The influence of 2018 listeria outbreak on the nutrition quality and dietary patterns of Langa township

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ABSTRACT

Introduction: In South Africa, polony was identified as the source of listeriosis on the 4th of March 2018. Polony serves as a protein source for many poor households in South Africa. Protein is described as the expensive nutrient of any diet but a necessity for human consumption as essential amino acids, the building blocks of protein, cannot be produced by the human body. To add, protein consumption is therefore often inadequate in developing countries as affordable sources are limited.

Aim: The primary aim of this study was to analyse the dietary intake data from 2186 adults aged 18-39 years in Langa to explore the possible differences in dietary intake (with a focus on protein intake and protein sources) pre-recall of polony and post-recall of polony from the shelves at all food retailers in South Africa during the 2018 outbreak of Listeriosis.

Methodology: This study followed a natural experiment (NE) method research design. This experiment was an observational study that made use of naturally occurring situations to provide answers to specific questions. As such, a secondary data analysis from a ROFE project was used. The ROFE project in Langa used standardized and validated 24-hour recall to explore the dietary intake of participants with ages 18 to 39 years.

The researcher made use of the South African Food Data System (SAFOODS) electronic database to assess the nutrient intake and the frequency of consumption. The researcher also explored propriety data from Euromonitor International to understand trends in cold meat sales before and during the listeriosis outbreak. For analysis, SPSS was used to outline food sources, frequency, range, and variations between the two groups. Lastly, the Chi-square test was utilized to assess differences between the groups with a p value of <0.05 as significance.

Regression was done to assess the impact of socioeconomic factors on differences in nutrient intake.

Findings: Even though there was a total recall of polony from the point of sale the consumption did not change by any significant margins after the recall of polony. The sales of meat, especially processed meat, dropped significantly after the recall of polony and the company involved in the outbreak lost over 25% of its market share as one of the direct consequences.

Conclusion: The Langa community is poor and living in unsatisfactory conditions. This study found that during the outbreak of listeria, this community was consuming a nutritionally inadequate diet. Even though there were participants who consumed polony in both the pre- and post-recall groups, intake was low, even before the withdrawal of polony from the point of sale.

KEY WORDS

Polony

Listeria

Listeriosis

Outbreak

Dietary patterns

Nutrient intake

Protein source

Processed meat

Sales

Ready-to-eat

Adults

Food security

DECLARATION

I, Sikhumbule Kagiso Joni, student number: 3881332, hereby declare that this dissertation with title “The influence of 2018 listeria outbreak on the nutrition quality and dietary patterns of Langa township” is my very own independent work and it has not been submitted for any degree, qualification or examination in any other university. All utilized sources have been acknowledged in a form of referencing.

SK. Joni

2023

DEDICATION

This thesis is dedicated to my mother, Bukelwa Joni, and my late cousin Lelethu Stemele. This is also dedicated to all the families that lost their loved ones to the 2018 Listeria outbreak.

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ACRONYMS AND ABBREVIATIONS

DAFF	Department of Agriculture, Forestry and Fisheries
DDS	Dietary Diversity Score
DoH	Department of Health
DRI	Dietary Reference Intake
DTI	Department of Trade and Industry
FSMS	Food Safety Management Systems
HACCP	Hazard Analysis Critical Control Points
ISO	International Organization for Standardization
NCDs	Non-Communicable Diseases
NICD	National Institute of Communicable Diseases
RTE	Ready-To-Eat
SADC	Southern African Democratic Countries
VAT	Value-added Tax

DEFINITION OF TERMS

Food Handler: any individual who directly prepares food by handling packed or unpacked food in a food establishment or any institution for the purpose of serving other person(s) (DoH, 2012)

Food safety: The assurance that food will not cause any sort of harm to the consume during the preparation and/or during the consumption or its otherwise its intended usage (DoH, 2010)

Health hazard: This includes any condition, object or act that may contaminate or cause spoilage of food deeming its consumption to be dangerous or detrimental to human health (DoH, 2012).

Contamination: This is a state or action of making the food impure by physically, chemically or biologically polluting or poisoning it.

Foodborne Outbreak: When two or more consumers get the same illness after consuming the same contaminated food or drink

Ready-to-eat: These are perishable foods that can be eaten without doing any further processing, like cooking, before consumption

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CHAPTER 1

ORIENTATION OF THE STUDY

1.1 Introduction and background

Listeriosis is a life-threatening foodborne disease with a mortality rate of 20% to 30% and mainly affects persons with compromised immunity systems, pregnant women, the elderly and persons living with chronic diseases (Thomas et al., 2020). The Center for Health Protection asserts that listeriosis is a global public health concern due to its outbreak occurrence throughout the world (Center for Health Protection, 2010). Globally, one in ten people is infected with food borne illness as a direct consequence of pathogenic contaminants (Riggio et al., 2019), with 90% of the foodborne diseases accounted for by listeria, salmonella, norovirus, E. coli, Campylobacter, Toxoplasma and Clostridium perfringens (Scallan et al., 2011).

Europe and United States of America (USA) reportedly had the largest of foodborne infection outbreaks in the world caused by listeria and other pathogens between 1991-2002. In Europe, countries such as England, Wales, Denmark, Belgium, Germany, Holland, Switzerland, and Finland also reported increases in the occurrence of listeriosis between 2000-2006 (Välimaa et al., 2015). The African continent often experiences sporadic listeriosis cases from different sources such as animals, environmental sources, and foods in countries such as Nigeria, Ethiopia, Egypt, Botswana, and South Africa (Dufailu et al., 2021). In South Africa, the first report of listeriosis occurred between 1977 and 1978 with only 14 cases in Johannesburg (Manganye et al., 2018). Since then there have been no alarming occurrences reported in South Africa. However, from July 2017 to March 2018 South Africa had the largest reported listeriosis outbreak in the world with the highest number of cases and fatalities ever reported globally during an outbreak before (Dufailu et al., 2021). These cases raised concerns after two

hospitals in Gauteng province reported an increase in the number of patients with listeriosis between July and August 2017 (Thomas et al., 2020). In total, there were 1060 laboratory-confirmed cases and 216 deaths reported from the 1st January 2017 to 17 July 2018. The Gauteng province had the largest percentage (57.9%) of reported cases followed by Western Cape and Kwa-Zulu Natal with 12.8% and 7.8% respectively (National Listeria Incident Management Team, 2018). The outbreak was attributed to two food-producing facilities namely Enterprise Foods in Polokwane and Germiston, and Rainbow chicken facility in the Free-State Province. The listeria strain responsible was ST6 found in polony products. The then Minister of Health, Dr Motsoaledi, issued a directive on the 04 of March 2018 for these producers to recall all their polony and other cold meats such as Vienna's, Russians, and Frankfurters as a proactive measure against possible contamination (Department of Health, 2018).

It is worth noting, in South Africa, listeria surveillance was not mandated by law to be observed by meat and meat-product producers until the 2017-2018 outbreak. Thereafter, the National Department of Health (NDoH) mandated producers to monitor and surveillance this pathogen through food safety management systems (Thomas et al., 2020).

Food recalls are costly and these costs can be imposed even on uninvolved parties such as producers or products retailers when the actual source has not been identified (Peake et al., 2014). In the USA, the impact of Listeria on ready-to-eat (RTE) foods is significant even in small outbreaks. This costs the USA approximately 2 billion dollars a year and also contributes as the 3rd highest cause of death in foodborne-related deaths. It is estimated to be 1.27 to 1.28 million United States Dollars (USD) per individual case (Ryu et al., 2013). In 2008, Canada experienced a listeriosis outbreak with 57 cases and 24 deaths, and the total cost of this outbreak was estimated at 241,702,723 USD, averaging over 4.2 million USD per case (Thomas et al., 2015).

Besides financial implications, food recalls affect consumers' purchasing and consumption behaviour. In the case of an outbreak, consumers tend to have less trust in food system safety and therefore broad consumption changes are adopted by avoiding the affected recalled foods even though this may include foods that may not be contaminated. It is somewhat difficult for consumers to identify the single actor responsible and so they elect to blame the whole food category or the entire food chain, and this may result in changing food consumption pattern behaviours by reducing the amount of the affected food or changing their overall purchasing behaviour (Charlebois et al., 2015). However, some consumers continue to consume recalled foods with the belief that the food will not harm nor affect their well-being (Peake et al., 2014).

1.2 Problem Statement

Food security is a state in which all persons; at any given time have physical and economical means to access adequate, safe, and nutritious foodstuff that caters to their food preferences and dietary needs to sustain a healthy life. Food security has several pillars which include; food availability, food accessibility, food dissemination, food utilization, and sustainability. When any of these four pillars are not met then food security is compromised (Koch, 2011).

The pillar of food availability includes reliable access to adequate food supply that is safe and nutritious. The world population is expected to reach 9 billion by 2050 and as such the food supply must meet demands to ensure global food security. However, that cannot be achieved without global food safety (King et al., 2017). Food safety is an important aspect of food security (Curtis & Halford, 2014).

A great deal of research has been conducted on general food safety and costs concerning food recalls however less is known about how consumers adjust their dietary consumption behaviour during food recalls (Peake et al., 2014), and if these changes have any impact on food and nutrition security. Studies have examined economic costs suffered by companies and

government as the results of the 2017-2018 South Africa listeria outbreak, however there have not been studies looking at the dietary quality during or post the listeria outbreak and if the outbreaks affected dietary quality negatively or positively. When dietary changes are unplanned and somewhat forced due to consumer concerns, the nutritional quality of the diet may also be affected and this may influence food and nutrition security negatively or positively.

1.3 Aim and objectives of the study

1.3.1 Aim of the study

This study aimed to assess the effect of the 2018 listeria outbreak in South Africa (and subsequent removal of all polony products from supermarket shelves) on the dietary patterns and nutrient quality of the Langa community in Cape Town

1.3.2 Research objectives

To realize the aim of this research, the following questions were formulated and probed

- To describe the range and frequency of consumption of specific food products by participants pre-recall and post-recall of polony during the listeria outbreak;
- To describe the nutritional intake of participants before the listeria outbreak and during the listeria outbreak's subsequent removal of polony from shelves in supermarkets;
- To assess the primary sources of specific nutrients (with a focus on protein sources) consumed by participants pre-recall and post-recall of polony during the listeria outbreak;
- To explore the sales figures of meat and meat products from 2015 to 2019 to understand if the patterns observed in the Langa community are similar to national trends.

1.4 Research questions

This study was formulated to answer the following research questions:

- What is the nutritional quality of the diet of the pre-recall and post-recall groups of study participants in Langa?
- Were there any differences in the nutritional quality (individual nutrient intake and dietary diversity) of the diet between the two groups (pre-recall and post-recall) from Langa township?
- What were the foods consumed by the two groups (pre-recall and post-recall) and were there any differences observed in the types of foods consumed by the groups of Langa township?
- What were the sources of protein for the pre-recall and post-recall groups, and was there any difference in polony consumption between the two groups?
- What were the national sales of processed meats three years before the listeria outbreak and the two years after?
- What was the market share distribution of meat and meat products between major companies in South Africa from 2016 to 2019?

1.5 Rationale of the study

The study's significance lies in understanding the impact of food safety with regards to food and nutrition security. The study will help understand the depth of use of cold meats, particularly polony products, in the Langa township thus contributing to our understanding of the food and nutrient diversity of the community, specifically around protein sources. This information can help a greater understanding of consumer behaviour and dietary adaptation techniques in low-income settings when foods are recalled. It may also inform the development of appropriate nutrition education and information on food sources and alternatives.

1.6 Scope and limitations of the study

A natural experiment study does not seek and cannot seek to determine the cause but only to explore the effects of the event, and as such this study's scope does not include the cause of the listeria outbreak. Furthermore, the findings of this study cannot be generalized to the whole population of South Africa.

1.7 Outline of the thesis

Chapter 1 outlines the study background, purpose, aim, and objectives. Chapter 2 discusses available literature on the relevant subject subsequently chapter 3 details the methodology employed in the study to meet the objectives. Furthermore, chapter 4 furnishes the findings of the research study. Lastly, chapter 5 discusses the findings within the context of similar existing studies, draws conclusions, and presents recommendations for future research.

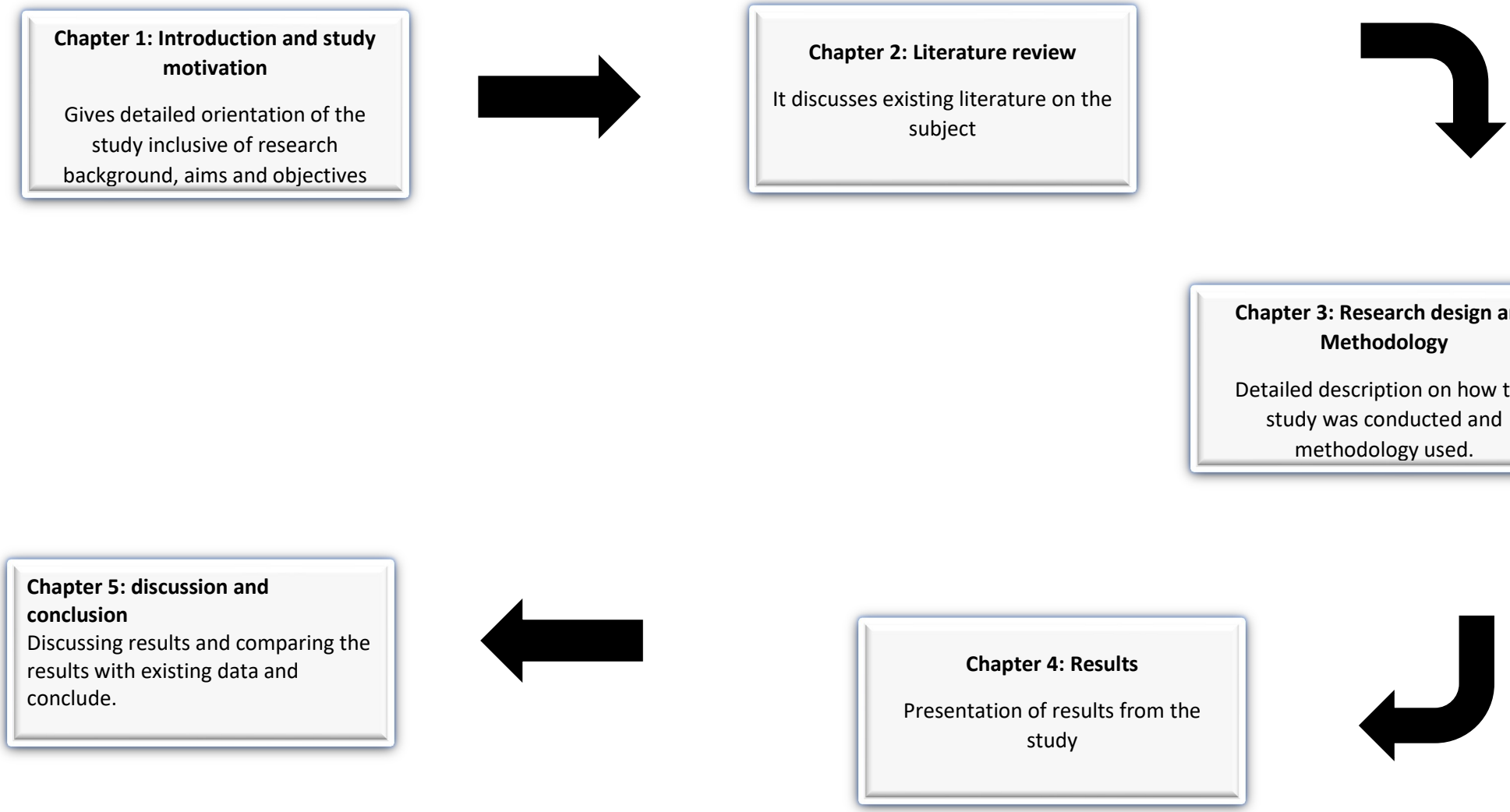


Figure 1.1: Depiction of the outline of the full thesis

1.8 Conclusion

This chapter has focused on the orientation of the research in its entirety. These entailed the research problem, the purpose of the study, and its objectives. The following chapter in this thesis will detail different themes of the study in the form of a literature review.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews available literature related to this study and therefore focuses on (i) detailing SA's socioeconomic profile, (ii) global and local listeria outbreaks (iii) hygiene practices by food handlers and the public, (iv), food production and food safety management systems used, (v) dietary and nutritional pattern influencers and lastly (vi) food security factors and indicators.

