature to the centre or as a control mechanism to check that the appropriate temperature to deactivate pathogens in food that is being cooked has been attained (Addis & Sisay, 2015; Parra et al., 2014). Like the case of NSNP food handlers, other authors have reported the non-usage of thermometers by food handlers in food service establishments in Italy (Buccheri et al., 2007), in South Africa (Marais et al., 2007) as well as in Malaysia (Abdul-Mutalib et al., 2012; Sani & Siow, 2014).

Table 5.15: Food safety attitudes of National School Nutrition Programme (NSNP) food service staff (N=440)

Question	Frequency (%)				
6.10 How often do you perform the following in your current work station?	**Always**	**Most of the time**	**Sometimes**	**Never**	**Missing system**
Cleaning and washing attitudes					
Clean by washing in hot soapy water and then sanitise cutting surfaces after cutting up raw meat.	17(3.9)	2(0.5)	0	420 (95.5)	1(0.2)
Clean by washing in hot soapy water and then sanitise cooking utensils after each use or when there is a chance that they have been contaminated.	33(7.5)	3(0.7)	48(10.9)	355 (80.7)	1(0.2)
Wash fruit and vegetables thoroughly under running water to remove dirt and other contaminants prior to using them.	361(82)	46(10.5)	9(2)	24(5.5)	0
Storage attitudes					
Cover and correctly label prepared food before storing.	26(5.9)	18(4.1)	366 (83.2)	29(6.6)	1(0.2)
Store raw meat in the refrigerator below ready-to-eat or cooked foods.	245(55.7)	183(41.6)	1(0.2)	11(2.5)	
Use the oldest food products first (first-in-first-out).	185(42)	242(55)	2(0.5)	8(1.8)	3(0.7)
Cooking and temperature control					
Reheat leftovers thoroughly before serving.	68(15.5)	46(10.5)	9(2)	355 (80.7)	1(0.2)
Use a calibrated food thermometer when checking food temperatures.	8(1.8)	4(0.9)	31(7)	393 (89.3)	4(0.9)

Analysis of variance ANOVA in food safety attitudes of NSNP food service staff

Respondents in the different subgroups within the "duration food handlers have worked in the NSNP" differed significantly ($p \leq 0.05$) in their attitudes towards the following: the cleaning and sanitising of cutting surfaces after the cutting up of raw meat, the washing of fruit and vegetables thoroughly under running tap water, and the usage of the oldest food products first (first-in-first-out). The partial cross tabulation results (PCT1, PCT2 & PCT3) indicate that the longer respondents have worked for the NSNP the better their attitude towards the aforementioned food safety parameters (Table 5.16). In addition to the "duration food handlers have worked in the NSNP", respondents in the different subgroups within the "level of education" differ significantly ($p \leq 0.05$) in their attitudes towards the following: storage of raw meat in the refrigerator below ready-to-eat or cooked foods, and the reheating of leftovers food thoroughly before serving. The partial cross tabulation results (PCT4, PCT5, PCT6 and PCT 7) indicate that the higher the level of education the better the attitude towards the aforementioned food safety parameters. Furthermore, respondents in the different subgroups within the "level of education" differed significantly ($p \leq 0.05$) in their attitudes towards the usage of a calibrated food thermometer when checking food temperatures. The partial cross tabulation results (PCT 8) indicate that the higher the level of education of respondents the better their attitude towards the usage of a calibrated food thermometer when checking food temperatures (Table 5.16).

Table 5.16: Analysis of variance (ANOVA) of Food safety attitudes of National School Nutrition Programme (NSNP) food service staff (N=440)

	Age	**Level of education**	**The duration you have worked in your current food preparation facility**
Cleaning and hygiene practices			
Clean and sanitise cutting surfaces after cutting up raw meat.	0.083	0.754	0.035¥ PCT 1
Clean and sanitise cooking utensils after each use or when there is a chance that they have been contaminated.	0.243	0.768	0.953
Wash my hands before I prepare food and after handling raw meat or poultry.	0.219	0.088	0.055
Wash fruit and vegetables thoroughly under running tap water to remove dirt and other contaminants.	0.756	0.137	0.038¥ PCT 2
Storage practices			
Cover and correctly label prepared food before storing.	0.111	0.675	0.342
Divide large quantities of food into smaller containers so as to cool them more quickly.	0.978	0.881	0.315
Use the oldest food products first.	0.291	0.384	0.000¥ PCT 3
Store raw meat in the refrigerator below ready-to-eat or cooked foods.	0.141	0.000¥ PCT 4	0.000¥ PCT 5
Temperature control			
Reheat leftovers thoroughly before serving.	0.436	0.003¥ PCT 6	0.000¥ PCT 7
Use a calibrated food thermometer when checking food temperatures.	0.082	0.022¥ PCT 8	0.818
¥: Significance at p≤0.05, **PCT**: Partial Cross Tabulation			
PCT 1: Less than a year (Never: 92.3%), One to two years (Never: 98%) More than two years (Never: 98.5%)			
PCT 2: Less than a year (Always: 75.8%), One to two years (Always: 82.2%) More than two years (Always: 87.7%)			
PCT 3: Less than a year (Always: 29.1%), One to two years (Always: 41%) More than two years (Always 57.4%)			
PCT 4: Less than high school (always or most of the time: 95.5%), High school (always or most of the time: 98.5%), College (always or most of the time: 100%)			
PCT 5: Less than a year (Always: 58.4%), One to two years (Always: 75.2%) More than two years (Always 96.3%)			
PCT 6: Less than high school (always or most of the time: 14.6%), High school (always or most of the time: 31%), College(always or most of the time: 100%)			
PCT 7: Less than a year (Always: 9.5%), One to two years (Always: 14.9%) More than two years (Always 22.9%)			
PCT 8: Less than high school (Never: 84.7%), High school (Never: 93.8%), College (Never: 100%)			

Overall, it can be seen that the level of education of NSNP food handlers and the term of employment food handlers have worked in the NSNP significantly affect the level of some aspects of the microbial food safety hazard knowledge and food safety attitudes of NSNP food handlers (Table 5.17). Therefore, continuous education and training on food safety procedures should be provided to the NSNP food handlers to strengthen their food safety knowledge, and improve their attitudes and skills in areas where there are lapses in order to minimise the risk of foodborne disease outbreaks in the NSNP (Al-Shabib et al., 2016). The level of education of food handlers alone does not automatically translate to food safety knowledge (Webb & Morancie, 2015).

Table 5.17: Food safety knowledge and attitude variables that are significantly affected by the level of education and/or the term of employment in the Nation School Nutrition Programme (NSNP) (N = 440)

FOOD SAFETY VARIABLE	SIGNIFICANT EFFECT PRODUCED BY FACTOR ($p < 0.05$)	
Knowledge of microbial food safety hazard	**Level of education**	**Term of employment in the NSNP**
Whether or not they have heard of HACCP	Edu↗FSK↗	NSD
Safety concerns in the usage of raw eggs in recipes that will not be cooked	Edu↗FSK↗	TE↗FSK↗
Whether or not undercooked chicken and raw egg can transmit *Salmonella*	Edu↗FSK↗	TE↗FSK↗
The acceptable way to clean a cutting board or counter after it is used and the safest way to cool a large pot of hot soup	Edu↗FSK↗	TE↗FSK↗
Food safety attitudes of food handlers		
The cleaning and sanitizing ~~sanitising~~ of meat cutting surfaces after usage	NSD	TE↗FSK↗
The washing of fruit and vegetables thoroughly under running tap water	NSD	TE↗FSK↗
The usage of the oldest food products first (first-in-first-out).	NSD	TE↗FSK↗
The storage of raw meat in the refrigerator below ready-to-eat or cooked foods	Edu↗FSK↗	TE↗FSK↗
The reheating of leftovers food thoroughly before serving	Edu↗FSK↗	TE↗FSK↗
The usage of a calibrated food thermometer when checking food temperatures	Edu↗FSK↗	NSD

NSD: No significant difference at $p < 0.05$, Edu↗FSK↗: The higher the education level, the better the knowledge, TE↗FSK↗: The longer the term of employment in NSNP, the better the knowledge.

5.2.5 Conclusion

The majority of the schools offering NSNP meals have got designated and permanent food preparation facilities with clean potable water supply. The majority of the NSNP food handlers working in these facilities are females older than 36 years who have attended at least a high school. Despite their literacy, the majority of them had no previous food handling or training when they started working for the NSNP. However, most of them have had in-service training at least once a year, mostly on personal hygiene, and not on chemical storage, purchasing and receiving procedures, pest control, equipment cleaning procedures, and food safety allergy procedures.

The vast majority of the NSNP food handlers have not heard of HACCP and most of their NSNP food service facilities have no such programmes in place. Most of these food handlers do not know the correct procedures for washing a cutting board after it has been used for raw meat preparation, the correct way of handling accidentally thawed meat, or the appropriate storage duration for storing beef burger patties in the refrigerator. Even though most of NSNP food handlers lack the knowledge, awareness and attitudes with regard to many important microbial food safety hazards, those with a higher level of education, and those with longer duration of service in the NSNP, are more knowledgeable about food safety hazards. Based on the findings of this study, we recommend that newly recruited food handlers be trained on food safety procedures and thereafter be provided with continuous food safety training on various aspects of microbial food safety hazards. In addition, even though not mandatory in South Africa, the HACCP programme should be implemented in all NSNP food service facilities to enhance food safety assurance in the NSNP and to be in compliance with regulations relating to the application of the hazard analysis and critical control point system number (R.908) of the foodstuffs, cosmetics and disinfectants act (Act No. 54 of 1972) of the republic of South Africa.