2.2 South African Population

2.2.1 Socio economic profile

The South African population grew from 52 million to 62 million between 2011 and 2022 (Statistics South Africa, 2023a). In that same period, the proportion of the population living under the food poverty line grew from 21.4% to 25.2% even though there had been a decrease of 12.1% from 2009 to 2011 (Statistics South Africa, 2023b). Furthermore, South Africa has 17.8 million households. Just over one in ten households (12.7%) of those households are in the Western Cape and only 12% of South African adults have post-school qualifications. Lastly, 8.7% of households do not have access to piped water and 94% have electricity (Statistics South Africa, 2023a)

2.2.2 Nutritional transition patterns in South Africa

There has been a nutritional transition influenced by urbanization and globalization amongst other factors. As such, a traditional diet is lost due to urban exposure, and a western diet is adopted (Bourne et al., 2002; Daran et al., 2023). This nutritional transition has also influenced

the Sub-Saharan countries to shift towards increased consumption of highly processed carbohydrates, oils, and animal-based foods (Popkin, 2015). Additionally, sugar and sweeteners consumption are also increasing in developing countries while whole grain cereals, fruit, and vegetable consumption is still insufficient. As such, overweight, obesity, and non-communicable diseases (NCDs) including other health problems are becoming prominent to the general population (Hawkes, 2006; Nel & Steyn, 2022; Popkin, 2015). South Africans are increasingly accessing Western diets, and this has largely been influenced by 'Big Food'a term used to describe large commercial producers of food and beverage products (Igumbor et al., 2012).

2.2.3 Protein consumption

There has been an emphasis on the significance of diet and lifestyle including sufficient intake of fruits and vegetables to prevent NCDs and maintain good well-being (Okop et al., 2019). All macro and micronutrients are important to be acquired from a diet and protein is described as the expensive nutrient of any diet but a necessity for human consumption (Schönfeldt & Hall, 2012). This protein is obtained from two sources, namely, animal and plant sources. Literature highlights that protein consumption is inadequate compared to the required amounts and the availability of protein in developing countries is limited (Schönfeldt & Hall, 2012).

Animal protein is a protein obtained from dairy products, meat, fish, eggs, and dishes made of animal by-products. Dairy products include milk, yogurt, coffee creamers, cheese, and more (Altorf-Van Der Kuil et al., 2012). Furthermore, animal-based protein sources contain the highest amount of protein per energy thus its quality is regarded as excellent (Layman, 2010). Processed meats such as polony, sausages, and Vienna's are the cheapest animal-sourced protein and may be preferred by poor communities however they are lower in nutrient density (Madlala et al., 2023) as their fat content is high.

Plant-based protein is a protein derived from plants such as cereals, nuts, and legumes. In addition, plant-based protein is incomplete in some amino acids. However, they consist of non-nutrients that bind and facilitate the metabolism of protein (Schönfeldt and Hall, 2012). Table 2.1 depicts commonly consumed protein-rich foods and the average protein per 100g of consumption by adults in South Africa.

Table 2.1: Average protein obtained from commonly consumed protein-rich foods by adults

Foods (commonly consumed)	**Protein (g/100g of food)**
Animal foods	
Milk	5.1
Meat	22.1
Egg	12.6
Fish	15.3
Plant foods	
Cereals	2.7-11.7
Nuts & seeds.	2- 21.4
Legumes	4.4 – 17.2

(source: MRC Food Composition Table)

Scholtz, Vorster, and Matsego (2001) highlight that South Africa's red meat consumption was declining at some point along with the world while there's an observed increase in white meat and protein derived from it (Scholtz et al., 2001). However, based on Euromonitor from 2005 to 2019 beef and veal consumption had increased from 14.6 to 19.1 per capita consumption while poultry increased from 22.2 to 27.3 per capita (Swart and Sambu, 2022). Furthermore, South Africa has a relatively high population living in poverty. As such, food prices force them to nutritionally inadequate foods even though healthy alternatives are available but they are expensive (Temple et al., 2011). In South Africa, dietary diversity is still significantly lower than the recommended levels such that when none-nutritive foods are excluded dietary diversity score becomes five or less (Frayne et al., 2009; Swart & Sambu, 2022). Therefore, with red meat being already identified as an expensive source of protein, white meat may be a

less-expensive alternative in particular for low-income communities as this is vital for complete protein consumption and improving dietary diversity.

2.2.4 Diseases and outbreaks

National Institute of Communicable Diseases (NCID) states that in South Africa, the first reported case of listeriosis outbreak occurred between 1977 and 1978 with only 14 cases in Johannesburg. Since then, there have been no alarming occurrences (National Institute for Communicable Diseases, 2016). However, from June 11th, 2017, to 7th April 2018 South Africa reportedly had the largest listeriosis outbreak in the world with a high number of cases and fatalities (Thomas et al., 2020). South African government reported that there were 1060 confirmed cases reported with 216 confirmed deaths of those infected between 01 January 2017 and 17 July 2018 (National Listeria Incident Management Team, 2018). The then South Africa's Minister of Health publicly informed South Africa on 04th March 2018 that the source of the listeriosis outbreak was three polony-producing factories, namely Enterprise factories in Polokwane and Germiston, and RCL Food Rainbow factory near Sasolburg (National Listeria Incident Management Team, 2018; SA Board of Personnel Practices (SABPP), 2018).

2.3 Factors contributing to pathogen outbreaks.

Hygiene is defined as the use of sanitary principles to preserve health and thus personal hygiene refers to an individual's cleanliness including body, teeth and hair (Marriott & Gravani, 2006). Food hygiene is intended to ensure food safety by ensuring that food is free of physical, chemical, microbiological, and allergen contamination (Foodstuffs, Cosmetics and Disinfectant Act, 1972 (Act 54 of 1972), 2012). Some foods are considered to be high-risk and more susceptible to contamination. These foods include animal products (milk and meat), fruits, and vegetables. These contaminated products can cause adverse effects when consumed, such as purging, severe pain, and even mortality (Tomaszewska et al., 2018). In food production, good hygiene practices start at receiving raw ingredients since such ingredients

could be a source of contamination from outside. Hygiene practices should continue through the processing, storage, and transportation of finished products until consumption (Foodstuffs, Cosmetics and Disinfectant Act, 1972 (Act 54 of 1972), 2012). Although hygiene is incorporated in food safety systems, there has been an increase in some cases of food poisoning and food-borne related outbreaks such as salmonella, listeria, and Escherichia Coli (E. coli) (Tam et al., 2014).

Food handlers include persons that are street vendors, hospital caterers, hotels, restaurants, and food producers. Food handlers are responsible for most food contaminations through their hands, breath, hair, and natural occurrences such as coughing and sneezing (Marriott & Gravani, 2006). In addition, pathogen growth is the most observed hazard attributed to food handlers (Mariana et al., 2018). Food handlers may transfer pathogens from a contaminated source, and this could be another food product, organisms infested area, poor sanitation, or even chemical agents (Bas, Ersun and Kivanc, 2006). Food handlers should be well informed about food safety protocols, however, over 93% of food services staff from the National School Nutrition Program (NSNP) in South Africa have never heard of Hazard Analysis and Critical Control Points (HACCP) even though 69.8% have been given some form of in-service training for safe food handling (Sibanyoni et al., 2017). Furthermore, this study found that only 52% of schools have a permanent kitchen while 9.8% and 5.5% are preparing food in an open area and classrooms respectively (Sibanyoni, 2017). This therefore means many school children are at risk of consuming foods that may be contaminated from the source of air, and or the surfaces used to prepare the food. Researchers from Brazil found similar inadequacy of public schools' facilities and equipment in their national school nutrition programme due to old structures, use of adapted spaces, and lack of public investments. A training intervention improved average good hygiene practices (hand hygiene, temperature control, etc) in the Brazil school nutrition programme by 10 percentage points (Martins Rodrigues et al., 2020) All food producers need

to comply with legislation even if the intent is not to sell but so long the prepared food is designated for human consumption. In the USA, food handlers of school nutrition program indicated that food safety was not their main concern and thus had challenges such as equipment to maintain prepared foods in desirable temperatures during transportation or services (Beckstead et al., 2022). In comparison, Fleetwood et al (2019) found that 94% of food-producing premises in the UK are broadly compliant with UK laws (Fleetwood et al., 2019). Similarly, in Vietnam education and training were identified as having a significant impact on achieving food safety compliance, and proper infrastructure such as clean water and sanitation, including waste management equipment is also a necessity (Huynh-Van et al., 2022).

South Africa has a considerable number of food street vendors and most of the time these foods are sold under improper hygienic conditions (Kubheka et al., 2001). Food safety of street foods can be affected by numerous factors such as the quality of raw ingredients, preparation area and condition, handling technique, storage condition and the overall business in a location that does not meet requirements or even regulated and monitored by the environmental practitioners and these foods pose high risk of contamination thus consequentially a health hazard (Asiegbu et al., 2016). In addition, a large number of street vendors have little to no knowledge of food safety and this can lead to unsafe foods sold to consumers (Nkosi and Tabit, 2021). However, the risk of foodborne outbreaks from street vendors may arguably be very low given the short value chain from food preparation to consumption.

The Food Safety Authority of Ireland states that a food facility and its design are of importance for ease of processing and thus minimizing chances of pathogen growth or cross contamination (Food Safety Authority of Ireland, 2005). According to South African law a business premise that produces or handles food needs to meet requirements which include furnishing walls, ceilings, or roofs with no open seams, toxins, rust, or absorbent material. Both vertical and

horizontal surfaces must be smooth and water resistant (Foodstuffs, Cosmetics and Disinfectant Act, 1972 (Act 54 of 1972), 2012). Each room of a facility must have ventilation either natural or artificial. In the case of natural ventilation, each room needs to have openings leading to outside air. The main purpose is to refresh and reduce polluted air (Food Safety Authority of Ireland, 2005) thus the drainage system of the facility should be thoroughly maintained to reduce any type of infestation. To add, the lighting of the facility must be away from the preparation sites so as not to attract insects (Foodstuffs, Cosmetics and Disinfectant Act, 1972 (Act 54 of 1972), 2012).

Food can be contaminated or cross-contaminated by the equipment used during processing and this happens even to equipment built with hygienic design as the equipment may contact pathogens from the air, the operator itself, or from the debris of other foods previously processed (Marriott & Gravani, 2006). As such, the equipment requires consistent monitoring and maintenance. Griffith agrees that equipment including processing machines are a typical problem area for food processors and therefore thorough cleaning is essential to minimize microbial growth (Griffith, 2016).

2.3.1 Listeria monocytogenes

Listeria monocytogenes is a listeria genus species that is characterized as virulent and haemolytic to human hosts. This is caused by a gram-positive, rod-shaped bacterium found in water, soil, and contaminated foods (National Institute for Communicable Diseases, 2016). This bacterium can contaminate raw and processed foods, particularly in ready-to-eat (RTE) foods (Ryu et al., 2013). Listeria monocytogenes grow and multiply in these foods because they are consumed without further heating thus these low temperatures create desirable living conditions for the pathogen (Välimaa et al., 2015). Lastly, infected persons may have mild to severe symptoms and may have consequences such as meningitis, septicaemia, abortion for

those pregnant, or death for those with compromised immune systems (National Institute for Communicable Diseases, 2016).

2.3.2 Surveillance and monitoring

In South Africa, listeriosis was not under surveillance before the outbreak, and food manufacturers were not forced to check any possible existence of this pathogen in their productions (Thomas et al., 2020). Even though South Africa has advanced food management systems which meet international standards the recent listeriosis outbreak showed that there are still limitations in its policies and bylaws (Tchatchouang et al., 2020). This has prompted the government to revise its local food safety management systems through certification of HACCP system, and making it a legal requirement for RTE producers to use microbiologic criteria to safeguard against *L*.monocytogenes (Thomas, 2020:641).

Food safety management systems (FSMS) are systems in place to ensure and maintain the safety of foods. Safety of food is the concept that food will not harm the consumer during preparation or consumption (Abu Al-Rub & Shibhab, 2020). Furthermore, the more developed the FSMS is, the more improved the compliance is in terms of food safety practices (Liggans et al., 2019). To add, safe food is food free of biological, physical, and chemical contaminants that could cause illness and in other cases free of allergies which could cause an allergic reaction or even fatality. It is, therefore, a requirement for food producers and sellers to have food safety systems in place to minimize any of these contaminants in foods that may pose a health hazard, and systems such as Hazard Analysis Critical Control Point (HACCP) and ISO22000 are the commonly accepted systems (Abu Al-Rub & Shibhab, 2020; Foodstuffs, Cosmetics, and Disinfectant Act, 1972 (Act 54 of 1972), 2012). The development, implementation, and maintenance of these systems vary from establishment to another as they

are specifically created around the facility, employees, and nature of products produced to name a few (Foodstuffs, Cosmetics and Disinfectant Act, 1972 (ACT 54 of 1972), 2012).

Hazard Analysis Critical Control Point is a globally accepted food safety management system that provides guidelines for food manufacturers and pharmaceutical facilities on food safety procedures. The HACCP system is designed for controlling and monitoring food safety during production processes and thus seeks to reduce operation costs by decreasing the number of microbial analyses to be done (Abu Al-Rub and Shibhab, 2020). An assessment is made under all four hazard categories namely allergy, biological, physical, and chemical; detailing its depth, likeliness of occurrence, and probable health issues. Using this information, detailed research into company history, customer complaints, and sufficient specifications should provide needed evidence in determining and forecasting hazards in all stages of production thus providing solutions to such. For a hazard to be viewed as significant, it must score a 4 and above using a predetermined criterion (Mariana et al., 2018).

In South Africa, no owner of a food business may operate and handle food without application of a valid HACCP system and its certification (Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972) HACCP), 2002). There is an increase in several food and pharmaceutical manufacturers adopting and implementing HACCP and other systems. However, even though there is an increase in HACCP application there are still incidences of foodborne outbreaks. The inadequacy of depth of understanding and lack of extensive training in the implementation of HACCP is observed to be the main cause of these contaminations (Kharub, 2018).

In a study about the use of HACCP audits on mass catering in a university canteen for over 4 years (2013 to 2016), the results concluded that in each year there was always an inadequacy in the application of good hygiene on one of the many process areas (Osimani et al., 2018). Since cross-contamination is a major cause of foodborne illness, it is suggested that during

mass catering there is high incidences of cross-contamination. As such, (Törmä and Lundén, 2019) argue that food business operators (FBOs) opinions of own-check programs often oppose HACCP guidelines, and that alone may be a contributor to inadequate application. The presence of pathogens continues to highlight that relevant education and training, and a long working experience on food safety prerequisite programs do have a significance in increasing food safety practices. This includes correct storage of raw materials and already processed food, cleanliness, and good personal hygiene (Törmä and Lundén, 2019).

2.3.3 Economic consequences of outbreaks

In the USA, the impact of Listeria on RTE foods is significant even in small outbreaks. This costs the USA approximately 2 billion USD a year and contributes to the 3rd highest cause of death in foodborne-related deaths. It is estimated to be 1.27 to 1.28 million in United States Dollars (USD) per individual case (Hoffmann et al., 2012; Hoffmann and Ahn, 2021). In 2002, the USA's second-largest poultry manufacturer had to recall around 13000 metric tons of RTE foods from retailers and that was the largest USA meat recall in the history of the USA (Food Safety Authority of Ireland, 2005). In South Africa, the economic costs of the 2017-2018 listeria outbreak were USD 260 million, USD 10.4 million, and USD 15 million for fatality cost evaluation, hospitalization, and production costs lost respectively (Olanya et al., 2019; Tchatchouang et al., 2020).

2.4 Nutritional status and dietary patterns of the South African population

There is a relationship between diet and health, and this relationship is characterized by food and food components that have nutrients that consequentially affect one’s health positively or negatively. Numerous studies on adults have investigated dietary patterns and their association with socio-demographic factors such as lifestyle, education, and physical activity (Mumme et al, 2020). Many factors influence these dietary patterns including outbreaks such as listeria

outbreaks, as well as demographic and epidemiologic transitions (Tapsell et al., 2016). When food cultures are disturbed, new food norms are formed, that changes dietary patterns and nutritional intake (Hough & Sosa, 2015).

2.4.1 Food security

The constitution of the Republic of South Africa states that every citizen has the right to have access to sufficient food and water and the State has a duty by legislation to provide this within its resources to ensure sufficient food (Department of Agriculture Forestry and Fisheries, 2014). Food security at a national level refers to a country's ability to produce, import, and sustain enough food to meet minimum per capita consumption while at the household level, it refers to the availability of food and the ability of the household to access it (Du Toit et al., 2011). Food insecurity can cause malnutrition (including undernutrition, nutrient deficiencies or obesity) as a result of poverty. Coping mechanisms of food insecure households sometimes cause low dietary diversity and consumption of low-quality diets (Rezaul Karim & Tasnim, 2022).

South Africa is deemed food secured at the national level (Du Toit et al., 2011; Swart & Sambu, 2022) however the country has high and increasing unemployment and poverty and therefore about 15% and 6% of households have inadequate and severe inadequate access to food respectively (Stats SA, 2023c). Additionally, 28% South African households in cities, and specifically in informal settlements, have a risk of experiencing hunger and 26% are already experiencing hunger (Mudau & Mahlatsi, 2022). In 2016, the provinces with high food insecurity included Free State, KwaZulu Natal, Eastern Cape, and Mpumalanga with 33.5%, 23%, 21.4%, and 21.5% respectively (Statistics South Africa, 2016). However, in 2021 the Northern Cape and North-West provinces were the provinces with the highest inadequate access to food (Stats SA, 2023c). Lastly, of all the metropolitan areas in South Africa, the City

of Cape Town and the City of Johannesburg reported the highest inadequate access to food however Mangaung and Buffalo City metros reported the highest severe inadequacy in accessing food (Stats SA, 2023c). In 2018 a quarter of South African households reported to have run out of money the previous year to purchase foodstuff (Statistics South Africa, 2018) while between 2015 and 2023 the food poverty line had increased by R319 (Figure 2.1).

Poverty line	2015-line values	2023-line values
Food poverty line (FPL)	R441.00	R760.00
Lower-bound poverty line (LBPL)	R647.00	R1 058.00
Upper-bound poverty line (UBPL)	R992.00	R1 558.00

Figure 2.1: Poverty lines and their Rand values between 2015 to 2023. (Source: Stats SA, 2023).

2.4.2 Factors affecting food security

Urbanization is defined as a population shift from rural to urban areas and create social, economic, and ecological changes (Poumanyvong et al., 2012). In addition, urbanization normally encompasses the economic development for households that moved from rural to urban settlements and this normally benefits the rural family left behind. In 2005 Southern African Development Community (SADC) countries had a combined population of 220 million people in urban and semi-urban settings while in 1990 it was 53.2 million (Crush & Frayne, 2011). The likewise rapid urbanization in South Africa resulted in unplanned urbanization which may have consequences such as loss of prime land for agricultural production (Ngcamu, 2022) which may affect food availability and affordability (Matuschke, 2009) consequently leading to poor health and poor nutritional status (Cohen & Garrett, 2010). The increase in urbanization also increases the number of people living in urban informal settlements and therefore the population that lacks access to infrastructure and economic means

(Mkhize & Sibanda, 2020). Crush and Frayne (2011) conclude that urbanization has made household agricultural practices less active while increasing purchasing as the primary means of acquiring foodstuff.

Wheeler and Braun (2013) highlight that the earth has been warming up for the last two centuries and humans are the main contributors to this phenomenon through the emission of greenhouse gases like carbon dioxide (CO2) (Wheeler & Braun, 2013). This phenomenon is termed climate change and is a direct problem in achieving food security through influence on food production outputs which subsequently influences prices (Hanjra & Qureshi, 2010; Islam & Wong, 2017). The climatic changes influence the eco-system and South Africa is not exempted from this as it affects water availability and subsequently affects household agriculture and agricultural commercial production (Dungelo, 2021).South Africa's annual greenhouse gas emission had decreased by 20% between 2009 and 2020 however the country is still warming at a rate of 2 degrees Celsius per century and this climate change has severe consequences on those living in poverty (Stats SA, 2023c). When food prices are rising faster than inflation it has dire consequences for household food security, particularly in poor communities (Crush & Frayne, 2011).

Ultra-processed foods are known to have a direct linkage to obesity and non-communicable diseases as these foods do not provide a nutritious balanced diet for a healthy life (Capone et al., 2016; Rasmussen et al., 2020). Shembe et al (2023) highlight that food security has been focusing on the availability, access, utilization, and stability of the food system however there has not been an adequate focus on the quality of the food (Shembe et al., 2023). The continuing increase in consumption of ultra-processed food has made many households' foods and nutrition insecure and therefore susceptible to NCDs (Shembe et al., 2023). Lastly, low micronutrient intakes are characterized by low fruit and vegetable intake as these are

substituted by the consumption of ultra-processed foods like sugar-sweetened beverages amongst others (Faber & Wenhold, 2016).

2.5 Conclusion

Foodborne outbreaks are increasing in the world and are a constant threat to life and nutritional status. Food safety management systems are implemented to safeguard against pathogens and any other contaminants but outbreaks are still prevalent. Food handlers are identified as the biggest contributors to foodborne outbreaks due to their carelessness in applying the prerequisite food hygiene practices. Foodborne outbreaks are not only a food safety issue, but also influence food availability and consequently nutritional and dietary diversity.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This chapter details and describes the research design and methodology used in this study to achieve the aims and objectives, of the study. These included dietary and nutritional assessments of the Langa (Cape Town, South Africa) residents and the sales of processed meats at a national level. This chapter discusses the data-collection methods, tools and analysis techniques employed in this study. For the success of this study, a thorough and precise planning was carried, selection of the correct research tools, and accurate analysis execution were followed. A research proposal (Appendix 8) was submitted to the Biomedical Research Ethics Committee of the University of the Western Cape and ethical approval was received.

3.2 Study design

A study design is defined as a specific plan or protocol for conducting a study. This allows the researcher to translate the conceptual hypothesis into a plan of action (Acharya et al., 2012). This plan is logical and stipulates how the study is to be carried out to answer the research questions through the data collected. Furthermore, it provides guidelines for a problem statement and plan on how to arrive to the study results. An appropriate study design is vital for any successful research particularly because it is the only tool to give valid answers to research questions.

This study makes use of a natural experiment design as an observational study. Secondary data from the Researching Obesogenic Food Environments (ROFE) study was analyzed as the "experiment" of removal of all polony products (the identified cause of the listeriosis outbreak) from food retail stores took place at the time when primary data collection was about halfway. The research design of the primary study was quantitative under the ROFE study approval (BM17/8/20) (Appendix 3). The primary research objectives were to understand how

implementation of Health Promotion Levy implementation of 2018 was going to affect what people of Langa eat. This consisted of interviews to assess dietary intake and sociodemographic characteristics as well as observation of participants' house structural makeup.

3.2.1 Quantitative research

Quantitative research is executed systematically to improve knowledge of culture and society. This means investigating facts, results, or experimenting to support or disprove theories. Furthermore, quantitative research involves researching the cause and effects of a phenomenon including natural experiments (Apuke, 2017). In addition, quantitative research examines the effect of specific phenomena on an outcome of interests that can be presented in numerical format (Polit & Beck, 2012). Findings can be reported with correlations, comparison of means & statistical significance (Apuke, 2017).

This study is a quantitative study that looks at the differences in nutritional status and dietary patterns of two groups namely the groups for whom dietary intake assessment was done before and after the listeriosis-related removal of polony products from food retail stores, due to the government-mandated recall of these products. Henceforth, the two groups will be referred to as pre-recall and post-recall groups. Even though these groups are from the same community they are different participants and will be compared against each other as pre-and-post-recall (of polony) groups.

3.2.2 Natural Experiment

In this study, a natural experiment method research design was used. This experiment is an observational study that makes use of naturally occurring situations to provide answers to specific questions (Messer & Boslaugh, 2012). The natural experiment compares data before and after an event and thus allows a thorough evaluation of the effects of an event. These may be occurrences such as elections, natural and human disasters, and policy implementation

(Mathison, 2011). Mckenna and Morrison (2009) assert that a natural experiment cannot determine the cause of the outbreak however can explore the effects of that outbreak. It provides answers to questions that would otherwise not be achievable on planned events as the researcher cannot influence the occurrence (McKenna & Morrison, 2009). The advantages of using natural experiment design are its pragmatic nature and its cost-effectiveness when data is readily available. However, a limitation is that the natural experiment method does not study the cause of the event but rather the effects of that event (Messer & Boslaugh, 2012).

In this study, the natural experiment is the comparison of groups before and after the recall of polony from supermarkets during the listeria outbreak and how this influenced the consumption of processed meats. In following that line of thought, the investigator is studying the effects of the recall of polony during the listeria outbreak on the dietary intake of the population.

3.3 Study setting

The study made use of secondary data that was collected during February and March 2018 in the Langa community in Cape Town, Western Cape, South Africa. The Western Cape is the 4th largest of the nine provinces of South Africa by area and the third most populated with an estimated 5.8 million occupants in 2011 (Census, 2011) which has grown to 7.4 million in 2022 (Statistics South Africa, 2023a). Furthermore, the Western Cape is divided into one metropolitan area (City of Cape Town) and five districts. The provincial capital of the Western Cape is Cape Town and about two-thirds of Cape Town population live in the metro. Langa is one of the oldest townships of Cape Town, created for black Africans in 1927 as an alternative to the Ndabeni location (Musewa, 1993). The township is part of the City of Cape Town Metro which has a total population of 4.7 million people (Statistics South Africa, 2023a).

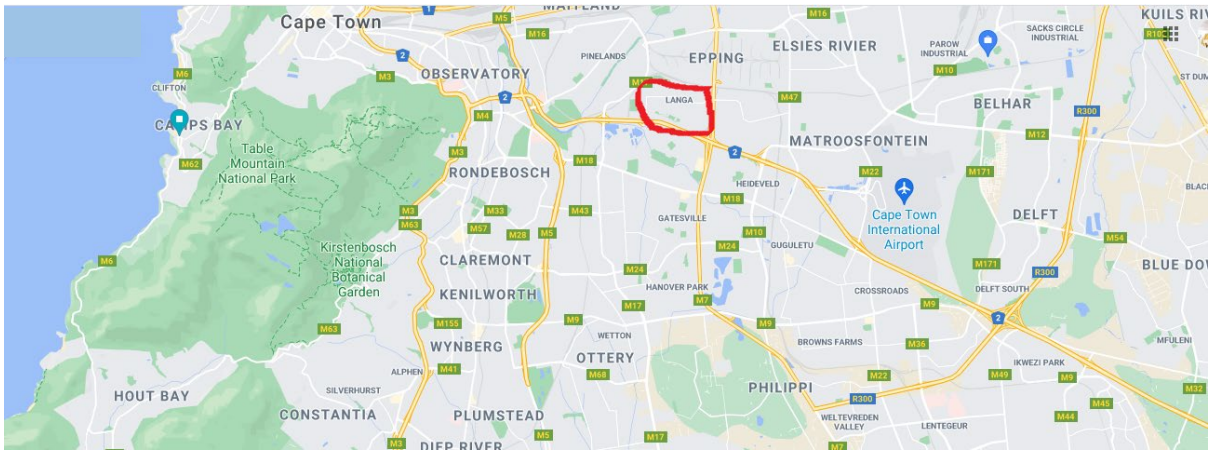


Figure 3. 1: Location of Langa township within the Cape Peninsula (Google Maps)

3.4 Study sample

The study sample included all households in Langa township. The natural experiment was made possible when the removal of all polony products from shelves of retail stores was announced on 4th March 2018 by the then Minister of the Department of Health, Dr Aaron Motsoaledi (Department of Health, 2018). An investigation by the Department of Health identified polony as the carrier food item in the listeriosis outbreak. At that stage, the data collection on the project "Researching the Obesogenic Food Environment" also known as ROFE (registration number BM17/8/20), in Langa had completed interviews on seven hundred and thirty-nine (739) participants for sociodemographic and household hunger surveys and the same number for dietary intake assessments for the abovementioned study. This provided the opportunity to explore the changes in dietary patterns during the period when polony was absent from the market.

The participants that had been interviewed before the 7th March 2018 were categorized as the pre-recall group while the participants interviewed on the 7th March onwards were categorized as post-recalls. Although the removal of polony was effective immediately on the 4th of March 2018, the 24-hour recalls that were done on the 6th would be recalling foods consumed on the 5th thus a hypothesis that foods consumed on the 5th were made on the day or 4th hence the use

of the 7th as the cut-off date to differentiate the two groups thus eliminating the possibility of polony that might have been bought `before the date of announcement.

3.5 Sampling techniques and sample size

The ROFE study followed a door-to-door approach and in each household one participant between the ages of 18 to 39 years old was invited to participate after receiving written informed consent. The inclusion and exclusion criteria included the following:

Inclusion criteria:

- ✓ Age: participants for dietary assessment had to be in the age range of 18 years to 39 years at the time of the interview.
- ✓ Residence: The person to be interviewed had to be a resident of Langa Township for at least one month.
- ✓ Nationality: participants for the study were open to South Africans & foreign nationals subject to their Langa residency.
- ✓ Sex: The research was open to both male and female participants.

Exclusion criteria:

- ✓ Age: participants under the age 18years and over 39years were excluded from the study
- ✓ Residence: participants who had less than a month as residents; or visitors to Langa Township were excluded from the study.
- ✓ Health status: Participants with disabilities that hindered their ability to prepare their food or resulted in an inability to answer the interview questions posed to them were excluded from the research.

As such, the total number of participants included in the study was two thousand one hundred and eighty-six (2186) participants interviewed for socio-demography and dietary assessment.

Participants interviewed from the start of February until the 6th of March were categorized as the pre-recall group (n = 739) and (n=1447) were categorized as the post-recall group. The planned sample for the ROFE assessment was 2534 participants. Post-hoc power of sample size calculation was done using G-power software accessible through https://gpower.software.informer.com/3.1/. Calculations suggests that the sample available in each of the pre-and post-recall groups will be sufficient to detect a small difference of 10 % in protein intake (using ANOVA) at 95% power and at 99% power using t-tests with 3 degrees of freedom (Df). See the power calculation in Figure 3.2.

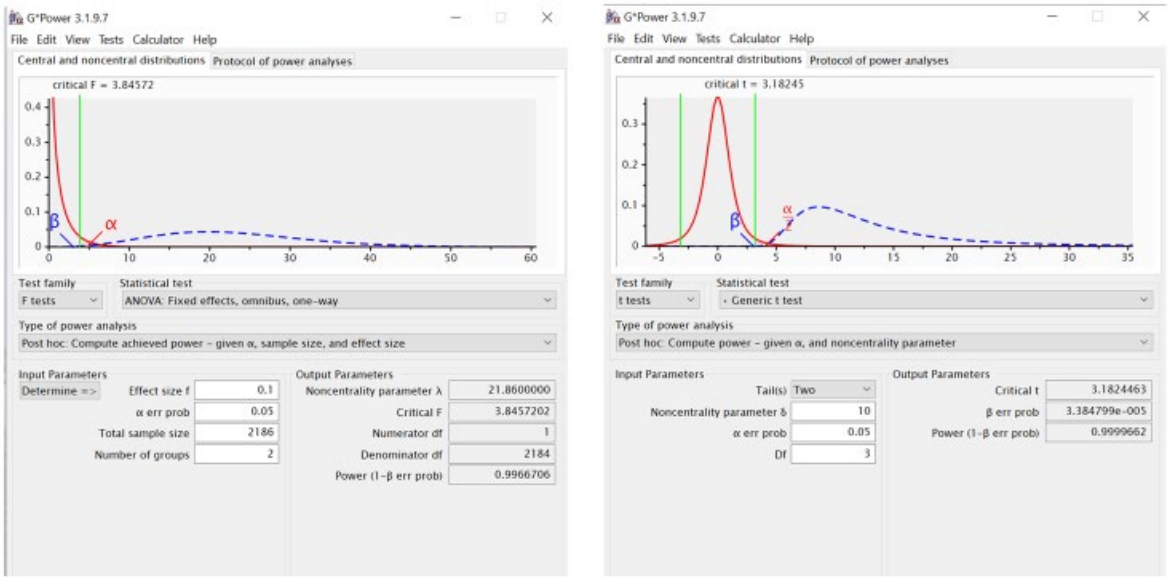


Figure 3.2: Power estimation of ROFE sample size to detect a difference of 10% in protein source.