5.3 MICROBIOLOGICAL QUALITY OF FOOD CONTACT SURFACES IN THE FOOD PREPARATION FACILITIES OF SCHOOLS INVOLVED IN SCHOOL FEEDING PROGRAMMES, MPUMALANGA, SOUTH AFRICA

(Submitted for publication in the Journal of Food Safety)

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5.3.1 Abstract

The microbial quality of food contact surfaces in the NSNP food preparation facilities is an indication of their hygiene standard and the likelihood ~~likely~~ ~~hood~~ of microbial cross contamination between food and these surfaces. The aim of our study was to evaluate the microbiological quality of contact surfaces in the National School Nutrition Programme (NSNP) food preparation facilities of different schools in Mpumalanga province, South Africa. A total of 192 surface samples were collected by Swabbing 10 - 100 cm^2 surface areas of food preparation surfaces in the facilities of randomly selected school. The bench tops were the most contaminated with 78.1% of samples having aerobic plate counts above 3log cfu/cm^2. This was followed by the Dry storage shelf, Sink faucet, cutting board, and refrigerator handle in which 59.4%, 50.1%, 47% and 37.6% of samples respectively had aerobic plate counts above 3log cfu/cm^2. *Listeria monocytogenes* detected in 53.13% of surfaces and *Staphylococcus aureus* detected in 25.52% were the most prevalent pathogens on the contact surfaces. The majority of the surfaces had counts above 3log cfu/cm^2 more than the 2 log cfu/cm^2 maximum acceptable limit stipulated by the South African Government Regulation 962. Most of the contact surfaces of the NSNP food preparation facilities are of poor hygiene standard and constitute a food safety risk to school children consuming NSNP meals. It is recommended that the NSNP staffs be trained on how to adequately use cleaning materials and sanitizers to clean and sanitize food contact surfaces to effective remove surface microorganism.

Keywords:

Food contact surfaces. Swab, Total aerobic count, foodborne pathogen, Salmonella, Listeria monocytogenes

5.3.2 Introduction

In many developing countries, school feeding programmes are used as tools to combat short-term hunger and undernourishment of learners from impoverished communities, by providing them with free meals in schools (Kristjanssona et al., 2016; Soares et al., 2017). In South Africa, the vast majority of schools offering NSNP meals are located in rural communities and informal settlements where some schools lack basic resources such as constant electricity and potable water supply (Sibanyoni & Tabit, 2016). Generally, school feeding programs are offered to populations that are food insecure and often reside in areas with high concentrations of families with low household income (WFP, 2013).

Food contact surfaces in food preparation facilities in schools offering feeding program can be associated to microbial cross contamination (Boro et al., 2015) due to ineffective cleaning and disinfecting of these surfaces effectively after usage (Cunningham et al., 2011; Nhlapo et al., 2014; Boro et al., 2015). Furthermore, the accumulation of biofilms and food debris on food contact surfaces can harbor microorganisms which can multiply or form spores and hence the possibility to be involved in cross contamination (Cortese et al., 2016). Food pathogens such *E. coli* 015:H7, *Staphylococcus aureus*, *Listeria* sp, and *Bacillus cereus* can survive in moist organic debries on food contact surfaces and proceed to contaminate food and other food contact surfaces in the food preparation facilities of schools (Assefa et al., 2015; Othman, 2015; Smigic et al., 2016).

Microbial cross contamination can occur directly between foods, between food and contact surfaces, between food and equipment and between food and human (Choi et al., 2016). The

cleaning and sanitizing of food contact surface in food preparation facilities is an important step in the elimination of microbial hazards, thereby reducing the risk of the foodborne diseases outbreaks in schools (Stangarlin et al., 2013; Zhao et al., 2014; Zwietering et al., 2016). Most school children are particularly susceptible to the effects of foodborne diseases during the first few years of life, because their immune systems are either not fully developed or may have been compromised by other disease conditions (Scallan et al., 2013). Some opportunistic bacteria that may not be harmful to most healthy people can cause disease and even death in children, especially those who are immuno-compromised (Mellou et al., 2013).

The prevention of food contamination and foodborne diseases outbreaks in school feeding programs is essential considering that schools have been identified as high food safety risk establishments (Da Cunha et al., 2012). Furthermore, young children are particularly vulnerable to pathogenic bacteria such as *Escherichia coli*, *Staphylococcus aureus* and some opportunistic pathogens (Boughattas & Salehi, 2014). The consequences of foodborne disease outbreaks in school feeding programs can result to life threatening illness, huge medical costs and spread of infection to other children and staff, thereby leading to disruption of learning in schools (Toth et al., 2016; Abushelaibi et al., 2016). It is important to investigate the microbial quality of food contact surfaces in schools so as to ascertain the level food safety risk posed by these surfaces (Valero et al., 2017). Hence the objective of this study is to evaluate the microbiological quality of selected food contact surfaces of NSNP food preparation facilities in Mpumalanga, South Africa.

5.3.3 Materials and methods

Sampling collection

192 swab samples were collected from six different types of food contact surfaces (bench top, cutting board, refrigerator handle, sink faucet, dry storage shelf and serving spoon) of the food preparation facilities of 32 randomly selected primary and secondary schools that offer meal of the National School Nutrition Program, in Mpumalanga, South Africa, after the normal daily routine activities of these facilities. Surface areas ranging from 10 to 100 cm^2 depending on dimension of each food contact surface were swabbed using sterile swab stick (Swabs and SwabChecks Kits, Sigma) following the manufacturer's protocol. The swab samples were transported on ice at 4°C to the laboratory and were analysed within 24 hours.

Sample preparation for microbial analysis

25 ml of each swab solution was pipetted into a sterile tube containing 225 ml buffered peptone water and mixed to a ten time diluted sample solution. Thereafter, 1ml from each 10X dilution ~~diluted~~ serial up to 10^6 was mixed into 9 ml of buffered peptone water serially to obtain a 10^2 and 10^3 dilutions of each sample.

Total aerobic counts

1 ml of each of the serial diluted sample was spread on Plate Count Agar (PCA) plates (Sigma Aldrich) and incubated aerobically at 37°C for 48h. After incubation, only plates containing between 30 – 300 colonies were counted.

Total fungi counts

1 ml of each of the serial diluted sample was spread on Rose Bengal Chloramphenicol Agar plates (Sigma Aldrich) and incubated aerobically at 25°C for up to five days. After incubation, only plates containing between 30 – 300 colonies were counted.

Detection of pathogens

Escherichia coli

1 ml of each swab sample was enriched in 12 ml HiCrome™ Enrichment Broth (Sigma) containing HiCrome™ EC 0157:H7 Selective Supplement I, prepared using the manufacturers protocol. Samples and enrichment media were mixed and incubated at 37°C for 21 h. The appearance of a purple colour in the enrichment medium indicated the presence of *E.coli* O157:H7.

Salmonella spp.

1 ml of each swab sample was enriched in 12 ml Salmonella Enrichment broth (Sigma) prepared using the manufacturer's protocol. Samples and enrichment media were mixed and incubated at 37°C for 21 hours. Thereafter, 1ml of the enriched samples was spread on Salmonella chromogen agar plates (Sigma) and incubated at 37^0C for 48 h. The appearance of red colour colonies indicated the presence of *Salmonella enteritidis* and *Salmonella typhimurium* in the samples.

Staphylococcus aureus

1 ml of each swab sample was enriched in 12 ml Modified Giolitti and Cantoni Broth (Sigma) containing Potassium tellurite (Sigma), prepared using the manufacturer's protocol. Samples and enrichment media were mixed and incubated at 37°C for 21 hours. Thereafter, 1ml of the enriched samples was spread on Rapid Staph agar plates (Biorad) plates and incubated for incubated at 37^0C for 48 hours. The appearance of black colonies with a clear halo indicated the presence of *Staphylococcus aureus* in the swab samples.

Listeria monocytogenes

1 ml of each swab sample was enriched in 12 ml Listeria enrichment broth (Sigma), prepared using the manufacturer's protocol. Samples and enrichment media were mixed and incubated at 37°C for 21 hours. Thereafter, 1ml of the enriched samples was spread on Rapid Listeria Spp. agar plates (Biorad) plates and incubated for incubated at 37^0C for 48 hours. The

appearance of blue to blue-green colonies indicated the presence of *Listeria* in the swab samples.

Identification of isolates by 16S rRNA gene sequencing

DNA extraction was done using the ZR Fungal/Bacterial DNA MiniPrep™ Kit (Zymo Research) following the manufacturers protocol. The extracted DNA was quantified using NanoPhotometer® P-Class P360 version 2.1 (IMPLEN). Prior to sequencing, the 16S rRNA gene of bacteria isolates were amplified using the primers ENV1 (5´-AGA GTT TGA TII TGG CTC AG-3´) and ENV2 (5´-CGG ITA CCT TGT TAC GAC TT-3´) as described previously by Olofsson, Ahrné, & Molin, (2006). Each reaction mix (50ul) consisted of 1 uM of each primer, 25 ul of 2-times PCR Master Mix (Promega, Madison, USA), 100 ng of DNA template and nuclease free water. Amplification was conducted with the Mx3005P qPCR System using the following reaction conditions: an initial denaturation step of 2 min at 94 °C, followed by 30 cycles of denaturation (15s at 95 °C), annealing (30s at 48 °C) and elongation (30s at 72 °C). The last cycle was a final extension (10 min at 72 °C).

10 µl of each PCR product was analysed on a 1% agarose gel stained 0.5 µg/ml ethidium and visualised as described above. Sample with clear visible band were sent for forward and reverse sequencing at Inqaba BiotecTM (South Africa). The resulting sequences were aligned using ClustalW in BioEdit (vision 7.0.9.1) and manually edited. The edited sequences obtained were then blasted in the EMBL nucleotide sequence database (Maidak et al., 1999). Species identification was considered to be confirmed if sequence similarity was ≥97%.

Analysis of data

The data were recorded on SPSS and descriptive statistics was used to analyze the microbial count and percentage occurrences.