3.6 Data collection methods and tools

During the primary study, general socio-demographic information and detailed dietary intake information were collected from each consenting participant using the language of their choice (either English or isiXhosa). Field workers were trained in data collection techniques and were fluent in both English and isiXhosa since the target population spoke at least one or both of

these languages. For dietary assessment, a training manual (Appendix 9) by Faber et al (2016) was used in the training fieldworkers for dietary assessment interview techniques. Fieldworkers worked in pairs with one person collecting the general socio-demographic information and the other fieldworker collecting the dietary intake information. The socio-demographic information was collected during an interview and recorded digitally on mobile phones using Open Data Kit (ODK) software accessible on the internet through www.Opendatakit.org. This software allowed the free collection and management of data (Opendatakit n.d). Before saving and uploading the sociodemographic information on ODK, it was double-checked for any errors and ensure quality data collection. The socio-demographic questionnaire from the primary study included questions on the number of people in the household, children residing in the household, electricity availability, house structure, water,, and health services access.

The dietary intake information was obtained using a multi-pass 24-hour recall (Gorshkov 1989). During completion of the 24-hour recall questionnaire (Appendix 2) a file with pictures of commonly consumed portion sizes as well as the 24-hour recall measurement kit with commonly used utensils were used to assist participants in recalling the volumes, amounts, and ratios of foods and beverages consumed during the past 24 hours. Food insecurity was investigated and categorized through the use of the Household Hunger Scale (HHS) (Ballard et al., 2011; Maxwell et al., 2023).

Food insecurity was measured using multiple questions on experienced household hunger and the frequency of the experienced hunger by participants in the household. This was further analysed using the Household Hunger Score (HHS) to assess the degree of food insecurity within the study sample. The HHS is used to monitor the prevalence of hunger in surveillance of food security and can be used in different cultures and settings of study samples.

Lived Poverty Index and frequency were measured using the Afrobarometer's survey which consists of a list of five questions about basic necessities and how often people in the household go without them (Appendix 2; 136-138). These questions were assigned a score of 0-4 on a lickert scale. Thereafter an average score was calculated for each respondent and each score was matched to its said experience. The participants with a score of 0 to 0.5 are said to be experiencing "low lived poverty, 0.51 to 1.0 "moderate lived poverty", 1.01 to 1.50 are experiencing "high moderate lived poverty" and participants with score greater than 1.51 are experiencing "high lived poverty" (Mattes and Patel, 2022).

National food purchasing patterns were explored using Euromonitor International© Packaged Food and Beverage Consumption propriety data extracted from the Euromonitor International© Passport for South Africa 2020. Euromonitor International© is a global independent market research company that focuses on a variety of market products and services in the world thus researching consumer preferences, trends, marketing, product development, and open market opportunities (Euromonitor: Global Market Research & Industry Analysis - Euromonitor.Com, n.d.). The data is reported at a national level and is done yearly. Euromonitor collects data from a synthesis of primary and secondary sources including; trade press, trade associations, national statistics, company reports, broker reports, and store checks. Interviews are also conducted with actors in the supply chain such as; manufacturers, retailers, distributors, packaging converters, and ingredients players to gather valuable market opinions. All inputs are cross-triangulated and synthesized into actionable findings in the form of cross-country comparable industry, economic, and consumer statistics evaluating the current market landscape and future implications. In this thesis, non-modeled Euromonitor International© Passport data from 2015 – 2019 is analyzed and reflected. This data was used to observe if the trends of national consumption of meat and meat products aligned with dietary assessment during the period of listeriosis outbreak.

3.7 Data Analyses

The data that were collected were transformed and saved in Microsoft Excel spreadsheets. All the different components (socio-demographic, anthropometric, and dietary intake) were linked together. The data was cleaned and screened to remove non-realistic portion sizes, age outside of the study sample age, and food codes that may be a mistake. Once a potential mistake was identified, the original questionnaire and 24-hour recalls were tracked to confirm and rectify or exclude. A dichotomous variable to identify the pre-recall group and the post-recall group was created. Data were statistically analyzed using the Statistical Package for the Social Sciences (SPSS) software version 28 as described below.

3.7.1 Sociodemographic characteristics

The SPSS software was used to analyze the demographic characteristics of the study sample. This also included houshold assets of the study sample. The inclusion of assets stems from the fact that polony would require storage after purchasing thus these assets also influence which foods one should buy.

3.7.2 Household hunger

Questions on household hunger were managed as recommended to categorise households to reflect levels of household hunger and frequency (Ballard et al., 2011)

Lived poverty and frequency of experience were also analysed from an outcome-orientated sense which explores poverty from experience (Mattes, 2020). This allowed exploration and depiction of a detailed picture of household socio-economic setup for both the pre-recall and post-recall groups.

3.7.3 Nutrient quality

For analysis of nutrition quality, the researcher used the South African Food Data System (SAFOODS) which is widely known as the South African Medical Research Council (SAMRC) Food Composition Table. This analysis involved converting information coded from the 24-hour recall information to macronutrients and micronutrient composition of foods consumed (Langenhoven et al., 1991; Faber et al., 2016). This was then exported to a Microsoft Excel document and then analysed using SPSS. Descriptive statistics were used to present the most consumed food sources (with an emphasis on protein sources), their frequency, and portion size consumed. Independent t-tests were used to determine if consumption patterns (food sources, frequency, and portion size consumed) were significantly different pre- and post-recall of polony during the listeriosis outbreak and for categorical variable layers (age, sex, socio-economic status, food security status, household composition such as presence of children) using the cut-off point of $p<0.05$ to indicate statistical significance. The t-test as an inferential test design was used to test the hypothesis by exploring differences between two groups on variables of interest to the researcher.

Nutritional assessments were analysed from the 24-hour recalls. Energy, carbohydrates, total fat, saturated fat, cholesterol, total dietary fibre, protein, vitamin A, vitamin B12, vitamin E, zinc, iron (Fe) and thiamine were selected as nutrients of interest. These nutrients were selected because polony is a source of protein and therefore the interest is how the protein was to be affected by the total recall of polony from the supermarkets. Energy consumption is also a point of interest as the participants might not replace one protein source with another protein source but might rather increase their carbohydrate consumption. One of the hypotheses was an increase in plant-based protein as a result of the polony recall, and therefore observing fibre

consumption is also one of the outcomes of interest. Another hypothesis was that a change in dietary patterns may also influence an increase or a decrease in other vitamins and minerals in particular vitamin A, B12, E, Iron and zinc which are found in polony.

Histogram and Q-Q plots were visually observed to see if the distribution of each nutrient was normally distributed over the study sample. One-way ANOVA was performed to determine differences in nutrient intake (continuous variables) between the pre-recall and post-recall groups. For nutrients that were normally distributed, a standard deviation and quartile range were generated. A nonparametric test (independent samples) was performed on animal protein, iron, vitamin A, saturated fat, vitamin B12, and dietary fibre as these variables did not show normal distribution when observed. For correlation tests, linear and binary logistic regressions were performed to explore the association between nutrients, and dietary diversity with socio-demographic characteristics. The analysed nutrients were tabulated and expressed in mean value, standard deviation, quartiles, and p-value (0.050) to indicate if the groups were similar or statistically different.

To determine dietary adequacy and inadequacy of specific nutrient intakes the Dietary Reference Intakes (DRIs) were used as cut-points. From the DRIs, the Recommended Dietary Allowances (RDAs) and Adequate Intake (AI) were used as cut-points for sufficient nutrient intake for specific ages of different sex, and tolerable Upper Intake Levels (UL) were used to categorise excessive nutrient intake (Otten et al., 2006). RDAs values are bolded while the AIs are in italics with asterisk*. RDAs/AIs (Otten et al., 2006) for age bracket 19-30 years and 31-50 years are similar for the selected nutrients of interest and for energy. For the purpose of this study the 19-30 years RDAs/AIs were also applied to the 18-year olds. For nutrient adequacy, participants that consumed nutrient amounts that were above cut-off values were classified as consuming adequate intake while those that consumed lower intakes were classified as consuming inadequate nutrient for each nutrient. Lastly, those who consumed excessive

nutrient intake were the participants that had consumed nutrient values higher than the UL cut-off values (Table 3.1)

Table 3. 1: DRIs used as cut-point to establish adequate/inadequate intake of specific nutrients by the population

Nutrient	Male (18-39years)		Female (18-39years)	
	RDA/AI	**UL/Excessive**	**RDA/AI**	**UL/Excessive**
Energy kJ (WHO)	9623.2#		7949.6	
Carbohydrates (55%) (g)	**5292.76**		**4372.28**	
Total fat (<30%) (g)		2886.96		2384.88
Sat fat (<10%) (g)		962.32		794.96
Trans fat (<1%) (g)		96.23		79.50
Fibre (g)	*38**		*25**	
Protein (g)	*56**		*46**	
Vitamin A (µg)	**900**	3000	**700**	3000
Vitamin B12 (µg)	**2.4**		**2.4**	
Iron (fe) (mg)	**8**	45	**18**	45
Zinc (mg)	**11**	40	**8**	40
Thiamine (mg)	**1.2**		**1.1**	
Vitamin E (mg)	**15**	1000	**15**	1000

Recommended Daily allowances (RDAs) are in **bold.** Adequate Intakes (AIs) are in *italics* with an asterisk*. Energy with # are World Health Organisation (WHO) recommendations.

For dietary quality, the minimum dietary diversity for women (MDD-W) indicator was used to calculate the dietary diversity score of the population using 10 predetermined food groups (FAO & FHI 360, 2016). The ten food groups were; (1) grain, white root, and tubers (2) pulses, beans, peas, and lentils, (3) nuts and seeds (4) dairy, (5) meat, poultry, and fish (6) eggs, (7) dark green leafy vegetable, (8) other vitamin-A rich fruits and vegetables, (9) other vegetables, (10) other fruits. Each food consumed by the participants on 24-hour recall was assigned to its food group and a total was then calculated to get a total number of different food groups (0 to 10) for each participant.

3.7.4 Sales

The Euromonitor sales data was extracted and summarised in Microsoft Excel and then presented in tables and graphs as per capita volume of sales to indicate consumption patterns of different food products over time. This data was used to specifically present processed meat consumption as well as processed fish products over the period 2016 - 2019 at the national level.

Retail volume was used to establish total meat consumption and per capita consumption (kg) was calculated by dividing the total volume of retail and food service in the country by the total population each year. Subcategories such as processed meats, seafood, and chilled processed seafood were also analysed at the national level to establish sales volume. The analysis only focused on companies that offered or manufactured meats, beef and veal, pork, poultry, processed meats (chilled and shelf stable), and meat substitutes, and a market share between these companies was calculated between 2016 to 2019. The names of these companies were concealed and instead, these coded names were used; company EX, company XA, company RA, company AF, private Label, and other companies to describe small family-owned companies. The names of companies were hidden because there is ongoing litigation involving the company involved and the families affected by the listeriosis outbreak.

3.8 Validity and reliability.

Validity refers to the degree of the measuring tools' correctness and effectiveness in achieving the objectives of the research while reliability is described as the extent to which the measuring tool produces the same results under similar environmental factors (Sun et al., 2010). Sichier and Everhart (1998) suggest that 24-hour recall showed correlations in a valid study of Brazil's diet (Sichieri & Everhart, 1998). Schatzkin et al (2003) adds that the 24-hour recall may slightly overestimate protein consumption, however, that does not make the instrument invalid

(Schatzkin et al., 2003). Systematic measurement errors may occur during 24-hour recall however these errors are managed through quality control by training interviewers, providing respondents with bowls and measuring tools, picture files showing food and portions, standardized calibration, food models, and the use of actual food samples commonly consumed in that particular region (Gorshkov 1989). Kim and Park (2023) supports that interviewer-administered 24hr recalls are valid tools to measure food and nutrition intake of adults and there's reported accuracy in any type of dishes (Kim & Park, 2023). Before data collection, all fieldworkers in the primary study were trained in all the tools used for data collection. To ensure validity, the researcher was one of the two coders who checked all coded socio-demographic questionnaires and 24-hour recalls before data entry. After nutrient content was computed, further quality checks were performed by identifying extremely low and high nutrients (per food item and individual), and the 24-hour record was double-checked to understand the reason for the high nutrient level. The researcher conducted data cleaning on the merged sociodemographic, dietary, food security and water and sanitation data sets. Where there were inaccuracies and uncertainties the researcher would access the primary document to ensure accurate data is captured.

3.9 Ethics

The researcher is aware of the principles of research ethics and the protection of Human Research Participants. As this study made use of secondary data, the researcher did not obtain direct consent from the participants themselves, but the researcher worked as a fieldworker on the primary ROFE project and thus experienced first-hand that consent forms and information sheets were given and explained to the participants in the primary research. . Participants in the original study agreed to the data collected being used for analyses of dietary intake and thus it was deemed acceptable to conduct secondary data analyses without additional consent required by the research participants.

During data collection participants were made aware of their rights to withdraw from the research at any given point should they wish to do so, without facing any detrimental consequences. Furthermore, both the consent form (Appendix 1) and information sheets (Appendix 6) were available in both isiXhosa and English to ensure that participants clearly understood the purpose of the research.

The primary research was granted approval by the Biomedical Research Ethics Committee of the University of the Western Cape with ref BM17/8/20 (Appendix 3). The researcher was also granted ethics approval for the secondary data analyses for his research project from the Senate Higher Degrees and the Humanities and Social Science Research Ethics Committee with reference HS19/7/3 (Appendix 4). The researcher did not require ethics approval for Euromonitor International data as it is propriety data. Furthermore, the researcher adhered to high research ethics including integrity, confidentiality, objectivity, honesty, and openness throughout the duration of the study.

The researcher was utilizing secondary data and had only access to an anonymised data set thus no personal information of participants was available to the researcher. The researcher kept all information such as Microsoft Excel spreadsheets with the data highly classified and password protected in Microsoft OneDrive (n.d). Permission to use the data for secondary data analyses was granted by the principal investigator (Appendix 7).

The researcher is aware that during the primary research, the principal investigator ensured confidentiality and anonymity to the participants by utilizing a code instead of names when documenting participants. Privacy included securing all hard copies of consent forms with information of participants in a locked cabinet, digital records were password protected, and only the primary investigator has access to these.

3.10 Contribution of the Researcher

The researcher served as a team leader in the primary ROFE study, ensuring logistics were sufficient and utilized in the correct manner. The researcher performed 24-hour recall interviews himself with the team of dietary intake fieldworkers. After the data collection, the researcher was part of the team that performed the coding and quantification of 24-hour recall information towards the nutrient analyses being conducted using the electronic database on nutrient composition of foods as contained in the Food Composition Table of the SAMRC. In addition, the researcher performed double-checking and quality assurance on all coding sheets of 24-hour recalls before signing them off for nutrient analysis. Lastly, the researcher performed all analyses of the data that is reported in this thesis.

3.11 Limitations

Due to the nature of the study being a natural experiment, the researcher couldn't explore the participant's perceptions about the listeria outbreak and its perceived effect on their general life and in particular their diet, and if they purposefully employed any strategies to sustain their protein intake and diet preferences. The observations from Langa may reflect dietary adaptations in neighborhoods of similar socio-demographic and dietary intake, but cannot be generalised to the population of South Africa.

Euromonitor data is not available at the regional or provincial level and therefore it is not possible to report on or compare food retail to the dietary patterns observed in Langa Township. Products are also reported in broad categories and not by individual food items. It is also worth noting that the data does not consider the different cultural aspects associated with meat, individual buying behaviour, food wastage, and the difference in food distribution between regions and households (Ronquest-Ross et al., 2015).

3.12 Conclusion

This chapter detailed the methodologies employed by the researcher to realize the objectives of the research. As such, the study aimed to assess the effect of the 2018 listeria outbreak on nutrient quality, dietary patterns, and trends in sales of specific food products, particularly polony. The study as a natural experiment utilized secondary data from the ROFE study. Utilizing the secondary data, the participants in the study were grouped into two groups. The pre-recall group comprised participants who were interviewed before the 7th of March 2018 (before polony was recalled from retail stores) and the post-recall group were participants interviewed from the 7th of March 2018 to the end of March 2018. To achieve the objectives of the study, the researcher used the 24-hour recall data to assess the consumption of specific food products to determine the dietary patterns of the groups. Lastly, Euromonitor data was acquired and analysed to determine the trends in sales of certain foods in South Africa at a national level before, during, and after the listeriosis outbreak.

CHAPTER 4

RESULTS

4.1 Introduction

This chapter presents the findings from the study. All data was generated quantitatively. The natural experiment occurred when a listeria outbreak resulted in the removal of all polony and polony products from food outlets on Sunday 4th March 2018. At that time data collection of the Health Promotion Levy Evaluation study was well underway. The date of 7th March 2018 (Wednesday) was used to define the pre-recall and post-recall groups. The pre-recall was defined as the group that was recruited and reported foods consumed before the 7th of March 2018 and the post-recall group was defined as the group that was recruited on the 7th and afterward thus reporting on foods consumed on the 6th (24hr recall) and afterward. The primary data included 2534 respondents, however after removal of parti cipants with missing values the total sample for this study included 2186 adults aged 18-39 years living in Langa, Cape Town in 2018 (86.1% of recruited participants). Seven hundred and thirty-nine (739) participants were included as the pre-recall group and one thousand four hundred and forty-seven (1447) were included as the post-recall group. The nutrient and dietary intake analysis was analyzed from 24-hour recalls. Lastly, the analysis in this study expanded more on dietary intake to gain greater detail of dietary intakes of the study sample as the influence may not only be found on the targeted polony consumption but also on dietary intake in general. This included an analysis of factors that may influence dietary intake differences such as food security status.

4.2 Socio-demographic attributes

The socio-demographic characteristics of the two groups are presented in ***Table 4.1***. Almost equal proportions of participants 18-29 years and 30-39 years were included in the two groups although in the younger age group (<30years) the pre-recall group had slightly younger

participants (18-24 years) than the post-recall group. These differences between the two groups were not statistically significant. The sex distribution amongst the two groups had a pre-recall group with statistically significantly more males compared to post-recall while the majority of the total sample were females (66.0%).

The majority of the study sample were single (80.1%) and unemployed (65.2 %). Fifty-five percent (n=1203) of the population earned less than R4000 per month plus almost nine out of ten (89.4%) had some secondary high school educational background.

The source of water and access to food preparation amenities were statistically different between the two groups. The majority (65.2%) of the pre-recall group were sourcing water within their dwellings whilst only 35.2% reported a within-dwelling water source in the post-recall group. Post-recall group participants most commonly reported sourcing water elsewhere (42.7%). Although the majority of the post-recall group had access to a microwave (57.6%) statistically significantly more participants had access to a microwave in the pre-recall group (74.4 %, $p<0.001$). To add, over two-thirds of the pre- and post-recall groups (85.5% and 78.3%) had refrigeration access, although there was a statistically significant difference between the two groups ($p<0.001$). Lastly, almost all of the study participants had access to electricity (98.2 %), and used it for cooking (97.8%).

Table 4.1: The proportionate distribution of socio-demographic characteristics of the study sample

Variable	Pre-recall n (%)	Post-recall n (%)	Total n (%)	Chi-square p-value
Age				0.801
18-24	267 (36.1)	493 (34.1)	760 (34.8)	
25-29	181 (24.5)	359 (24.8)	540 (24.7)	
30-34	160 (21.7)	330 (22.8)	490 (22.4)	
35-39	131 (17.7)	265 (18.3)	396 (18.1)	
Sex				<0.001*
Male	359 (48.6)	384 (26.5)	743 (34.0)	
Female	380 (51.4.)	1063 (73.5)	1443 (66.0)	
Marital status				0.014*
Single	618 (83.6)	1134 (78.4)	1752 (80.1)	
Married	92 (12.4)	236 (16.3)	328 (15.0)	
Other	29 (3.9)	77 (5.3)	106 (4.8)	
HH Income				<0.001*
≤R4000	343 (46.4)	860 (59.4)	1203 (55.0)	
R4001-R10000	194 (26.3)	293 (20.2)	487 (22.3)	
≥R10001-above	202 (27.3)	294 (20.3)	496 (22.7)	
Education level				0.004*
No education	0 (0.0)	2 (0.1)	2 (0.1)	
Primary education	56 (7.6)	173 (12.0_	229 (10.5)	
Secondary education	683 (92.4)	1272 (87.9)	1955 (89.4)	

Table 4.1: The proportionate distribution of socio-demographic characteristics of the study sample (continued)

Variable	Pre-recall n (%)	Post-recall n (%)	Total n (%)	Chi-square p-value
Employment				0.015*
Unemployed	456 (61.7)	969 (67.0)	1425 (65.2)	
Employed	283 (38.3)	478 (33.0)	761 (34.8)	
HH electricity				0.035*
Yes	731 (99.1)	1415 (97.8)	2146 (98.2)	
No	7 (0.9)	32 (2.2)	39 (1.8)	
Microwave				<0.001*
Yes	605 (74.4)	899 (57.6)	1504 (63.4)	
No	208 (25.6)	661 (42.4)	869 (36.6)	
Water source				<0.001*
Dwellings	482 (65.2)	510 (35.2)	992 (45.4)	
Yard	245 (33.2)	319 (22.0)	564 (25.8)	
Shared public tap	12 (1.6)	618 (42.7)	628 (28.7)	
Fridge/Freezer				<0.001*
With fridge/freezer	631 (85.5)	1129 (78.3)	1760 (80.8)	
No fridge/freezer	107 (14.5)	312 (21.7)	419 (19.2)	
Fuel for cooking				0.017*
Electricity	716 (96.9)	1423 (98.3)	2139 (97.8)	
Gas /fire	22 (3)	19 (1.3)	41 (1.9)	
No cooking	1 (0.1)	5 (0.3)	6 (0.3)	

*Level of statistical significance assumed at p<0.05

The study sample was assessed for the number of people receiving different types of social grants. The results in ***Table 4.2*** show the number of households with a person(s) receiving each of the listed grants irrespective of the number of persons within a single household. The results point out that the most common of all the grants is a child support grant with half (50.7%) of the households in the pre-recall group and 46.6% of the post-recall group receiving at least one child support grant in the household. The proportion of households receiving each of the types of grants is statistically significantly higher in the pre-recall group compared to the post-recall group for old age grants (12.3% vs 5.0%) and disability grants (6.1% vs 3.0%).

Table 4.2: The proportionate distribution of households with person(s) receiving a particular social government grant.

Grant name	Pre-recall n (%)	Post-recall n (%)	Total n (%)	Chi-square P-value
Child support grant				0.065
Yes	375 (50.7)	674 (46.6)	1049 (48.0)	
No	364 (49.3)	773 (53.4)	1137 (52.0)	
Pension / old age grant				<0.001*
Yes	91 (12.3)	73 (5.0)	164 (7.5)	
No	648 (87.7)	1374 (95.0)	2022 (92.5)	
Disability grant				<0.001*
Yes	45 (6.1)	43 (3.0)	88 (4.0)	
No	694 (93.9)	1404 (97.0)	2098 (96.0)	
Foster grant				0.086
Yes	17 (2.3)	19 (1.3)	36 (1.6)	
No	722 (97.7)	1428 (98.7)	2150 (98.4)	

*Level of statistical significance assumed at p<0.05

4.3 Food Security

Household hunger was assessed and the most frequently experienced measure of hunger by both the groups was lack of resources to get food as 19.6% (n=145) and 16.7% (n=241) of the sample experienced this in the pre-recall and post-recall respectively. There was no statistically significant difference between the proportions of the pre-recall and post-recall groups reporting on any of the three experiences (*Table 4.3*).

Table 4.3: The proportionate distribution of hunger experienced by the study sample.

Experienced Hunger	Pre-recall n (%)	Post-recall n (%)	Total n (%)	Chi-square P-value
Lack of resources to get food				0.085
Yes	145 (19.6)	241 (16.7)	386 (17.7)	
No	594 (80.4)	1206 (83.3)	1800 (82.3)	
Sleeping hungry				0.882
Yes	100 (13.5)	199 (13.8)	299 (13.7)	
No	639 (86.5)	1247 (86.2)	1886 (86.3)	
Hungry day and night				0.142
Yes	87 (11.8)	141 (9.7)	228 (10.4)	
No	652 (88.2)	1306 (90.3)	1958 (89.6)	

*Level of statistical significance assumed at $p<0.05$

Household Hunger Score (HHS) was calculated to assess the degree of food insecurity within the study sample. Upon conversions and calculations, the results are categorised into three levels of experienced hunger; (i) little to no hunger in the household (when the household hunger score falls between 0-1), (ii) moderate hunger in the household (when household hunger

score falls between 2-3), (iii) severe hunger in the household (when the household hunger score falls between 4-6) (Ballard et al., 2011).

The results of the Household Hunger Scale (HHS) in *Table 4.4* revealed that the majority (85.7%) of the pre-recall group experienced little to no hunger while none (0.0%) of the households in both groups reported experiencing severe hunger. Lastly, there was no statistical difference (p=0.137) between the two groups and only 12.9% of the households in the study sample had reported experiencing moderate hunger (*Table 4.4*).

Table 4.4: The proportionate distribution of household hunger score categorial indicator within the study sample

Household hunger score	Household hunger category	Pre-recall n (%)	Post-recall n (%)	Total n (%)	Chi-square p-value
0-1	Little to no hunger in the household	633 (85.7)	1272 (87.9)	1905 (87.1)	0.137
2-3	Moderate hunger in the household	106 (14.3)	175 (12.1)	281 (12.9)	
4-6	Severe hunger in the household	0 (0.0)	0 (0.0)	0 (0.0)	

*Level of statistical significance assumed at p<0.05

4.4 Experienced poverty and income

Figure 4.1 shows that most of the households experiencing moderate hunger were households with a total income of <R4 000 in both pre-recall and post-recall groups. The households in both groups with the total income bracket >R10 000 never reported to experience severe

hunger. Most of the households experiencing moderate hunger were households with income less than R4000 as 8.8% and 9.3% of the households were from pre-and post-recall groups respectively. Lastly, the majority (50.2%) of post-recall households had a household income of R4000 and below and experienced little to no hunger while fewer households with income of >R10000 experienced hunger in post-recall group compared to pre-recall group.

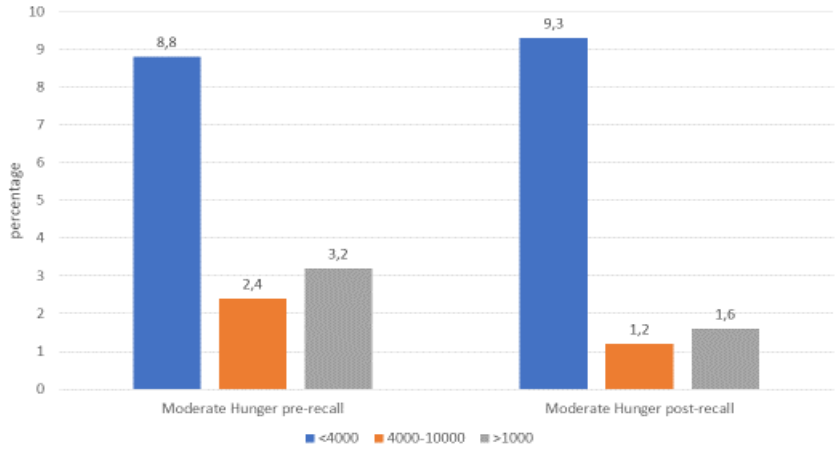


Figure 4.1: The proportionate distribution of moderate hunger by household income category

Lived poverty within a household was measured and is presented in ***Table 4.5***. The results point out that over two-thirds (78.1%) of households in the pre-recall group, and eighty-two percent (n=1160) in the post-recall group never experienced being without enough food to eat and there was no statistical difference (p = 0.698) between the groups. The most commonly experienced form of lived poverty was not having enough water for home use with half (50.6%) of the households in the study sample experiencing this and twenty-eight percent experiencing this at a frequency of once or twice in a month. There were no differences observed between the two groups in all other forms of lived poverty besides the statistical difference (P=0.001) observed in households going without cash income in a month

Table 4.5: Proportionate distribution of lived poverty among the study sample.

Lived poverty and frequency	Group			Chi-square
	Pre-recall n (%)	Post-recall n (%)	Total n (%)	P-value
Gone without medicine or medical treatment in the last year				0.272
Never n (%)	666 (90.1)	1294 (89.4)	1960 (89.7)	
Once/twice n (%)	60 (8.1)	112 (7.7)	172 (7.9)	
Several times n (%)	10 (1.4)	36 (2.5)	46 (2.1)	
Many times n (%)	2 (0.3)	5 (0.3)	(0.3)	
Always n (%)	1 (0.1)	0 (0.0)	1 (0.0)	
Gone without enough fuel to cook food in the last year				0.269
Never n (%)	557 (75.4)	1134 (78.4)	1691 (77.4)	
Once/twice n (%)	115 (15.6)	191 (13.2)	306 (14.0)	
Several times n (%)	53 (7.2)	84 (5.8)	137 (6.3)	
Many times n (%)	12 (1.6)	31 (2.1)	43 (2.0)	
Always n (%)	2 (0.3)	7 (0.5)	9 (0.4)	
Gone without enough food to eat in the last year				0.698
Never n (%)	577 (78.1)	1160 (80.2)	1737 (79.5)	
Once/twice n (%)	95 (12.9)	166 (11.5)	261 (11.9)	
Several times n (%)	51 (6.9)	87 (6.0)	138 (6.3)	
Many times n (%)	14 (1.9)	27 (1.9)	41 (1.9)	
Always n (%)	2 (0.3)	7 (0.5)	9 (0.4)	
Gone without enough water for home use in the last year				0.314
Never n (%)	391 (52.9)	715 (49.4)	1106 (50.6)	
Once/twice n (%)	210 (28.4)	406 (28.1)	616 (28.2)	
Several times n (%)	112 (15.2)	269 (18.6)	381 (17.4)	
Many times n (%)	23 (3.1)	50 (3.5)	73 (3.3)	
Always n (%)	3 (0.4)	7 (0.5)	10 (0.5)	
Gone without a cash income in the last year				<0.001*
Never n (%)	430 (58.2)	819 (56.6)	1249 (57.1)	
Once/twice n (%)	114 (15.4)	215 (14.9)	329 (15.1)	
Several times n (%)	125 (16.9)	188 (13.0)	313 (14.3)	
Many times n (%)	54 (7.3)	169 (11.7)	223 (10.2)	
Always n (%)	16 (2.2)	56 (3.9)	72 (3.3)	

*Level of statistical significance assumed at $p<0.05$ The majority of the study sample experienced low-lived poverty based on the lived poverty index (LPI) at 62.1% and 61.7% in pre-recall and post-recall groups respectively. There was no statistical difference (p=0.265) between the two groups. About five percent (n=108) of the total study sample experienced high-lived poverty

(absence of all basic necessities) while a quarter (25.1%) of the study sample had experienced a low to moderate level of LPI (*Table 4.6*).

Table 4.6: The proportionate distribution of Lived Poverty Index (LPI) between the pre- and post-recall groups.

Lived Poverty Index (LPI score)	Pre-recall (n=739) n (%)	Post-recall (n=1447 n (%)	Total n (%)	Chi-Square. P-value
Low lived poverty (LPI=0-0.5)	459 (62.1)	893 (61.7)	1352 (61.8)	0.265
Low-moderate lived poverty (LPI=0.51-1.0)	186 (25.2)	363 (25.1)	549 (25.1)	
High-moderate lived poverty (LPI=1.01-1.50)	66 (8.9)	111 (7.7)	177 (8.1)	
High lived poverty (LPI=>1.51)	28 (3.8)	80 (5.5)	108 (4.9)	

*Level of statistical significance assumed at p<0.05

4.5 Nutrient quality of the diet

The hypothesis of this study was that the removal of polony from the shelves may have resulted in consumption of replacement foods with different nutrient compositions thus resulting in differences in nutrient intake of the pre-recall and post-recall groups. Nine nutrients were included for consideration namely, the macronutrients protein, fibre, and total energy as well as the micronutrients zinc, iron, vitamin A, vitamin E, vitamin B12 and thiamine.