5.3.4 Results

Total aerobic counts

Of all the surfaces analysed, the bench top samples were the most contaminated, in which a total 78.1% of the samples had aerobic plate counts above the 2-3 log cfu/cm^2 range. This was followed by Dry storage shelf, Sink faucet, cutting board, and refrigerator handle in which 59.4%, 50.1%, 47% and 37.6% of samples respectively had aerobic plate counts above 2-3 log cfu/cm^2 range (Table 5.18).

Table 5.18: Frequency of the aerobic plate count levels on food contact surfaces in the NSNP food preparation facilities

Log CFU/ml range	Frequency within different surface types						
	Bench top (%)	Cutting board (%)	Refrigerator handle (%)	Sink faucet (%)	Dry storage shelf (%)	Serving spoon (%)	Total (%)
≤1	0(0)	6(18.8)	9(28.1)	6(18.8)	2(6.3)	7(21.9)	30(15.63)
>1-2	0(0)	0(0)	0(0)	3(9.4)	0(0)	0(0)	3(1.56)
>2-3	7(21.9)	11(34.4)	11(34.4)	7(21.9)	11(34.4)	10(31.3)	57(29.69)
>3-4	16(50)	6(18.8)	10(31.3)	8(25)	12(37.5)	7(21.9)	59(30.73)
>4-5	8(25)	6(18.8)	2(6.3)	6(18.8)	7(21.9)	7(21.9)	36(18.75)
>5	1(3.1)	3(9.4)	0(0)	2(6.3)	0(0)	1(3.1)	7(3.65)
Total	32	32	32	32	32	32	192(100)

Fungi counts

With the exception of dry storage shelf surfaces, in which 75% of samples had fungi counts above 2-3 log cfu/cm^2 range, while the majority of the refrigerators handle (87.5%), serving spoon (65.6%), and sin faucet (62.5%), cutting board (56.3%) and bench top (50%) samples had fungi counts which did not exceed the 1-2 log cfu/cm^2 range. The majority of samples has fungi counts above the 1-2 log cfu/cm^2 range (Table 5.19).

Table 5.19: Frequency of the fungi count levels on food contact surfaces in the NSNP food preparation facilities

Log CFU/ml range	Frequency within different surface types						
	Bench top (%)	Cutting board (%)	Refrigerator handle (%)	Sink faucet (%)	Dry storage shelf (%)	Serving spoon (%)	Total (%)
≤1	11(34.4)	15(46.9)	20(62.5)	15(46.9)	4(12.5)	17(53.1)	82(42.71)
>1-2	5(15.6)	3(9.4)	8(25)	5(15.6)	4(12.5)	4(12.5)	29(15.10)
>2-3	13(40.6)	11(34.4)	4(12.5)	10(31.3)	13(40.6)	9(28.1)	60(31.25)
>3-4	2(6.3)	0(0)	0(0)	1(3.1)	8(25)	1(3.1)	12(6.25)
>4-5	1(3.1)	2(6.3	0(0)	0(0)	2(6.3	0(0)	5(2.60)
>5	0(0)	1(3.1)	0(0)	1(3.1)	1(3.1)	1(3.1)	4(2.08)
Total	32	32	32	32	32	32	192(100)

Occurrence of pathogens

E.coli 015:H7 was detected in 15.63% of all the surface samples and all the selected food contact surfaces had at least one sample in which *E.coli* 015:H7 was detected. The highest incidence of *E.coli* 015:H7 was recorded on bench top (21.9%) and cutting board (21.9%) samples. This was followed by sink faucet (15.6%) and dry storage shelf (15.6) samples. The refrigerator handle and serving spoon had the least percentage of samples in which *E.coli* 015:H7 was detected.

Salmonella sp. was detected in only 1.56% of all food contact surfaces, out of which, only the bench top, cutting board and sink faucet produced at least one sample in which *Salmonella* sp. were detected. *Salmonella* was not detected in the surface samples of the refrigerator handle, dry storage shelf and serving spoon. On the other hand, *Shigella* was detected ~~in~~ in 4.69 of all food contact surfaces and all the food contact surfaces had at least one sample in which *Shigella* was detected.

Staphylococcus aureus was detected in 25.52% of all the food contact surfaces, out of which all the food contact surfaces had at least one sample in which *Staphylococcus aureus* was detected. The highest incidence of *Staphylococcus aureus* contamination was recorded on dry storage shelf (37.5%) and cutting board (31.3%) surface samples. This was followed by bench top (25%) and refrigeration handler (25%) samples. Serving spoon (12.5%) and Sink faucet (21.9%) had the least percentage of samples in which *Staphylococcus aureus* was detected.

Listeria monocytogenes was detected in 53.13% of all food contact surfaces and all these surfaces had at least one sample in which *Listeria monocytogenes* was detected. The highest incidence of *Listeria monocytogenes* contamination was recorded on dry storage shelf (68.8%) and cutting board (59.4%) surface samples. This was followed by serving spoon (53.1%) and bench top (50%) surface samples. Refrigerator handle (40.6%) and Sink faucet (46.9%) had the least percentage of samples in which *Listeria monocytogenes* was detected. Overall, *Listeria monocytogenes* was the pathogens with the most incidences and this was followed by *Staphylococcus aureus*, *E. coli* 015:H7, and lastly *Salmonella and Shigella* species (Table 5.20).

Table 5.20: Occurrence of pathogens on contact surfaces of food preparation facilities in schools offering the NSNP (N=192)

Frequency within surface types	Frequency within different surface types						
	Bench top (%)	Cutting board (%)	Refrigerator handle (%)	Sink faucet (%)	Dry storage shelf (%)	Serving spoon (%)	Total
Escherichia sp							
E.coli 015:H7	7(21.9)	7(21.9)	3(9.4)	5(15.6)	5(15.6)	3(9.4)	30(15.63)
Other *E.coli*	3(9.4)	3(9.4)	0(0)	2(6.3)	1(3.1)	2(6.3)	11(5.73)
Not detected	22(68.8)	22(68.8)	29(90.6)	25(78.1)	26(81.3)	27(84.4)	15(7.81)
Total	32	32	32	32	32	32	192(100)
Salmonella/ Shigella sp							
Salmonella sp	1(3.1)	1(3.1)	0(0)	1(3.1)	0(0)	0(0)	3(1.56)
Shigella sp	1(3.1)	2(6.3)	1(3.1)	2(6.3)	1(3.1)	2(6.3)	9(4.69)
None detected	30(93.8)	29(90.6)	31(96.9)	29(90.6)	31(96.9)	30(93.8)	180(93.75)
Total	32	32	32	32	32	32	192(100)
Staphylococcus sp							
Staphylococcus aureus	8(25)	10(31.3)	8(25)	7(21.9)	12(37.5)	4(12.5)	49(25.52)
None detected	24(75)	22(68.7)	24(75)	25(78.1)	20(62.5)	28(87.5)	143(74.48)
Total	32	32	32	32	32	32	192(100)
Listeria sp							
Listeria monocytogenes	16(50)	19(59.4)	13(40.6)	15(46.9)	22(68.8)	17(53.1)	102(53.13)
None detected	16(50)	13(40.6)	19(59.4)	17(53.1)	10(31.2)	15(46.9)	90(46.88)
Total pathogen incidence							
Total	32	32	32	32	32	32	192(100)

Predominant bacteria genera and their species identified on contact surfaces

A total of 22 different bacteria genera were identified from bacteria colonies isolated from incubated aerobic agar plates (PCA) which were spread with different dilutions of swab samples of food contact surfaces. More than half of the bacteria genus identified was *Bacillus,* followed by *Enterobacter, Pantoea* and *Staphylococcus.* The other genus made up 27.2% of the isolates identified (Table 5.21).

Enterobacter cloacae was the most predominant *Enterobacter* species identified on food contact surface while *Staphylococcus sciuri* was the most predominant *Staphylococcus* sp. identified and *Ralstonia pickettii* was the most predominant *Pantoea* species identified (Table 5.21).

Table 5.21: The four most predominant bacteria genera and their species identified from aerobic growth isolates from food contact surfaces in NSNP food preparation facilities (N=195)

Genus	**Frequency of occurrence (%)**	**Frequency of the most abundant species within genus (%)**
BACTERIA		
Enterobacter	30 (20)	*Enterobacter Cloacae* 18 (60)
Staphylococcus	11 (7.33)	*Staphylococcus* sciuri 5 (45.45)
Pantoea	14 (9.33)	*Ralstonia pickettii* 6 (42.86)
Bacillus	87 (58)	*Bacillus substilis* 26 (47.13)
¥Others	53 (27.2)	

NB: Between two and four isolates (colonies) per sample that looked morphologically different were isolated from plate count agar growth. Only bacteria species with more than 99% sequence homology were considered. ¥ = A total of 22 different bacteria genera were identified. Only bacteria genera with more than two species have been included in the table.

B. substilis was the most predominant *Bacillus* species identified on the food contact surfaces. This was followed by *B. amyloliquefacien* and *B. safensis*. Together the aforementioned *Bacillus* species made up more than 50% of all the *Bacillus* species identified on food contact surfaces (Table 5.21 & 5.22).

Table 5.22: The most predominant *Bacillus* species identified on food contact surfaces in NSNP food preparation facilities (N=87)

***Bacillus* species**	**Frequency of occurrence (%)**
B.Substilis	31
B.amyloliquefacien	7
B.licheniformis	14
B.safensis	4
B.paralicheniformis	2
B.tequilensis	3
B.sonorensis	2
¥Other species	24

¥ = A total of 87 different Bacillus species were identified and only *Bacillus* species that were identified more than twice have been included in the table.