Table 4.7 shows that the energy intake of the two groups were statistically different (p=0.003) and the median intake of energy (kJ) for the study sample was 8064.47 kJ/day (IQR: 4242.97 kJ). The protein, zinc and thiamine intake of the pre-recall group was statistically significantly higher than the post-recall group. The median (IQR) intake of protein was 64.74 g/day (39.53 g) for the pre-recall group and 61.10 g/day for the post-recall group (38.08 g) and thiamine 1.28 mg (0.95) and 1.17 mg (0.89) for pre and post-recall groups respectively. Zinc intake was 11.57 (8.57) for pre-recall group and 10.91 mg (7.43) for post-recall group. The high number of food items with missing zinc levels in the SAMRC Food composition tables should be considered in the interpretation. Lastly, the pre-recall group had a slightly higher consumption than the post-recall group on all the other nutrients albeit not statistically significant.

Table 4.7: Macronutrients and micronutrients consumed by adults in the Pre-recall and Post-recall groups.

Nutrient	Pre-recall (n=739)		Post-recall (n=1447)		Total sample (n=2186)		P value
	Median	IQR	Median	IQR	Median	IQR	
Energy (KJ)	8485.27	4344.89	7904.38	4167.59	8064.47	4242.97	**0.003***
Carbohydrates (g)	277.46	145.36	258.69	140.18	266.48	140.79	**0.050***
Protein (g)	64.74	39.53	61.10	38.08	62.37	38.79	**0.001***
Fat (g)	55.19	46.73	52.99	43.23	53.32	45.07	0.073
Cholesterol (mg)	147.00	277.78	146.40	248.85	146.75	256.10	0.658
Saturated fat (g)	14.35	13.33	14.04	12.14	14.19	12.31	0.167
Total dietary fibre (g)	16.57	12.83	16.02	11.71	16.30	12.10	0.172
Iron (mg)	12.82	9.03	12.26	8.16	12.46	8.39	0.137
Zinc (mg)	11.57	8.57	10.91	7.43	11.19	7.83	**0.014***
Thiamine (mg)	1.28	0.95	1.17	0.89	1.19	0.92	**0.001***
Vitamin B12	2.16	2.96	2.02	3.38	2.09	3.21	**0.125**
Vitamin E	8.73	9.14	8.08	9.90	8.24	9.61	**0.423**

p-values: Mann-Whiteney U-test (skew data) and Independent t-test. The bolded *p-values are those that are statistically significant **(p<0.05).** IQR = Interquartile range

Dietary Reference Intakes (DRIs) are proposed by the Institute of Medicine as indicators of good health (Otten et al., 2006). The Recommended Dietary Allowance (RDA) represents the nutrient needs of almost all (97-98%) of individuals in gender-specific groups, similar to the average intakes (AIs) while estimated average requirements (EAR) indicate the adequacy of intake for at least 50% of the population. ***Table 3.1*** in the methodology chapter shows the various nutrient values that were used to evaluate dietary intake in this study. The World Health Organisation's (WHO) EER was used as a cut point for energy requirements, AI which indicates a level of intake at which there is a low probability of deficiency, was used for protein, fibre, vitamin B12, Thiamine, vitamin E, vitamin A, and zinc. Tolerable Upper Intake Level (UL) was used as cut-points to determine excessive nutrient intake of iron, vitamin A, and zinc (Otten et al., 2006).

Table 4.8 depicts that over a third of the females consumed inadequate intake of protein in both groups, however the groups were not significantly different for protein or any of the other nutrients (p=0.466). Females' vitamin A consumption was low as over half of the females on both pre-recall and post-recall had an inadequate intake, although 6.1% and 4.7% of the females consumed excessive intake in post-recall and pre-recall groups respectively. The female pre- and post-recall groups remained similar in all macronutrient and micronutrient consumption adequacy and only for vitamin E and total fats were there no females that consumed excessive intakes.

Table 4.8: The proportionate distribution of females 18-39 years with inadequate, adequate and excessive dietary intake pre-recall and post-recall

Nutrient	Pre-recall n (%)			Post-recall n (%)			Total n (%)			P
	Adequate	Inadequate	Excessive	Adequate	Inadequate	Excessive	Adequate	Inadequate	excessive	P-Value
Energy	160 (42.1)	220 (57.9)	-	431 (40.5)	632 (59.5)	-	591 (41.0)	852 (59.0)	-	0.596
Total Fat			0 (0.0)			0 (0.0)			0 (0.0)	a
Protein	238 (62.6)	142 (37.4)	-	688 (64.7)	375 (35.3)	-	926 (64.2)	517 (35.8)	-	0.466
Fibre	71 (18.7)	309 (81.3)	-	173 (16.3)	890 (83.7)	-	244 (16.9)	1199 (83.1)	-	0.282
Vitamin A	144 (37.9)	219 (57.6)	17 (4.7)	386 (36.3)	612 (57.6)	65 (6.1)	530 (36.7)	831 (57.6)	82 (5.7)	0.469
Vitamin B12	151 (40.1)	226 (59.9)	-	443 (42.6)	597 (57.4)	-	594 (41.9)	823 (58.1)	-	0.391
Vitamin E	62 (16.4)	317 (83.6)	0 (0.0)	201 (18.9)	860 (81.1)	0 (0.0)	263 (18.3)	1177 (81.7)	0 (0.0)	0.263
Iron (fe)	64 (16.8)	314 (82.6)	2 (0.5)	155 (14.6)	898 (84.5)	10 (0.9)	219 (15.2)	1212 (84.0)	12 (0.8)	0.442
Zinc	245 (64.5)	135 (35.5)	0 (0.0)	696 (65.5)	366 (34.4)	1 (0.1)	941 (65.2)	501 (34.7)	1 (0.1)	0.860
Thiamine	188 (53.3)	165 (46.7)	-	496 (50.9)	479 (49.1)	-	684 (51.5)	644 (48.5)	-	0.442

*Level of statistical significance assumed at $p<0.05$ a: no p-value, variable is a constant Note: p-values that are bolded are statistically significant: $p<0.05$

Table 4.9 shows that nutrient intake for males from the two groups remained similar in all macronutrients and micronutrients consumption. Over a third (n=136) of the males in the pre-recall group and two out of five in the post-recall group had inadequate protein intake. Just over a half (n=217) of the post-recall group met AI minimum intake Zinc, iron, and thiamine were the only micronutrients where at least half of the males in both the pre-recall group and post-recall group had adequate intake. Lastly, no (0.0%) males consumed excessive amounts of vitamin E in both groups and this follows the same trend as in females (*Table 4.9*).

Table 4.9: Proportion of males 18-39 years with inadequate, adequate and excessive dietary intake pre-recall and post-recall.

Nutrient	Pre-recall n (%)			Post-recall n (%)			Total n (%)			Chi-square
	Adequate	Inadequate	Excessive	Adequate	Inadequate	Excessive	Adequate	Inadequate	Excessive	P-Value
Energy	131 (36.5)	228 (63.5)	-	124 (32.3)	260 (67.7)	-	255 (34.3)	488 (65.7)	-	0.228
Total Fat			0 (0.0)			0 (0.0)			0 (0.0)	a
Protein	223 (62.1)	136 (37.9)	-	217 (56.5)	167 (43.5)	-	440(59.2)	303 (40.8)	-	0.120
Fibre	22 (6.1)	337 (93.9)	-	18 (4.7)	366 (95.3)	-	40 (5.4)	703 (94.6)	-	0.385
Vitamin A	77 (21.4)	256 (71.3)	26 (7.2)	96 (25.0)	273 (71.1)	15 (3.9)	173 (23.3)	529 (71.2)	41 (5.5)	0.093
Vitamin B12	163 (45.4)	193 (54.6)	-	175 (45.7)	208 (54.3)	-	338 (45.6)	404 (54.4)		0.937
Vitamin E	78 (21.7)	281 (78.3)	0 (0.0)	86 (22.4)	298 (77.6)	0 (0.0)	164 (22.1)	579 (77.9)	0 (0.0)	0.826
Iron (fe)	278 (77.4)	78 (21.7)	3 (0.8)	303 (78.9)	80 (20.8)	1 (0.3)	581 (78.2)	158 (21.3)	4 (0.5)	0.532
Zinc	199 (55.4)	157 (43.7)	3 (0.8)	196 (51.0)	188 (49.0)	0 (0.0)	395 (53.2)	345 (46.4)	3 (0.4)	0.083
Thiamine	192 (53.5)	167 (46.5)	-	200 (52.1)	184 (47.9)	-	392 (52.8)	351 (47.2)	-	0.703

*Level of statistical significance assumed at $p<0.05$ a: no p-value, variable is a constant Note: p-values that are bolded are statistically significant: $p<0.05$

4.3.1 Hypothesis testing

Problem:

To investigate if socio-economic status has a significant role on the consumption of nutrients that are different between the two groups

Hypothesis

H_1: Marital status has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine.

H_2: Sex has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine

H_3: Employment has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine

H_4: Income has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine.

H_5: Water source has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine.

H_6: Education has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine.

H_7: Electricity has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine

H_8: Cooking fuel has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine

H_9: Microwave availability has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine

H_{10}: Fridge availability has a significant impact on nutrient intake; energy, carbohydrates, protein, zinc and thiamine

The hypothesis tests if each of the socio-demographic and household assets carries a significant impact on the nutrient intake that is different between the two groups. The dependent variable energy (kJ) was regressed on predicting socio-demographic variables. H_2. Sex significantly predicted energy (kJ), $F(10,2152) = 39.286$, $p<0.001$, which therefore indicates sex particularly female played a significant role in energy consumption ($b=--912.501$, $p<.001$). These clearly

show only sex and income of <4001 variables were a confounding factor to energy consumption thus the adjusted R^2=.134 depicts the model explains a 1.8% change in energy can be accounted for by sex and 2% by income (Table 4.10.1).

Table 4.10.1: Linear regression of total daily energy consumption and polony recall adjusted for socio-economic covariates

Hypothesis	Regression weighs	Beta coefficient	R^2	Adjusted R^2	F	t-value	p-value	Hypothesis supported
H2	Sex	-912.501	0.134	0.018	39.286	-5.652	<0.001	Yes
H4	Income	417.378	0.021	0.020	5.232	2.786	0.005	yes

The following ;variables were regressed and were not statistically significant; employment, water source, education, electricity, cooking fuel, microwave availability and fridge availability.

The hypothesis tests if each of the socio-demographic and household assets carries a significant impact on nutrient intake. The dependent variable carbohydrates were regressed on predicting socio-demographic variables. H_2. Sex significantly predicted carbohydrates, F (10,2152) = 22.361, p<0.001, which therefore indicates Sex played a significant role in carbohydrate consumption (b=-25.497, p<.001). These clearly show only socioeconomic variables were a confounding factor to energy consumption thus the adjusted R^2=.010 depicts the model explains a 1% change in carbohydrate can be accounted for by Sex while 1.2% is accounted by income (Table 4.10.2).

Table 4.10.2: Linear regression of total daily carbohydrates consumption and polony recall adjusted for socio-economic covariates

Hypothesis	Regression weighs	Beta coefficient	R^2	Adjusted R^2	F	t-value	p-value	Hypothesis supported
H2	Sex	-25.497	0.010	0.010	22.361	-4.629	<0.001	Yes
H4	income	12.799	0.013	0.012	13.804	-2.207	0.023	Yes

The following; variables were regressed and were not statistically significant; marital status, employment, water source, education, electricity, cooking fuel, microwave availability and fridge availability.

The hypothesis tests if each of the socio-demographic and household assets carries a significant impact on nutrient intake. The dependent variable protein was regressed on predicting socio-demographic variables. The income variable significantly predicted protein, F (10,2152) = 29.651, p=0.006, which therefore indicates income played a significant role in protein consumption (b=-3.895, p=0.006). These clearly show only sex and income were confounding factors to protein consumption thus the adjusted R^2=.013 depicts the model explains a 1.6% change in protein can be accounted for by the income variable (Table 4.10.3).

Table 4.10.3: Linear regression of total daily protein consumption and polony recall adjusted for socio-economic covariates

Hypothesis	Regression weighs	Beta coefficient	R^2	Adjusted R Square	F	t-value	p-value	Hypothesis supported
H2	Sex	-8.021	0.014	0.013	29.651	-5.445	<0.001	Yes
H4	income	3.895	0.017	0.016	18.727	-5.516	0.006	Yes

The following ;variables were regressed and were not statistically significant; marital status employment, water source, education, electricity, cooking fuel, microwave availability and fridge availability.

The hypothesis tests if each of the socio-demographic and household assets carries significant impact on the zinc intake. The dependent variable zinc was regressed on predicting socio-demographic variables. Only sex variables significantly predicted zinc, F (10,2152) =52.518, P<0.001, which therefore indicates only sex played a significant role in zinc consumption (b=-0.024, p<.001). These clearly show only sex was a factor to zinc consumption thus the adjusted R^2=.022 depicts the model explains a 2.2%% change in zinc consumption can be accounted for by zinc (Table 4.10.4).

Table 4.10.4: Linear regression of total daily zinc consumption and polony recall adjusted for socio-economic covariates

Hypothesis	Regression weighs	Beta coefficient	R^2	Adjusted R Square	F	t-value	p-value	Hypothesis supported
H2	Sex	0.024	0.024	0.022	52.518	-7.247	<0.001	Yes

The following ;variables were regressed and were not statistically significant; marital status, income employment, water source, education, electricity, cooking fuel, microwave availability and fridge availability.

The hypothesis tests if each of the socio-demographic and household assets carries significant impact on the zinc intake. The dependent variable thiamine was regressed on predicting socio-demographic variables. Income variables significantly predicted thiamine, F (10,2152) =11.091, P=0.010. The model predicted sex and income each accounted for 1.3% in change in thiamine consumption (Table 4.10.5).

Table 4.10.5: Linear regression of total daily thiamine consumption and polony recall adjusted for socio-economic covariates

Hypothesis	Regression weighs	Beta coefficient	R^2	Adjusted R Square	F	t-value	p-value	Hypothesis supported
H2	Sex	-0.165	0.013	0.009	15.535	-3.941	<0.001	Yes
H4	income	0.102	0.013	0.009	11.091	2.570	0.010	Yes

The following; variables were regressed and were not statistically significant; marital status, employment, water source, education, electricity, cooking fuel, microwave availability and fridge availability.

4.6 Dietary quality

4.6.1 Dietary patterns of the pre-recall and post-recall groups

The dietary quality and patterns reported through the 24-hour recalls were analysed according to the proportions of food groups consumed. The most commonly consumed food group by the study sample was cereal and cereal products for both pre-recall and post-recall groups. Sugars were the second most (77.8%) consumed food group with an average consumption of 17g/day followed by meat and meat products with a mean consumption of 145.0g/d and 143.2g/d for the pre-recall and the post-recall groups respectively. Nuts and seeds were the least (0.7%) consumed food group and less than a third (n=402) of both groups consumed any fruits on the day before data collection compared to two-thirds (n=1697) of the sample that consumed vegetables in both groups (***Table 4.11***).

Table 4.11: The proportion of the study sample that reported consuming each of the food groups during the previous 24hrs pre-recall and post-recall.