5.3.5 Discussion

Aerobic counts on contact surfaces

The vast majority of contact surfaces samples had count above 3log cfu/cm^2 and the reason for this can be attributed to inadequate cleaning and sanitation of food contact surfaces (Losito eta al., 2017). In addition to in adequate cleaning and sanitization, cross-contamination and recontamination during food preparation can be another reason for the high surface aerobic counts (Carrasco et al., 2012). The fact that the vast majority of the contact surfaces in the NSNP food service facilities had viable counts above 2 log cfu/cm^2 (100cfu/cm^2) which is the maximum acceptable limit stipulated by the South African Government regarding the aerobic counts on contact surfaces of food premises and food transport facilities. Therefore, most of

the contact surfaces analysed contravened the Government Regulation 962 of South Africa (South African Government Notice, 2012).

Of all the food contact surfaces analysed, the bench tops were the most contaminated and this can be attributed to the fact that bench tops are often in contact with raw and fresh foods materials than the other food contact surfaces (Flores et al., 2011; Biranjia-Hurdoyal & Latouche, 2016). Bench tops in food preparation facilities often come in contact with raw materials, equipment and food handlers themselves during food preparation (Taulo et al., 2009; Tan et al., 2013; Baluka et al., 2015). Ineffective cleaning and sanitizing of food contact surfaces can contribute to microbial cross-contamination, hence effective cleaning and sanitizing of food contact surfaces before, during, and after food preparation can reduce the risk of microbial cross contamination in food preparation facilities (Goncalves *et al*., 2013). Even though contaminated food contact surfaces can serve as possible reservoirs for microorganisms, the transmission of foodborne infections and the source of transmission these microorganisms from one food contact surface to another is mostly due to the actions of food handlers (Kampf, & Kramer, 2004).

High levels of food contact surface contamination by microorganisms can also be due to the lack of proper infrastructure, equipment as well as incorrect layout within the food preparation facilities in schools (Sibanyoni, &·Tabit, 2016). Furthermore, the lack of adequate food safety knowledge by food handlers and the non-implementation of HACCP can negatively influence the hygienic quality of food contact surfaces in food preparation facilities (Sibanyoni et al., 2017). The high aerobic count on food contact surfaces of the NSNP food preparation facilities constitute a food safety risk to school children, considering that these surfaces may be potential source of contamination with pathogens such as *Salmonella* spp., *Escherichia coli*, *Campylobacter* spp., *Staphylococcus aureus*, *Listeria monocytogenes*, and *Bacillus cereus*

which are among the major causative agents of foodborne disease (Kirk et al., 2015). High aerobic counts on kitchen surfaces has been associated with poor cleaning and sanitization practices considering that that most bacteria can be dislodged with the usage of some heat and low concentrations of antibacterial dishwashing liquids (Dharod et al., 2009; Kusumaningrum et al., 2002; Biranjia-Hurdoyal & Latouche, 2016).

Fungi count on contact surfaces

The dry shelf in the food preparation facilities were the most contaminated with fungi and this can be attributed to inadequate cleaning and sanitization practices which can eliminate fungi and their spores from the storage shelves of NSNP food preparation facilities (Kirezieva et al., 2013). Fungi contamination was less on the refrigerators handle, serving spoon, sink faucet, cutting board, and bench top of NSNP food preparation facilities because these areas more likely to be cleaned regularly and are less likely to accumulate propagate fungi spores (Ye et al., 2012). Fungi contamination of foods in food preparation facilities can result in spoilage and consequently leads to significant food waste and economic losses (Fleurat-Lessard, 2017). However, food poisoning outbreaks due to the consumption of mycotoxin-contaminated foods are rare compared to food borne disease outbreak due to bacteria contamination (Hymery et al., 2014). *Candida*, *Galactomyces* and *Yarrowia* and, *Penicillium*, *Mucor* and *Cladosporium* for yeasts and molds, respectively have been found to be the main genera of fungi involved in bread and dairy product spoilage (Cornea et al., 2011; Garnier et al., 2017).

Occurrence of pathogens on contact surfaces

The occurrence of *Listeria monocytogenes*, *Staphylococcus aureus*, *E. coli* 015:H7, *Salmonella* and *Shigella* species on contact surfaces of the NSNP food preparation facilities constitute a food safety risk considering the contamination of food by these pathogens can lead to food borne disease outbreaks (Jung et al., 2017). *L. monocytogenes* can cause listeriosis which can

produce symptoms such meningitis, meningoencephalitis, septicemia, and abortion (Wehner et al., 2014). *Listeria monocytogenes* which has the ability to replicate in contaminated food during storage in a refrigerator has been found to be prevalent in raw and processed ready-to-eat foods that required low temperature storage (Du et al., 2017). The high usage of food products which goes through the cold chain such as meat, vegetable, dairy products and fruits in the NSNP could be the reason for high incidence of *Listeria monocytogenes* on food contact surfaces (Stepanović et al., 2005).

Staphylococcus aureus which can cause gastroenteritis due to the consumption of contaminated food such meat products, poultry and eggs products, milk and dairy products has the ability to adhere to food contact surfaces and subsequently multiple form biofilms (Azelmad et al., 2017). *Staphylococcus aureus* can adhere to food contact surface of food preparation and will not be removed by most cleaning procedures hence a source of contamination for other foods and objects (Teixeira et al., 2007; Silva et al., 2003).

The consumption of food contaminated with *E. coli* O157:H7 can cause devastating and severe foodborne diseases such as haemorrhagic colitis and haemolytic uremic syndrome (Chien, Sheen, Sommer, & Sheen, 2017). *E. col*i O157:H7 which has an infectious dose that ranges from 10–100 cells, mostly contaminate raw or undercooked meat, unwashed produce, unpasteurized milk and waters via faecal-oral transmission (Song et al., 2016).

Salmonella species which are prevalent in poultry and other meat products can contaminate foods such as freshly cut vegetables and salad and can cause Salmonellosis, a food borne ~~infections~~ disease in humans (Maffei et al., 2017). The usage of antibiotics ~~antibiotic~~ in animal farming can lead to contamination of the food with *Salmonella* species that have acquired antimicrobial-resistance. Similarly, *Shigella* species which can cause shigellosis are also prevalent in meat fresh produce (Cetinkaya et al., 2008).

The fact that *Listeria monocytogenes* and *Staphylococcus aureus* had the most incidences on the contact surfaces of NSNP food service facilities can be attributed to the cross contamination and usage of poultry and other meat products in the NSNP food preparation facilities (Du et al., 2017) as well as the fact that *Staphylococcus aureus* possesses the ability to adhere to food contact surfaces (Teixeira et al., 2007). Furthermore, food handlers can also cross-contaminate food contact surfaces and food product with *S. aureus* by sneezing, talking, laughing or using soiled coats during food preparation and serving of food (Sinclair, & Gerba, 2011).

Most schools offering NSNP do not have adequate water supply and handwashing facilities within the food preparation areas and this can contribute to the presence of high bacteria load and pathogen on food surfaces (Nhlapo et al., 2014; Sibanyoni, &·Tabit, 2016). The taps that supply water in most schools located in rural areas, were stationed outside the food preparation premises (Sibanyoni et al., 2017). The food preparation facilities of most schools ~~were~~ have been found not to be in compliance with the South African Health Regulations (R.918 of 1999), which prescribes that surfaces in food preparation and service facilities which come into direct contact with food should be made of smooth, rust-proof, non-toxic and non-absorbent material that is free of open joints, chips or cracks (South African Government Notice, 2012; Sibanyoni & Tabit, 2016). In addition to inadequate cleaning and the application of HACCP shows an indication of lack of/inadequate implementation of Good Hygienic Practices (GHP) which is fundamental to HACCP. If GHP cannot be implemented effectively, then there is no point pushing for HACCP. Moreover, GHP, if applied effectively and efficiently, could be sufficient for the resource poor schools that are part of the NSNP. The utilization of inadequate food preparation and service facility may have contributed to the high microbial counts and incidence food borne pathogen on food contact surfaces (Sibanyoni et al., 2017). The presence of coliforms on kitchen counters and chopping boards has been previously reported in a study conducted on Household Kitchen Tables (Biranjia-Hurdoyal & Latouche, 2016).

Predominant bacteria genera and species on contact surfaces

The reason why the *Bacillus* genus constituted more than half of the bacteria genus identified can be attributed to their ability to form spores within mono- or mixed-culture biofilms, hence the ability to resist inadequate cleaning procedures (Faille et al., 2014). The spores of *Bacillus sp* particulary those of *Bacillus subtilis* which was the most predominant on food contact surfaces can food such as beverages and processed liquid milk and related products (Chen et al., 2015; Cregenzán-Alberti et al., 2017). The high incidence of *Enterobacter* on contact surfaces can be due to their high prevalence in dairy and cereal products as well as on the contact surfaces of food processing environments (Shaker et al., 2007). *E. cloacae* which were the most predominant *Enterobacter* identified on food contact surfaces can cause health care related diseases such respiratory and urinary tract infection, intra-abdominal infections, endocarditis, septic arthritis, osteomyelitis, skin and soft tissue infections (Mezzatesta et al., 2012). Furthermore, *E. cloacae* possess the ability to express and produce curli fimbria which is involved in cell accumulation, adherence and biofilm formation on surfaces (Akbari et al., 2016).

Pantoea species, especially *Ralstonia pickettii* are members of the *Enterobacteracea* can occasionally cause opportunistic infections to immunocompromised individuals such as cancer patients, patients with hematological malignancies, individual with HIV/AID and infants (Moghadam et al., 2016; Strateva et al., 2012). In addition to the ability of *Staphylococcus* species to produce biofilm, *Staphylococcus sciuri*, the most predominant *Staphylococcus* species found on food contact surfaces are often associated to food such as meat, milk and related products, which are often processed in the NSNP food preparation facilities (Stepanović et al., 2005).

The results of this study agree with the study by Saouide el ayne et al., (2014) at the hospital El Idrissi Kenitra-Morocco, where they have found that *Bacillus* and predominant coagulase negative *staphylococci*, followed by *Staphylococcus aureus.* Foodborne disease could be caused by the formation of biofilm on food contact surfaces such as bench tops, cutting boards and storage shelves which could disseminate the potential bacteria pathogens continuously in the kitchen environment as well as ultimately affecting food quality and safety (Van Houdt, & Michiels, 2010). However, their presence on food contact surfaces would indicate poor hygiene and sanitation practices which could eventually affect food safety (Biranjia-Hurdoyal & Latouche, 2016).

Results from the current study have indicated the vital role played by food preparation areas in the safety of food in school feeding programs and the study has shown that insufficiently cleaned food contact surfaces and the presence of opportunist microorganisms can place children at high risk of contracting a food-borne illness (Setlhare et al., 2013).

5.3.6 Conclusion

The majority of the surfaces had aerobic counts above 3log cfu/cm^2 more than the 2logcfu/cm^2 maximum acceptable limit stipulated by the South African Government Regulation 962. Of all the surfaces, the bench tops were the most contaminated and this was followed by dry storage shelf, sink faucet, cutting board, and refrigerator handle respectively. *Listeria monocytogenes* was the most prevalent pathogen on surfaces and this was followed by *Staphylococcus aureus*, *E. coli* 015:H7, *Salmonella* and *Shigella* species respectively. Most of the contact surfaces of the NSNP food preparation facilities are of poor hygiene standard and constitute a food safety risk to school children consuming NSNP meals.

CHAPTER 6: GENERAL CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

These results are of educational interest to NSNP managers and the Department of Basic Education to prevent foodborne illnesses and infections and give insight into the reality of the food safety and quality assurance measures in the NSNP so as to be able to take measures to reduce or prevent foodborne illness outbreaks in schools.

6.1.1 Food safety attitudes and awareness of managers of school feeding programmes

In the study, most NSNP managers were female, older than 45 years, in possession of a post-high school qualification and employed full- time as educators by the DBE. The majority of the schools offering NSNP meals were located in informal settlements, where most schools lack basic resources such as electricity (power supply to the food preparation facility) and potable tap water (in kitchens). Despite regular visits by DBE monitors, and the availability of hygiene policies and procedures, no school was found to be implementing the HACCP programme and only a few food handlers in select schools had received food safety training. Food safety implementation was found to be worst in informal schools, mainly due to resource and infrastructural constraints, as well as relatively more limited knowledge and awareness of HACCP on the part of NSNP managers in those schools. The majority of the schools offering NSNP meals had temporary and permanent food preparation kitchens with clean portable water supply.

6.1.2 Food safety knowledge and awareness of food handlers in school feeding programmes

The majority of the NSNP food handlers working in these facilities were female older than 36 years who have attended at least a high school. Despite their literacy, the majority of them had no previous food handling or training when they started working for the NSNP. However, most of them have had in-service training at least once a year, mostly on personal hygiene but not on chemical storage, purchasing and receiving procedures, pest control, equipment cleaning procedures and food safety allergy procedures. The vast majority of the NSNP food handlers have not heard of HACCP and most of their NSNP food service facilities have no such programmes in place. Most of the food handlers did not know the correct procedures for washing a cutting board after it had been used for raw meat preparation, nor the correct way of handling accidentally thawed meat and the appropriate storage duration for storing beef burger patties in the refrigerator. Even though most of NSNP food handlers lacked the knowledge, awareness and attitudes regarding important microbial food safety hazards, those with higher levels of education and those with longer duration of service in the NSNP, are more knowledgeable on this topic.

6.1.3 Microbiological quality of food contact surfaces in school feeding programmes

The NSNP food contact surfaces could be very important sources of potential pathogens which have been reported to cause foodborne illnesses. There was significant contamination of the different food contact surfaces studied, with high bacterial and fungi counts. The lack of hygiene was confirmed by the presence of *Listeria monocytogenes, Staphylococcus aureus, E.coli 015:H7*, *Salmonella* and *Shigella* on food contact surfaces. A total of 22 different bacteria genera were identified from isolates of aerobic growth plates of food contact surfaces. More than 70% of the isolated bacteria were showed the presence of *Bacillus, Enterobacter, Pantoea* and *Staphylococcus.* The other isolated bacteria were identified as *B. subtilis*

Enterobacter Cloacae, *Staphylococcus sciuri*, *Ralstonia pickettii*, *B. amyloliquefaciens* and *B. safensis* was the least isolated identified bacteria. The frequency of germs encountered varied between species and between food contact surfaces. This information is important to determine if systems designed to improve the cleaning and sanitising in the NSNP are having an effect. The findings illustrate that bacterial contamination is present on food contact surfaces of the NSNP.

6.2 RECOMMENDATIONS

The managers of school feeding programmes are responsible for ensuring the safety of food provided to school children, and food handlers working in the school feeding programmes can play an important role in the prevention of foodborne disease outbreaks. The development of food safety knowledge, attitudes and awareness of managers in the NSNP will improve food safety implementation and compliance in schools. It is recommended that food safety training of staff and managers of the NSNP, especially in schools located in rural settlements, be implemented to improve their knowledge and awareness. Schools must be provided with relevant resources such as kitchen infrastructure, equipment and utensils, potable water supplies, electricity and dedicated food preparation facilities, to ensure that food is prepared and served safely to school children. SOPs and food safety policies should be provided and enforced in all schools offering NSNPs, to ensure the production of safe meals at all food service facilities. Newly recruited food handlers should be trained on food safety procedures and thereafter be provided with continuous food safety training on the various aspects of microbial food safety hazards. It is very important to strengthen the GHP in a NSNP as a start pave way for implementing HACCP, even though the HACCP programme is not mandatory in South Africa to enhance food safety assurance and to be in compliance with regulations relating to the application of the HACCP system number (R.908) of the food stuffs, cosmetics and disinfectants act (Act No. 54 of 1972) of the republic of South Africa.

The NSNP staffs should be trained on how to adequately use cleaning materials and sanitizers to clean and sanitize food contact surfaces to effective remove surface microorganism as the incidence of aerobic plate count (APC) on food contact surfaces was extremely high. Effective and efficient cleaning and sanitising of food contact surfaces in the NSNP is critical if cross contamination is to be reduced. Furthermore, food handlers should be encouraged to apply basic food hygiene practices to ensure food safety. Good Manufacturing Practice (GMP) and Sanitation Standard Operating Procedures (SSOP) are the two mandatory aspects that every food handlers should comply with to ensure the safety of the food produced. The food preparation facilities of the NSNP should be equipped with adequate infrastructure as stipulated by South African Government Regulation 962. A set of standard sanitary operating procedures such as those used by the food industry and food service industry should be developed to assist the NSNP with effective cleaning and sanitising of surfaces to reduce potential hazards. In addition, monitoring of the kitchen, especially surfaces, is also recommended to ensure the minimal contamination of food products prepared for school children.

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APPENDIX A: NSNP SCHOOL CO-ORDINATOR/MANAGER QUESTIONNAIRE:

FOOD SAFETY AND QUALITY ASSURANCE IN NSNP, MPUMALANGA

PROVINCE

Objective 1: To investigate the implementation of food safety and quality assurance procedures of managers of the NSNP at different schools.

SECTION 1: DEMOGRAPHICS
Name of the school: _____
Name of the school district: _____

Answer to the following questions by placing a cross (X) in the box or filling in the relevant information e.g. number.

Please choose 1 answer for each question

1.1 What is your gender?

1	Male
2	Female

1.2 What is your age?

Under 25 years	25-35 years	36-45 years	46-55 years	56-65 years	Over 65 years
1	2	3	4	5	6

1.3 Which of the following best describes your education level?

Less than high school	High school	Some college	University of Technology	University
1	2	3	4	5

1.4 You are employed

full-time	part-time
1	2

1.5 Is the school location classified as urban or rural?

1	Urban
2	Informal
3	Rural

1.6 Do all the learners benefit from National School Nutrition Program (NSNP)?

1	Yes
2	No

1.7 If no, how many learners benefit from the NSNP? _____

1.8 Indicate your position:

Volunteer	Food handler	Manager/coordinator	Other
1	2	3	4

1.9 Indicate the age (years) of the youngest and oldest learners participating in the NSNP?
_____

1.10 Where does the school water come from?

Kitchen tap (i.e. running water)	Outside tap (i.e. running water)	Water tanker (mobile)	Communal water supply (collected)	River (collected)
1	2	3	4	5

1.11 Are meals prepared in the school?

1	Yes
2	No

SECTION 2: NSNP MANAGEMENT COMMITMENT

2.1 Does the school have a governing body?

1	Yes
2	No

2.2 If yes, are they involved in the NSNP implementation at this school?

1	Yes
2	No

2.3 How often do you monitor your staff regarding the application of food safety and procedure manuals?

Daily	Weekly	Monthly	Once a term	Seldom	Never
1	2	3	4	5	

2.4 Do you delegate any of the food safety monitoring duties to any other staff members?

1	Yes
2	No

2.5 How frequently does a representative from the Department of Basic Education visit the school to assess the NSNP? (Select one).