Food group description	Rank based on proportion	Proportionate distribution of consumption			mean amount consumed by the groups (g/day)		
	Overall Rank	Pre-recall n (%)	Post-recall n (%)	Total n (%)	Pre-recall	Post-recall	Total
		739	**1447**	**2186**			
Cereals and cereal products	1	731 (98.9)	1426 (98.5)	2157 (98.7)	514.4	508.0	510.2
Sugar, syrups and sweets	2	579 (78.3)	1122 (77.5)	1701 (77.8)	16.3	17.7	17.2
Meat and meat products	3	579 (78.3)	1118 (77.3)	1697 (77.6)	145.0	143.2	143.8
Miscellaneous	4	578 (78.2)	1080 (74.6)	1658 (75.8)	703.1	724.1	716.8
Vegetables	5	543 (73.5)	1054 (72.8)	1597 (73.1)	153.1	153.4	153.3
Fats and oils	6	369 (49.9)	683 (47.2)	1052 (48.1)	30.9	28.4	29.3
Milk and milk products	7	297 (40.2)	591 (40.8)	888 (40.6)	214.0	221.4	218.8
Beverages	8	138(18.7)	314 (21.7)	452 (20.7)	494.8	427.5	448.0
Fruit	9	142 (19.2)	260 (18.0)	402 (18.4)	227.9	220.1	222.9
Eggs	10	125 (16.9)	253 (17.5)	378 (17.3)	124.3	119.9	121.4
Fish and seafood	11	67 (9.1)	159 (11.0)	226 (10.3)	126.3	131.9	130.2
Soups, sauces, seasonings and flavour.	12	95 (12.9)	206 (14.2)	301 (13.8)	80.9	70.0	73.5
Legumes and legume products	13	33 (4.5)	70 (4.8)	103 (4.7)	92.8	109.2	104.0
Nuts and seeds	14	8 (1.1)	7 (0.5)	15 (0.7)	37.6	63.1	49.5
Food groups are based on MRC Food composition tables for South Africa 2017. food group 14 (infant and paediatric foods) and food group 15 (therapeutic/special/diet products) are not listed since the study included healthy adults.							

Individual foods consumed were analysed from the 24hr recalls and quantitative analysis was done to establish the most commonly consumed foods and the average portion size consumed. These data are presented in ***Table 4.12***. The most consumed food by both the pre-recall and post-recall groups was cooked white rice which was consumed by 51.3% and 50.8% respectively, with an average serving of four serving spoons (225.1g and 218.2g respectively) per person for both the pre-recall and post-recall groups. Potatoes were the most commonly reportedly consumed type of starchy root vegetable by both groups, and they were ranked ninth in total food rankings consumed by both the groups while chicken was the only meat and meat product foodstuff commonly consumed in the top 10 foods. Lastly, sugar (white granulated) was reported as the second most consumed foodstuff as it was reported by almost half (48.8%) of the study sample with an average portion size of 3 level teaspoons per day. (***Table 4.12***).

Table 4.12: The top 10 foods reportedly consumed per day by the proportion of each group and the average portion consumed

Food names		Number of Consumers n (%)			Mean amount consumed g/day		
Rank	**Food**	**Pre-recall n=739**	**Post-recall n=1447**	**Total n=2186**	**Pre-recall**	**Post-recall**	**Total**
1	Rice, white, cooked	379(51.3)	735(50.8)	1114(51.0)	102.5	99.4	100.4
2	Sugar (granulated)	371 (50.2)	696(48.1)	1067(48.8)	15.0	13.7	14.1
3	Bread(brown/white)	334 (45.2)	645 (44.6)	979 (44.8)	62.6	57.2	59.0
4	Chicken	289 (39.1)	561(38.8)	850(38.9)	24.2	24.9	24.7
5	Milk (UHT, FC)	207(28.0)	394(27.2)	601(27.5)	45.1	46.8	46.2
6	Potatoes	196(26.5)	386(26.7)	582(26.6)	19.3	20.9	20.4
7	Onion	151(20.2)	294(20.3)	445(20.4)	5.6	5.3	5.4
8	Carrots	148(20.0)	273(18.9)	421(19.3)	6.4	7.1	6.9
9	Tea/Coffee	114(15.4)	228(15.8)	342(15.6)	45.9	47.6	47.0
10	Cooking oil	111(15.0)	217(15.0)	328(15.0)	0.6	0.7	0.7

Foods that met at least 15% of the Nutrient Reference Values (NRV) for nutrients of interest were ranked based on which nutrient-rich foods were most commonly consumed. ***Table 4.13*** shows that two of the top 5 protein-rich foods consumed were animal products in both pre-recall and post-recall groups. The commercial bread was the most reportedly consumed (45.2% and 44.6%) by pre and post-recall groups respectively with similar portion sizes (3 slices). Dairy-mix juice is the only beverage rich in protein commonly consumed by the study sample.

Table 4.13: Top five protein-rich foods with at least 15% of protein NRVs consumed by the study sample

Protein					
Pre-recall			**Post-recall**		
Food	**Proportion of population n (%)**	**Average portion size (g)**	**Food**	**Proportion of population n (%)**	**Average portion size (g)**
Bread (brown/white)	334 (45.2)	62.6	Bread (brown/white)	645 (44.6)	57.2
Chicken	289 (39.1)	24.2	Chicken	561 (38.8)	24.9
Eggs	91 (12.3)	64.9	Eggs	191 (13.2)	120.7
Maize meal porridge	60 (8.1)	24.2	Maize meal porridge	148 10.2)	24.9
Dairy-mix juice	37 (5.0)	260.6	Dairy-mix juice	56 (3.9)	301.4

Less than one-tenth (7.3 %) of the pre-recall group consumed polony and the average portion size was 27.7g. The two groups were similar in polony intake in the pre- and post-recall groups however the proportion and portion serving size is slightly greater in the post-recall compared to the pre-recall group (***Table 4.13.1***).

Table 4.13.1: Proportion of population that had consumed polony pre-recall and post-recall of the removal of polony in the retail shelves

Groups	Proportion n (%)	Average serving (g)
Pre-recall	54 (7.3)	27.7g
Post-recall	108 (7.5)	28.9g
Total	162 (7.4)	28.5

The top five vitamin-A-rich foods with at least 15% of the vitamin A NRV for daily requirements include commercial bread as the most consumed vitamin A-rich food by the proportion of the study sample for both pre-recall and post-recall groups. Carrots are the only vitamin-A rich vegetable in the top 5 consumed by similar proportions in both groups. Lastly, maizemeal consumption is the fourth ranked food in pre-recall however a third in the post-recall group with a slightly lower portion size (*Table 4.14*).

Table 4.14: Top five vitamin-A-rich foods with at least 15% of vitamin A NRVs consumed by the study sample

Vitamin A					
Pre-recall			Post-recall		
Food	Proportion of population n (%)	Average portion (g)	Food	Proportion of population n (%)	Average portion (g)
Bread (brown/white)	334 (45.2)	62.6	Bread (brown/white)	645 (44.6)	57.2
Eggs	91 (12.3)	64.9	Eggs	191 (13.2)	120.7
Carrots	65 (8.8)	71.9	Carrots	117 (8.1)	72.1
Maize meal porridge	60 (8.1)	24.2	Maize meal porridge	148 10.2)	24.9
Margarine (polyunsaturated)	8 (1.1)	31.9	Margarine (polyunsaturated)	6 (0.4)	18.3

Chicken was the most consumed vitamin B12-rich food by the study population. Three of the top five vitamin B12-rich foods were animal products while two were beverages. The foods

consumed by the post-recall group had slightly greater portion sizes compared to pre-recall group with the exception of milk *(Table 4.15)*.

Table 4.15: Top five vitamin B12 foods with at least 15% of vitamin B12 NRVs consumed by the study sample

Vitamin B12					
Pre-recall			**Post-recall**		
Food	**Proportion of population n (%)**	**Average portion (g)**	**Food**	**Proportion of population n (%)**	**Average portion (g)**
Chicken	289 (39.1)	24.2	Chicken	561 (38.8)	24.9
Eggs	91 (12.3)	64.9	Eggs	191 (13.2)	120.7
Vetkoek (cake flour)	88 (11.9)	147.8	Vetkoek (cake flour)	160 (11.1)	166.8
Milk	73 (9.9)	75.7	Milk	148 (10.2)	70.5
Dairy-mix juice	37 (5.0)	260.6	Dairy-mix juice	56 (3.9)	301.4

The top five foods with at least a 15% NRV daily requirement are presented in *Table 4.16*. Commercial bread was the most consumed foodstuff with proportions of 45.2% and 44.6% and average portion size of 3 slices for both groups. Maize meal was also among the top 5 zinc-rich foods consumed in the form of soft porridge, crumble porridge, or stiff porridge and consumed by the proportion of 8.1% and 10.4% of pre- and post-recall groups respectively (*Table 4.16*).

Table 4.16: Top five zinc-rich foods with at least 15% of Zinc NRVs consumed by the study sample

Zinc					
Pre-recall			**Post-recall**		
Food	**Proportion of population n (%)**	**Average portion (g)**	**Food**	**Proportion of population n (%)**	**Average portion (g)**
Bread (brown/white)	334 (45.2)	62.6	Bread (brown/white)	645 (44.6)	57.2
Chicken	289 (39.1)	24.2	Chicken	561 (38.8)	24.9
Milk	73 (9.9)	75.7	Milk	148 (10.2)	70.5
Maize meal	60 (8.1)	524.5	Maize meal	150 (10.4)	492.7
Samp and beans	20 (2.7)	125.5	Samp and beans	34 (2.3)	174.1

Consumption of iron (Fe) -rich foods was mostly attributed to commercial bread in both groups. Maize meal average portion size was the biggest portion size compared to all other foodstuffs in both groups. Weetbix were the only breakfast cereal on the top five iron-rich foods by proportionate distribution (*Table 4.17*).

Table 4.17: Top five iron-rich foods with at least 15% of Iron (fe) NRVs consumed by the study sample

Iron (Fe)					
Pre-recall			**Post-recall**		
Food	**Population n (%)**	**Average portion (g)**	**Food**	**Proportion of population n (%)**	**Average portion (g)**
Bread (brown/white)	334 (45.2)	62.6	Bread (brown/white)	645 (44.6)	57.2
Milk	73 (9.9)	75.7	Milk	148 (10.2)	70.5
Maize meal	60 (8.1)	524.5	Maize meal	150 (10.4)	492.7
Pilchard	41 (5.5)	124.9	Pilchard	100 (6.9)	137.2
Weet-bix	28 (3.8)	118.2	Weet-bix	46 (3.2)	116.4

Vitamin E-rich food consumption looked similar in both groups as both groups only had one vegetable in the top five vitamin E-rich foods. Eggs (boiled or fried) had the highest reported

proportion of the study sample with 12.3% and 13.2% in pre-recall and post-recall respectively however post-recall group had almost double the portion size compared to pre-recall group. Homemade vetkoek (fat cake) was the second-highest-consumed vitamin E-rich food in both groups while cabbage was the only vitamin E-rich vegetable reported in both groups. Lastly, vetkoek had the largest average portion size reported in both groups (*Table 4.18*).

Table 4.18: Top five vitamin-E-rich foods with at least 15% of Vitamin E NRVs consumed by the study sample

Vitamin E					
Pre-recall			**Post-recall**		
Food	**Proportion of population n (%)**	**Average portion (gram)**	**Food**	**Proportion of population n (%)**	**Average portion (gram)**
Eggs	91 (12.3)	64.9	Eggs	191 (13.2)	120.7
Vetkoek (cake flour)	88 (11.9)	147.8	Vetkoek (cake flour)	160 (11.1)	166.8
Milk	73 (9.9)	75.7	Milk	148 (10.2)	70.5
Cabbage	69 (9.3)	74.4	Cabbage	118 (8.2)	78.5
Margarine (50% polyunsaturated)	8 (1.1)	31.9	Margarine (50% polyunsaturated)	6 (0.4)	18.3

The top 5 thiamine-rich foods are dominated by ultra-processed and semi-processed foods and only samp and beans is an unprocessed food. Commercial bread and milk are the most reported foods consumed by the proportion of both groups. Weetbix are reportedly consumed by four percent (n=28) of the pre-recall with an average portion size of 118.2g however post-recall had a slightly lower proportion and average portion size compared to pre-recall (*Table 4.19*).

Table 4.19: Top five thiamine-rich foods with at least 15% of Thiamine NRVs consumed by the study sample

Thiamine					
Pre-recall			**Post-recall**		
Food	**Proportion of population n (%)**	**Average portion (gram)**	**Food**	**Proportion of population n (%)**	**Average portion (gram)**
Bread (brown/white)	334 (45.2)	62.6	Bread (brown/white)	645 (44.6)	57.2
Milk	73 (9.9)	75.7	Milk	148 (10.2)	70.5
Maize meal	60 (8.1)	524.5	Maize meal	150 (10.4)	492.7
Weet-bix	28 (3.8)	118.2	Weet-bix	46 (3.2)	116.4
Samp and beans	20 (2.7)	125.5	Samp and beans	34 (2.3)	174.1

4.6.2 Dietary diversity

Minimum Dietary Diversity for Women (MDD-W) was used as an indicator level for dietary diversity of the groups, based on 10 food groups. The MDD-W calculation for dietary diversity from the 24-hour recall showed that 72.31% and 72.51% of pre-recall and post-recall groups respectively were not dietary diverse ***(Table 4.20)*****.** This means only 27.69% and 27.49% of the pre-recall and post-recall population had consumed at least 5 food groups or more on the day prior to data collection. There was no statistical difference between the two groups (p=0.920). This is supported by the results from ***Figure 4.2*** as only 4 food groups were reported to be consumed by over 50% of the population of both the pre-recall and post-recall groups. Lastly, less than a third of the total study sample was consuming a sufficiently diverse diet **(*Table 4.20*)**

Table 4.20: The proportionate distribution of adequate and poor dietary diversity and proportion of population who consumed MDD-W food groups in the pre-recall and post-recall groups.

	Study Sample		Pre-recall		Post-recall		P-value
	n=2186	**%**	**n = 739**	**%**	**n= 1447**	**%**	
Mean dietary diversity score (SD)		***1.12 (1.33)***		***1.12 (1.32)***		***1.12 (1.32)***	
Adequate diet diversity (MDD-W≥5)	258	11.8	91	12.3	167	11.5	0.596
Poor diet diversity (MDD-W<5)	1928	88.2	648	87.7	1280	88.5	
Proportion of study sample consuming each food group							
Grains, roots, and tubers (%)	2157	98.7	731`	98.9	1426	98.5	0.476
Pulses (%)	64	2.9	23	3.1	41	2.8	
Nuts and seeds (%)	15	0.7	8	1.1	7	0.5	0.109
Dairy (%)	888	40.6	297	40.2	591	40.8	0.768
Meat, poultry, and fish (%)	1796	82.2	609	82.4	1187	82.0	0.828
Eggs (%)	378	17.3	125	16.9	253	17.5	0.739
Dark leafy greens vegetables (%)	1	0.0	0	0.0	1	0.1	0.475
Vitamin A-rich fruits and vegetables (%)	3	0.1	0	0.0	3	0.2	0.215
Other vegetables (%)	1593	72.9	543	73.5	1050	72.6	0.649
Other fruits (%)	399	18.3	142	19.2	257	17.8	0.405

MDD-W food groups were used to formulate the analysis of nutrient-rich foods however nuts and seeds were excluded from the list due to the fact that these foods were not consumed by many. ***Figure 4.2*** shows that meat, poultry, and fish were the most consumed nutrient-rich foods that were consumed by both groups followed by other vegetables. However, less than 1% consumed green leafy vegetables or vitamin A-rich fruit and vegetables. Only two nutrient-rich food groups were consumed by more than 50% of the study sample while five remained below that in both pre-recall and post-recall groups.