Once a month	Once a term	Twice a year	Once a year	Less than once a year	Never
1	2	3	4	5	6

SECTION 3: NSNP FOOD SAFETY POLICIES AND OBJECTIVES

3.1 Are food hygiene practices manual been applied?

1	Yes
2	No

3.2 In your opinion, has the implementation of the NSNP made any difference to school attendance?

Increased	No change	Decreased
1	2	3

3.3 Is there a budget for the NSNP at your school?

1	Yes
2	No

3.4 Who devises the budget? (Answer all options)

Department of Basic Education	Principal	NSNP Site manager	Other (please specify)
1	2	3	4

3.5 Does the budget change from one year to the next?

1	Yes
2	No

3.6 Is your budget enough to cover the year?

1	Yes
2	No

3.7 Have you ever overspent on the budget?

1	Yes
2	No

3.8 Have you ever had to stop providing food because there was no money available towards the end of the year?

1	Yes
2	No

3.9 Do you anticipate this problem in 2015?

1	Yes
2	No

3.10 If yes, in which term? (Answer all options)

First	Second	Third	Fourth
1	2	3	4

3.11 Are there written policies and procedures regarding each of the following? (Answer all options, 1=Yes and 2= No).

3.11.1

Receiving		Storage		Serving		Hygiene		Administration	
1	2	1	2	1	2	1	2	1	2

3.11.2

3.11.2.1	Are written policy and procedures for personal hygiene for employees and all visitors (vendors, teachers, students, etc.) in place and documented?	1	2
3.11.2.2	Are personal hygiene policy and procedures followed by every person who enters the production or service area	1	2

SECTION 4: NSNP food safety plan: Standard Operating Procedures (SOP's)

4.1 Indicate which of the following guidelines have been developed in your school (NSNP) (answer all options, 1=Yes and 2 =No)

1	2	Food storage procedures
1	2	Procedures for personal hygiene of food service staff
1	2	Cleaning and disinfection of surfaces and equipment
1	2	Temperature monitoring of foods

4.2 Indicate which of the following food hygiene practices are carried out in your NSNP (check all that apply)

1	Hazard analysis of food practices
2	Inspection of raw materials
3	Microbial testing of food
4	Microbial testing of surfaces
5	None

4.3 Have educational courses or trainings on HACCP (Hazard Analysis and Critical Control Points) and food hygiene for food service staff been given?

1	Yes
2	No

4.4 How many food handlers are in the National School Nutrition Program (NSNP)?

One	Two	Three	Four	More than 4
1	2	3	4	5

4.5 During the past school year (2013-2014) did you provide employees an opportunity to attend a food safety certification program**?**

1	Yes
2	No

4.6 Did the food handlers receive training?

1	Yes
2	No

4.6.1 If yes, which topics did the training cover? (Mark all that applies)

1	Safety
2	Hygiene
3	Hand washing techniques
4	Cooking methods

4.6.2 If yes, who provides / provided the training? (Mark only one options).

1	Department of Basic Education
2	Department of Health
3	Principal
4	Head teacher
5	NSNP Site manager
6	Food handler

7	Teachers
8	Community volunteer
9	Learners
10	Previous employer
11	Other (please specify)

4.6.3 When last was training conducted? (Select one).

Ongoing	Last week	Last month	Last term	Last year	Never
1	2	3	4	5	6

4.6.4 How frequently is training conducted? (Select one).

Ongoing	Weekly	Monthly	Once a term	Once a year	Never
1	2	3	4	5	6

4.7 Do the learners receive any information on the following? (Answer all options).

Personal hygiene	Food safety	Nutrition
1	2	3

4.8 Name the number of volunteers appointed from the local community.

One	Two	Three	Four	More than 4
1	2	3	4	5

4.9 How often does the food handler rotate?

1	First to third month
2	Every fourth to fifth months
3	After six months
4	Never
5	Yearly

4.10 Do the volunteers undergo training for NSNP?

1	Yes
2	No

4.11 If yes, which topic did the training cover?

Safety	Hygiene	Hand washing techniques	Cooking methods
1	2	3	4

4.12 Have you ever had training in food safety or nutrition? (Choose all those that apply)

1	I have not had any education/training in food or nutrition
2	I have had education/training in nutrition
3	I have had education/training in food preparation
4	I have had education/training in food safety

4.13 Do you experience problems with the current delivery of the food for NSNP?

1	Yes
2	No

4.14 If yes, which type of problems do you experience? (Choose all those that apply)

Late deliveries	Poor quality food	No deliveries
1	2	3

4.15 Where do the supplies come from?

Commercial supplier	Local community member	Both 1 & 2	Other
1	2	3	4

4.16 Are there contracts with the suppliers?

1	Yes
2	No

4.17 Is there a planned delivery schedule?

1	Yes
2	No

4.18 What happens to the food that is judged to be of inadequate quality? (Mark all relevant options)

Returned to supplier	Received and used	Received and thrown away	Other
1	2	3	4

4.19 Who receives the deliveries?

Principal	Head teacher	NSNP site manager	Food handler	Teacher	All above
1	2	3	4	5	6

4.20 Is it the same person every time?

1	Yes
2	No

4.21 Does the delivery note / invoice get checked?

1	Yes
2	No

4.22 Is the documentation (invoice & delivery note) adequately completed?

1	Yes
2	No

4.23 Are all the food items checked?

1	Yes
2	No

4.24 If yes, how? (Mark all relevant options)

Weighed	Counted	Other
1	2	3

4.25 Is the delivery moved / transferred to the correct storage area immediately after delivery?

1	Yes
2	No

4.26 How often is the stock checked? (Select one).

Not checked	Once a month	Twice a month	Once a week	Twice a week	Three times a week	Four times a week
1	2	3	4	5	6	7

4.27 How often is a stock-take done? (Select one).

Not done	Once a month	Twice a month	Once a week	Twice a week	Three times a week	Four times a week	Every day of the week
1	2	3	4	5	6	7	8

4.28 Is a stock rotation system in place?

1	Yes
2	No

4.29 If yes, how is this done? (Select one).

Delivery dates	Expiry dates	Correct storage on delivery	First In First Out (FIFO)	All of the above
1	2	3	4	5

4.30 Is the storage area kept locked?

1	Yes
2	No

4.31 Who has access to the storage area?

Principal	Head teacher	NSNP Site manager	Food handler	Teacher	Other
1	2	3	4	5	

4.32 Are daily issues done? i.e. are all the supplies for the day given to the food handlers at one time e.g. the day before or in the morning.

1	Yes
2	No

4.33 Do you dry your hands?

1	Yes
2	No

4.34 If yes, what do you usually use to dry your hands?

Paper	Towel	Dish towel
1	2	3

4.35 When does the food handler need to wash their hands? (Choose all those that apply)

After going to the toilet	After smoking	After disposal of garbage	Before food preparation	After touching any part their face or hair
1	2	3	4	5

SECTION 5: HACCP Knowledge of managers

5.1 Could you please tick (x) whether you agree or disagree with each of the following:

	Statement	**Agree**	**Disagree**	**Don't Know**
1	I don't really know what HACCP is	1	2	3
2	HACCP is too complicated	1	2	3
3	I don't have the time for food safety issues	1	2	3
4	Food safety is not really a business priority	1	2	3
5	I can't see the benefits of HACCP/food safety system	1	2	3
6	There is no real incentive for having a HACCP/food safety system	1	2	3
7	There are language problems in communicating food safety issues to staff	1	2	3
8	It costs too much to have a proper food safety system in place	1	2	3
9	Food safety is not really a major priority	1	2	3
10	There should be more food safety checks by the authorities	1	2	3

SECTION 6: MANAGEMENT OF NSNP FOOD SAFETY RESOURCES: HR, INFRASTRUCTURE AND WORKING ENVIRONMENT

6.1 Where is the food prepared?

Designated kitchen	Temporary/ makeshift kitchen	Classroom	Outside building	Outside Open area	Other, please specify
1	2	3	4	5	6

6.2 What power supply is used to prepare the food? (Answer all options).

Electricity	Gas	Fire
1	2	3

6.3 Does the school have a working telephone?

1	Yes
2	No

6.4 Do you have volunteers in NSNP?

1	Yes
2	No

6.5 If yes, who are the volunteers?

Parents	Community members	Other (please specify)
1	2	3

6.6 Are community members involved in any way in the delivery of the NSNP at the school?

1	Yes
2	No

6.7 If community members are involved in the NSNP in what capacity are they involved? (Select one).

Suppliers	Delivery of food items	Food preparation	Planning	Vegetable growers	Other (please specify)
1	2	3	4	5	6

6.8 Do they receive compensation / payment for their involvement?

1	Yes
2	No

6.9 Does the school have storage facilities?

1	Yes
2	No

6.10 If yes, please answer the following:

Separate storage room	Fridge	Lockable cupboard	Airtight containers
1	2	3	4

6.11 Where are the food supplies stored? (Mark all relevant options).

Kitchen	Classroom	Designated store room	Site managers office	Other
1	2	3	4	5

6.12 Is there a regular cleaning schedule for the storage area?

1	Yes
2	No

6.13 How often is the storage area cleaned? (Select one).

Once a week	Twice a week	Three times a week	Four times a week	Every day of the week
2	3	4	5	6

THANK YOU FOR YOUR PARTICIPATION!

Kind regards

July J. Sibanyoni
Doctoral candidate, UNISA

APPENDIX B: FOOD HANDLERS QUESTIONNAIRE: FOOD SAFETY AND QUALITY ASSURANCE IN NSNP, MPUMALANGA PROVINCE

Objectives 2: To determine the food safety and quality assurance knowledge and awareness of food handlers of the NSNP at different schools.

SECTION 1: DEMOGRAPHICS

Name of the school: _____
Name of the district: _____

Information to be obtained from the Food Handlers at the school

The following set of questions aims to investigate some of the aspects of the day to day running of the National School Nutrition Programme (NSNP) at your school. Please answer only Yes or No or answer one of the choices you are given. You will be given the chance to make other comments at the end. Please insert the answer to the following questions by placing a cross (X) in the box or filling in the relevant information.

Please tick the appropriate response for each question.

1.1 What is your gender?

1	Male
2	Female

1.2 What is your age?

1	Under 25 years
2	25-35 years
3	36-45 years
4	46-55 years
5	56-65 years
6	Over 65 years of age

1.3 Which of the following best describes your education level?

1	Less than high school
2	High school
3	Some college
4	University of Technology Diploma/ degree
5	University degree
6	Post graduate degree

1.4 How long have you been a food handler for?

1	Less than a year
2	One (1) to (2) years
3	More than (2) two years

1.5 Do you have previous experience in food service?

1	Yes
2	No

SECTION 2: Details of NSNP food service facilities of Schools

2.1 Do you have a menu in your school?

1	Yes
2	No

2.2 Have you attended any food safety training course in which you were offered a certificate?

1	Yes
2	No

2.3 Are you currently utilizing a HACCP program/monitoring system in your school?

1	Yes
2	No

2.4 Does your school have designated food safety assurance personnel?

1	Yes
2	No

2.5 Where is the food prepared? (Select one).

1	Designated kitchen
2	Temporary / makeshift kitchen
3	Classroom
4	Outbuilding
5	Outside
6	Other (please specify)

2.6 Is there adequate space for cooking?

1	Yes
2	No

2.7 Is there enough water for food preparation?

1	Yes
2	No

2.8 Is there adequate space for serving / portioning of cooked food?

1	Yes
2	No

2.9 Are there enough cleaning tools to clean the kitchen e.g. broom, mop, cloths, sponge, etc?

1	Yes
2	No

SECTION 3: Training information of NSNP food service staffs

3.1 Has any training about food safety and hygiene been provided?

1	Yes
2	No

3.2 How frequently is training conducted? (Select one).

1	At least every term
2	At least every year

3.3 Have you received training regarding the following? (Answer all options, 1=Yes and 2=No).

1	2	Personal hygiene
1	2	Chemical storage
1	2	Purchasing procedures
1	2	Pest control program
1	2	Equipment cleaning procedures
1	2	Kitchen operation polices
1	2	Equipment maintenance program
1	2	Food safety training program
1	2	Food allergy procedures

SECTION 4: Microbial Food safety hazard knowledge NSNP food service staffs

In this section, each question may have more than one correct answer. Please select all of the correct answers.

4.1 Which is an acceptable way to clean a cutting board or counter after it is used for raw meat?

1	Wash with hot soapy water only
2	Wash with hot soapy water, rinse with water, then rinse with bleach
3	Clean with a disinfectant (example: Lysol, Clorox, bleach)
4	Wash cutting board in a dishwasher

Please choose the correct answer for the following statements

4.2 The presence of E. coli in undercooked hamburger can cause kidney failure in children after a disease outbreak?

1	True
2	False

4.3 Undercooked chicken and raw eggs can carry *Salmonella* (a harmful germ).

1	True
2	False

4.4 It is safe to use raw eggs in recipes that will not be cooked.

1	True
2	False

4.5 It is safe to give an infant a bottle of baby formula that has been out of the refrigerator for longer than 2 hours?

1	True
2	False

4.6 Refrigeration eliminates harmful germs in food.

1	True
2	False

4.7 Have you ever heard of HACCP?

1	Yes
2	No

4.8 Do you think you need more information about HACCP and food hygiene in NSNP?

1	Yes
2	No

4.9 Do you touch or distribute food to learners?

1	Yes
2	No

4.10 You just realised your electricity has been off and the meat, chicken and fish in your freezer has thawed. What will be the best thing to do to prevent a food borne disease due to microbial growth?

1	Throw them away
2	Cook them right away
3	See how they smell or look before deciding what to do
4	Immediately re-freeze until solidly frozen, then cook it

4.11 What is the appropriate way to store a prepared meal for 2 hours?

1	Store it in the refrigerator and reheat it when the child is ready to eat it
2	Place it on the kitchen counter until the child is ready to eat it
3	Store it in a cool oven until the child is ready to eat it
4	Store it in a warm oven until the child is ready to eat it

4.12 What will be the safest way to cool a large pot of hot soup?

1	Put the soup in a clean shallow pan and refrigerate right away
2	Keep the soup in the cooking pot and refrigerate right away
3	Put the soup in a clean, deep pot before and refrigerate right away
4	Cool the soup to room temperature on the counter, then refrigerate it

4.13 What is the appropriate duration to store beef hamburger patties in the refrigerator?

1	1-2 days
2	3-4 days
3	5-7 days
4	More than a week

SECTION 5: Food Safety awareness of NSNP food handlers

	Question	**Yes**	**No**
5.1	Do you use gloves when you touch or distribute food to learners?	1	2
5.2	Do you use a mask when you touch or distribute food to learners?	1	2

5.3	Do you wear a cap when you touch or distribute food to learners?	1	2
5.4	Do you wash your hands before touching unwrapped raw foods?	1	2
5.5	Do you wash your hands after touching unwrapped raw foods?	1	2
5.6	Do you wash your hands before touching unwrapped cooked foods?	1	2
5.7	Do you wash your hands after touching unwrapped cooked foods?	1	2
5.8	Do you always check the use-by dates of food products before using them?	1	2

SECTION 6: Food safety attitudes of NSNP food service staffs

Could you please tick (x) 1 of the 4 practice answers in each of the statements below:

6 How often do you perform the following in your current work station?	**Always**	**Most of the time**	**Sometimes**	**Never**
Cleaning and washing attitudes				
6.1 Clean and then sanitize cutting surfaces after cutting up raw meat.			0	
6.2 Clean and sanitize cooking utensils after each use or when there is a chance that they have been contaminated.				
6.3 Wash my hands before I prepare food and after handling raw meat or poultry.				
6.4 Wash fruits and vegetables thoroughly under running water to remove dirt and other contaminants prior to using them.				
Storage attitudes				
6.5 Cover and correctly label prepared food before storing.				
6.6 Divide large quantities of food into smaller containers to cool the food more quickly.				
6.7 Store raw meat in the refrigerator below ready-to-eat or cooked foods.				
6.8 Use the oldest food products first (first-in-first-out).				
Cooking and temperature control				
6.9 Reheat leftovers thoroughly before serving.				
6.10 Use a calibrated food thermometer when checking food temperatures.				

THANK YOU FOR YOUR PARTICIPATION!

Yours truly,
July J. Sibanyoni
Doctoral candidate, UNISA

APPENDIX C: CONSENT FORM

CONSENT FORM

TITLE OF RESEARCH PROJECT

FOOD SAFETY AND QUALITY ASSURANCE MEASURES OF THE NATIONAL SCHOOL NUTRITION PROGRAMME IN MPUMALANGA PROVINCE, SOUTH AFRICA

Dear Mr/Mrs/Miss/Ms_____ Date...../...../20.....

NATURE AND PURPOSE OF THE STUDY

Thank you for agreeing to participate in this important research study aimed at investigating the quality assurance and food safety of the NSNP service provided by the Department of Basic Education to primary and secondary public schools in Mpumalanga province. This research will provide answers to questions about the safety of food and quality assurance provided by the NSNP to learners.

The questionnaire will capture data on demographics and food handler's food safety knowledge in a NSNP and participants will be expected to fill the questions, which will take about 20 minutes to complete. The research study will identify gaps in food safety knowledge among food handlers of NSNP in Mpumalanga province.

RESEARCH PROCESS

The researcher will interview people who are handling food and involve in the management of the NSNP in their respective schools district. Questionnaires will be given to participants and they will be asked to complete a questionnaire relating to food safety knowledge, behaviour, practices and microbial food safety hazard awareness/food borne illness experiences. Your demographic information such as gender; age; level of education and how often you use a refrigerator in storing food will be recorded.

NOTIFICATION THAT TAPE RECORDINGS WILL BE REQUIRED

Photos may be taken when deemed necessary by the researcher.

CONFIDENTIALITY

Your ratings and assessments of any of the research instruments as well as your opinions are viewed as strictly confidential, and only members of the research team will have access to the information.

No data published in dissertations and journals will contain any information by means of which you may be identified. Your anonymity is therefore ensured.

WITHDRAWAL CLAUSE

I understand that I may withdraw from the study at any time. I therefore participate voluntarily until such time as I request otherwise.

POTENTIAL BENEFITS OF THE STUDY

The findings of this research will give an insight into the current level of food safety and quality assurance in a NSNP in Mpumalanga Province. Based on these findings, appropriate recommendations will be made to the relevant authorities for possible intervention and the findings gathered from this study will facilitate the development of an effective food safety and quality assurance programme.

INFORMATION (contact information of your supervisor)

If there is any question concerning this study contact DR Frederick Tabit, 011 471 2080, Department of Life and Consumer Sciences, UNISA.

CONSENT

I, the undersigned, …… (full name) have read the above information relating to the project and have also heard the verbal version, and declare that I understand it. I have been afforded the opportunity to discuss relevant aspects of the

project with the project leader, and hereby declare that I agree voluntarily to participate in the project.

I indemnify the university and any employee or student of the university against any liability that I may incur during the course of the project.

I further undertake to make no claim against the university in respect of damages to my person or reputation that may be incurred as a result of the project/trial or through the fault of other participants, unless resulting from negligence on the part of the university, its employees or students.

I have received a signed copy of this consent form.

Signature of participant: .....

Signed at …… on ……

WITNESSES

1 .....

2 .....

APPENDIX D: SCHOOL PERMISSION LETTER

PERMISSION LETTER

If you are willing to grant permission for this study, please sign the form below that confirms that you have read the explanatory statement, understand the nature of the study being conducted and you give permission for the study to be conducted in this school.

I [Name:_____] as [Position: _____] of [Name of School: _____] am aware that the study titled: 'FOOD SAFETY AND QUALITY ASSURANCE MEASURES OF NATIONAL SCHOOL NUTRITION PROGRAMME IN MPUMALANGA PROVINCE, SOUTH AFRICA' will be conducted in our school and I give my permission for the study to be conducted as approved by the Mpumalanga Department of Basic Education.

Signature:_____ Date: _____

APPENDIX E: DEPARTMENT PERMISSION LETTER

APPROVAL TO CONDUCT RESEARCH FOR MR. JJ. SIBANYONI: NATIONAL SCHOOL NUTRITION PROGRAMME-PhD

education
DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

Private Bag X 11341
Nelspruit 1200
Government Boulevard
Riverside Park
Building 5
Mpumalanga Province
Republic of South Africa

Litiko leTemfundvo Umnyango weFundo Departement van Onderwys Umnyango wezeMfundo
Enquiries: H.A. Baloyi (013) 766 5476

MR. JJ. SIBANYONI
UNIVERSITY OF SOUTH AFRICA
P.O. UNISA
PRETORIA
0001

RE: APPLICATION TO CONDUCT RESEARCH: MR. JJ. SIBANYONI-UNISA

Your application to conduct research was received it is therefore acknowledged. Your request is approved subject to you observing the content of the departmental research manual which is attached. You are required to discuss with the principals of the sampled schools regarding the approach to your observation and data collection as no disruption of tuition will be allowed. You are also requested to adhere to research ethics as spelt out in your research ethics document.

In terms of the attached manual (2.2. bullet number 4 & 6) data or any research activity can only be conducted after school hours as per appointment. You are also requested to share your findings with the relevant sections of the department so that we may consider implementing your findings if that will be in the best interest of department.

For more information kindly liaise with the department's research unit @ 013 766 5476 or a.baloyi@education.mpu.gov.za. The department wishes you well in this important project and pledges to give you the necessary support you may need.

MPUMALANGA
A Pioneering Spirit

Sisonke Sifundzisa Sive

APPROVAL TO CONDUCT RESEARCH FOR MR. JJ. SIBANYONI: NATIONAL SCHOOL NUTRITION PROGRAMME-PhD

APPROVED/~~NOT APPROVED~~:

MRS MOC MHLABANE
HEAD OF DEPARTMENT
2,10,14
DATE

Sisonke Sifundzisa Sive

MPUMALANGA
A Pioneering Spirit

APPENDIX F: ETHICS APPROVAL LETTER

UNISA university of south africa

CAES RESEARCH ETHICS REVIEW COMMITTEE

Date: 25/02/2015

Ref #: **2015/CAES/018**
Name of applicant: **Mr JJ Sibanyoni**
Student #: **55765254**

Dear Mr Sibanyoni,

Decision: Ethics Approval

Proposal: Food safety and quality assurance measures of the National School Nutrition Programme in Mpumalanga Province, South Africa

Supervisor: Dr FT Tabit

Qualification: Postgraduate degree

Thank you for the application for research ethics clearance by the CAES Research Ethics Review Committee for the above mentioned research. Final approval is granted for the duration of the project.

Please consider points 4 to 8 below for further action.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the CAES Research Ethics Review Committee on 25 February 2015.

The proposed research may now commence with the proviso that:

1) *The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
2) *Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the CAES Research Ethics Review Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.*
3) *The researcher will ensure that the research project adheres to any applicable*

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national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study.

4) *The application contains contradictory information on the number of schools that will be included in the study. This must be clarified to the Committee.*
5) *The permission letter from the Department of Education stipulates that the research may not disrupt tuition at the schools, and that the research activities must take place after school hours. The researcher is requested to adhere to these stipulations.*
6) *Once the schools that will be included have been identified, the researcher must obtain a permission letter from each school and submit these to the Committee as they are obtained.*
7) *The application contains contradictory information on whether any photographs will be taken as part of the study. This must be clarified to the Committee*
8) *Should serious cases of contamination of food be found, the researcher must inform the Department of Education accordingly, and it will be the Department's responsibility to take action. The researcher must therefore have a coding system in place for the schools so that samples can be traced to a specific school should this be necessary. However, the researcher must take care that this information is held secure, and that the confidentiality and anonymity of the participating schools are not compromised.*

Note:
The reference number [top right corner of this communiqué] should be clearly indicated on all forms of communication [e.g. Webmail, E-mail messages, letters] with the intended research participants, as well as with the CAES RERC.

Kind regards,

Signature
CAES RERC Chair: Prof EL Kempen

Signature
CAES Executive Dean: Prof MJ Linington

Please note condition

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APPENDIX G: PUBLISHED RESEARCH PAPER 1

J Community Health
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ORIGINAL PAPER

Assessing the Food Safety Attitudes and Awareness of Managers of School Feeding Programmes in Mpumalanga, South Africa

J. J. Sibanyoni[1] · F. T. Tabit[1]

Abstract The managers of school feeding programmes are responsible for ensuring the safety of the food which is provided to schoolchildren, but very few studies have been conducted on the food safety knowledge and awareness of these managers. The objective of this study is to evaluate the food safety attitudes and awareness of managers of the National School Nutrition Programme (NSNP) in schools in Mpumalanga, a province of South Africa. A cross-sectional survey study was conducted in which questionnaires were used to collect data from 300 NSNP food service managers. The majority of schools offering NSNP meals were located in informal settlements and most were found to lack basic resources such as electricity (power supplies to the food preparation facility) and potable tap water in their kitchens. No school was found to have implemented the hazard analysis and critical control points (HACCP) programme, and only a few staff had received food safety training. Food safety implementation is worst in informal schools in rural areas due to limited resources and infrastructure. The NSNP food service managers in some schools—especially those located in rural settlements—were found to have little knowledge and awareness of HACCP. These results indicate an urgent need to provide NSNP managers with food safety training and resources (potable water supplies, electricity, dedicated food preparation facilities), particularly in schools in rural settlements.

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Keywords Food safety · Attitude · Awareness · Managers · School feeding programme

Introduction

School feeding programmes are powerful instruments that seek to alleviate short-term hunger and improve nutrition and the cognitive abilities of school children by providing free meals in schools [1–3]. A positive correlation has been found between the academic performance of school children and the provision of free school meals in schools located in poor communities [4]. Endemic poverty in many communities in developing countries has necessitated the implementation of school feeding programmes [2, 5]. The implementation of food safety measures in school feeding programmes is important, considering that many schoolchildren are deemed vulnerable due to their weaker immune systems, when compared to healthy adults [6–8]. Foodborne disease outbreaks are becoming a frequent occurrence in school settings [9] due to a lack of adequate infrastructure as well as inadequate food safety knowledge on the part of employees of school feeding programmes [10, 11].

Foodborne disease outbreaks in school feeding programmes can be caused by inadequate food preparation and food storage facilities in food preparation establishments which do not meet hygiene standards [12]. The absence of prerequisite programmes such as production control, raw material control, pest control, good manufacturing practices (GMP), good hygiene practices (GHP) together with the absence of standard food safety programmes such as hazard analysis and critical control points (HACCP) in most food preparation facilities at schools constitute a food safety concern [13].

APPENDIX H: PUBLISHED RESEARCH PAPER 2

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Food safety knowledge and awareness of food handlers in school feeding programmes in Mpumalanga, South Africa

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ABSTRACT

Food handlers working in school feeding programmes can play an important role in the prevention of outbreaks of foodborne diseases in schools. This research aims to investigate the food safety knowledge and awareness of food handlers working for the National School Nutrition Programme (NSNP), Mpumalanga, South Africa. A cross-sectional, quantitative research method was used and food handlers were interviewed using a structured questionnaire. A total of 440 food handlers from 147 randomly selected public schools participated in this survey. The vast majority (98.9%) of the respondents were females of 36 years and older with a high school education. Up to 91.4% of NSNP food preparation facilities did not have a hazard analysis and critical control points (HACCP) programme in place and about 93.2% of food handlers did not know about HACCP. Up to 60% of food handlers did not know the correct procedure for washing a cutting board after it had been used. In addition, 95.5% of the food handlers had never sanitized utensils and cutting surfaces after cutting up raw meat. Most food handlers of the NSNP are lacking in knowledge, awareness and attitude on many important aspects of microbial food safety hazards.

1. Introduction

The inadequate food safety knowledge and skills of food handlers can result in unsafe food handling practices and cross-contamination in food service establishments (McGill, Fulgoni, & Devareddy, 2015; Rahman, Arif, Bakar, & Tambi, 2012). Previous studies have revealed that some food handlers in many food service establishments often lack basic food safety knowledge when it comes to temperature control, personal hygiene and the prevention of cross-contamination (Afolaranmi, Hassan, Bello, & Misari, 2015; Jianu & Chis, 2012; Martins, Hogg, & Otero, 2012). The urgency of the matter is stressed by the findings of the World Health Organisation (WHO) that human actions are the leading cause of food contamination during food preparation in food service establishments as a result of non-adherence to good hygiene practices (WHO, 2013).

Ensuring the safe handling of food in school feeding programmes remains a big challenge in many countries, considering that many of these school feeding schemes are often regarded as poverty and hunger alleviation initiatives (Jomaa, McDonnell, & Probart, 2011; WHO/FAO, 2010). Furthermore, the available resources of most schools involved in school feeding programmes are sometimes inadequate to support the proper implementation of food safety systems (Bas, Ersun & Kivanç, 2006; Fotopoulos, Kafetzopoulos, & Gotzamani, 2011; WFP, 2012). Food safety assurance in food service establishments depends heavily on the availability of adequate infrastructure, appropriate management support and commitment, as well as knowledgeable and skilled food handlers (Rendall-Mkosi, Wenhold, & Sibanda, 2013).

Outbreaks of many foodborne diseases are due to contamination that occurs during food preparation within food service establishments (Smigic et al., 2016). Cases of food poisoning are prevalent in schools as a result of cross-contamination during food preparation (Sanlier & Konaklioglu, 2012). The outbreaks of foodborne diseases in school feeding programmes can result in life-threatening diseases, huge medical costs and the spread of infection to other children and staff, thereby leading to disruption of learning in schools (Scharff, 2012).

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APPENDIX I: SIMILARITY INDEX (TURN-IT-IN REPORT)

Turnitin Originality Report

PhD Consumer Science thesis by Jj Sibanyoni

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