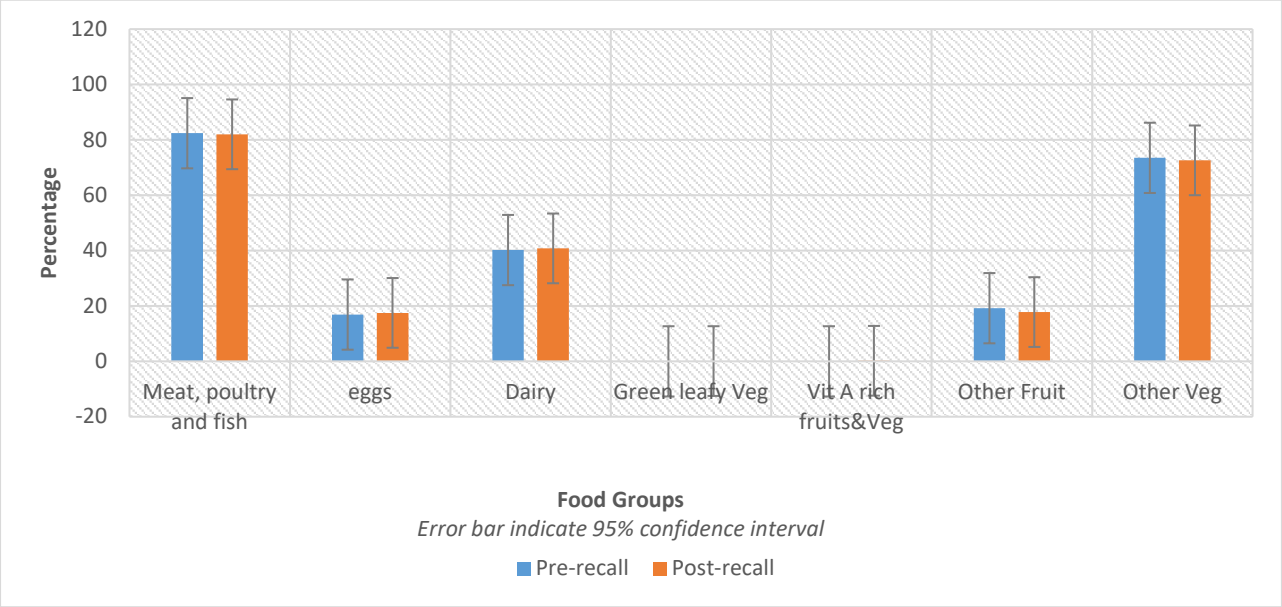


Figure 4.2: Proportion of study participants consuming nutrient-rich food groups

The MDD-W food groups were also used to analyse low-nutrient density foods. These are food groups that are more energy dense but lower in nutrient density. For the purpose of this study, we refer to these food groups as low-nutrient food groups. ***Figure 4.3*** depicts the proportion of participants consuming low-nutrient density foods remained lower than half of the study sample for all the foods in both groups. However, fats and oils were the most consumed low-nutrient foods while sweets and candies were the least consumed. Lastly, sugar-sweetened beverages were the second most consumed food groups in this category with 15.5% and 15.8% of the pre-recall and post-recall respectively.

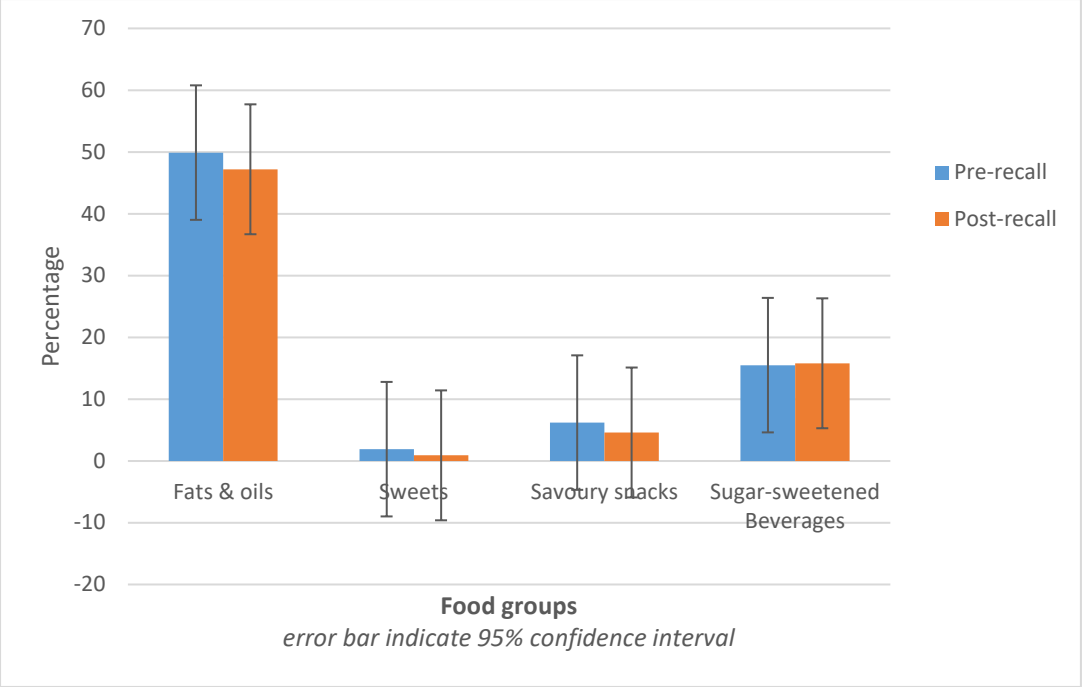


Figure 4.3: Proportion of study sample consuming low-nutrient density food groups

4.7 Meat sales, trends and market share

National food purchasing patterns were explored in this study using Euromonitor International propriety data. The Euromonitor International Passport database showed that South African consumers consumed 14.8 kg of raw and uncooked meat per annum in 2016 and there was a decline in consumption of meat during the period of the listeriosis outbreak (2018) as the year showed 14.7 kg per person per annum (see Table 4.21). The consumption of lamb, mutton, and goat meat had a significant increase of 4% in consumption between 2016 and 2019. The total meat consumption of fresh, frozen, and processed meats showed a 14.7% decline between the period 2016 and 2019. The major contributor to this decline was processed meats which showed a continued decline from the year of the listeria outbreak (2018) and continued to 2019. The processed meat food category declined by 37.1% between 2016 and 2019. The total meat reported does not account for offal meat and other ready-to-eat foods that may include meat as an additional ingredient, such as pizza, lasagne, etc (***Table 4.21***)**.**

Table 4.21: The Comparison of meats and seafood consumption in South Africa between 2016 and 2019 assessed by Euromonitor Package Food and Beverage Consumption

Food item	Euromonitor (Kg.capita/year)				
	2016	2017	2018	2019	% Change (2016-2019)
Total Fresh Meat	14.8	14.7	14.7	14.8	0
Beef and Veal	1.5	1.5	1.5	1.5	0
Lamb, Mutton and Goat	2.5	2.5	2.5	2.6	4
Pork	3.4	3.4	3.3	3.2	-5.9
Poultry	2.1	2.1	2.2	2.3	9.5
Other meats	5.3	5.2	5.2	5.2	-1.9
Total Processed Meat and Fish	2.6	2.6	2.3	2.3	-11.5
Processed meat	9.7	9.7	6.3	6.1	-37.1
Processed fish	1.4	1.5	1.5	1.5	7.1
Total Meat (fresh, frozen and processed)	24.5	24.4	21	20.9	-14.7
Meat substitutes	1.6	1.6	1.6	1.7	6.25

The subcategories of processed meat and seafood include chilled processed meats and chilled processed seafood. Initially, in 2016 twice as much chilled processed meat was being consumed

compared to chilled processed seafood however, this changed between 2018 and 2019 due the drastic drop in chilled meat consumption. The biggest decline of chilled processed meats consumption was observed in 2018 with consumption declining by 3.4 kg in the year compared to the previous year. The chilled processed seafood consumption was almost consistent throughout the 4 years, most notably there was no decline in the year of the listeriosis outbreak and a decline of 0.1kg was observed in 2019 (***Figure 4.4***).

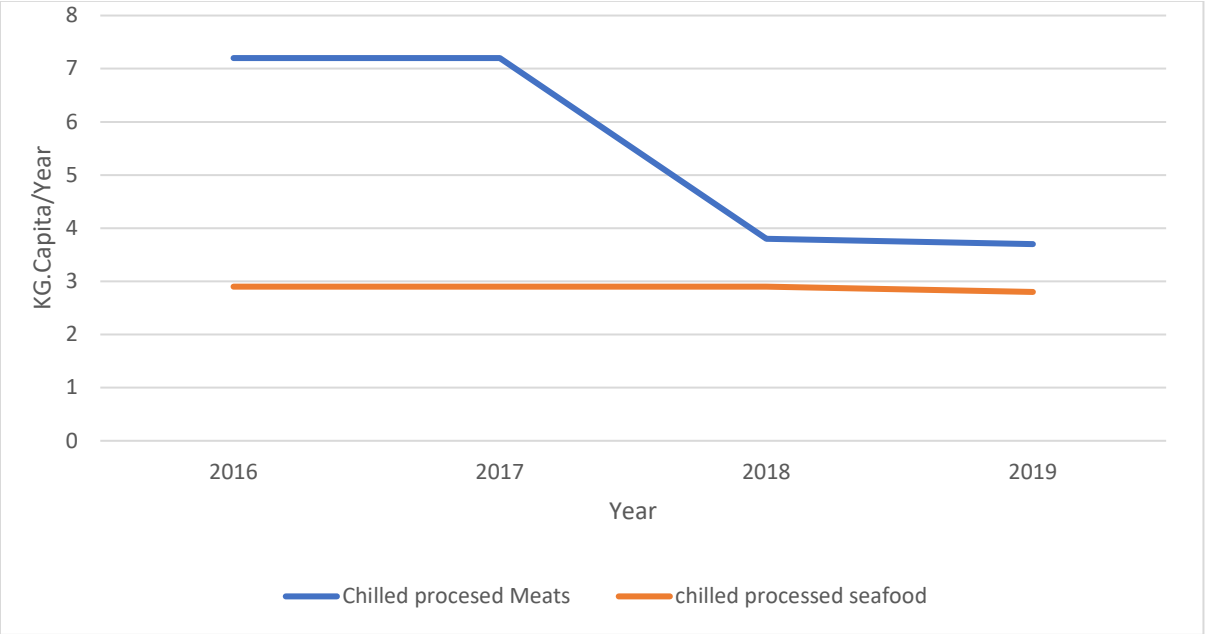


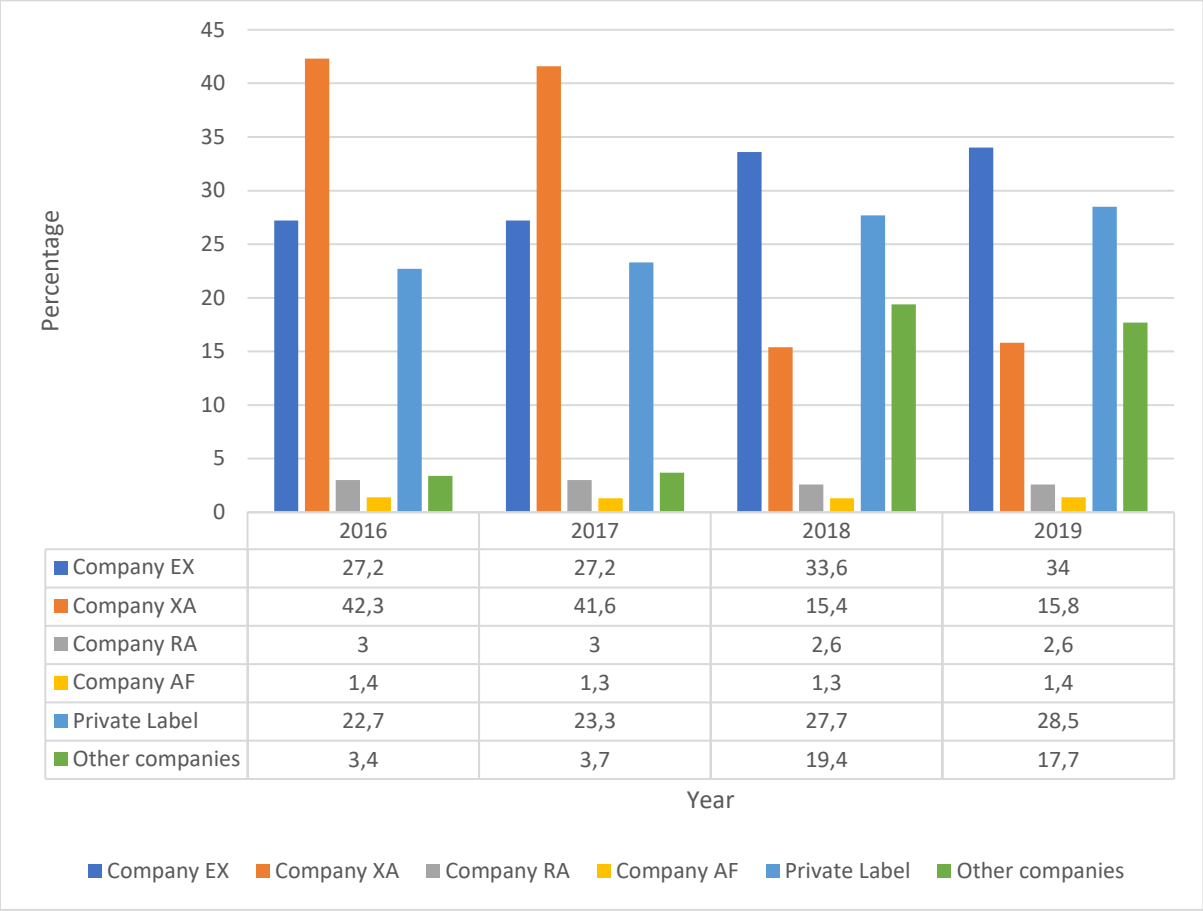
Figure 4.4: South African consumption of chilled processed meat and chilled processed seafoods per capita over 4 years

In 2016 only four companies held 73.9% of the chilled processed meat market share in South Africa while private labels held 22.7% and other companies took 3.4%. In 2017 a similar trend was observed between these companies with company AX holding 41.6% market share in 2017.

It is worth noting that Company XA was responsible for the listeriosis outbreak. As such, during the polony recall Company XA had the biggest decline of 26.2% in market share while other

companies benefitted a big gain of 15.7% and Company EX also made the second biggest gain of 6% market share in the same year compared to the previous year.

In 2019, other companies experienced a loss of 1.7% market share while Company XA made a gain of 0.4% of the market share following the 2018 year when the company had lost the majority of its market share. Company AF did not experience a significant change during these four years as it reported a 0% change between 2016 and 2019. Lastly, it is worth noting that Company XA reported the highest change of --62.6 % between the years 2016 and 2019 compared to all the other Global brands (***Figure 4.5***).



	2016	2017	2018	2019
Company EX	27,2	27,2	33,6	34
Company XA	42,3	41,6	15,4	15,8
Company RA	3	3	2,6	2,6
Company AF	1,4	1,3	1,3	1,4
Private Label	22,7	23,3	27,7	28,5
Other companies	3,4	3,7	19,4	17,7

Figure 4.5: The proportionate distribution of market share of companies manufacturing chilled processed meats between 2016 and 2019 in South Africa

4.8 Conclusion

Polony is often assumed to be consumed more frequently by lower socio-economic groups. The a priori assumption was that the total recall of polony as a result of the listeria outbreak will result in a change of dietary quality of South Africans, either positively or negatively. On a macro level this assumption held true as the sales of meat, especially processed meat, dropped significantly after the recall of polony and the company involved in the outbreak lost over 25% of its market share as a direct consequence. However, even though there was a total recall of polony from the point of sale, the consumption did not change by any significant margins after recall of polony in this particular study group. Lastly, there were no definitive differences in dietary intake between the two groups as dietary quality remained poor pre- and post-recall. Over two-thirds of the study sample in both groups reported consuming diets of insufficient dietary diversity.

CHAPTER 5

DISCUSSION

5.1 Introduction

In this chapter, I will discuss the main findings of the research study and reflect on these against already existing data in the South African context. Lastly, the main findings will be explored in relation to the current events and limited to the objectives of this study.

5.2 Theory of behaviour change

Human behaviours such as dietary consumption, liquor consumption, and social activities play a role in some of the leading causes of death in the developing world and any changes in these behaviours can have significant effects on the population's health (Davis et al., 2015). This study is grounded by the theory of behaviour change on how the listeria outbreak could influence changes in dietary patterns including the exclusion of polony products from the diet. A behavioural change theory such as The Precaution Adoption Process Model has been a widely used methodology to study changes or influence a change in specific behaviours as part of targeted intervention (Scherrens et al., 2018). In the case of the Langa community included in this study, the listeria outbreak did not necessarily lead to behavioural changes in relation to dietary patterns as both groups' diets remained similar. This may be due to similar socio-economic priorities across members in this community that play a more important role in food selection and dietary behaviour than food safety. In a systematic review (Liguori et al., 2022), 11 out of the 46 studies included found that despite food safety concerns, consumers could not always ensure that they consumed safe food; barriers were affordability, accessibility and appeal.

5.3 Nutritional Status

Protein consumption was adequate in both sexes on both groups as 64.2% (n=926) of females consumed adequate intake while 59.2% (n=440) of males met the minimum DRIs at a level that should meet the nutritional requirements of 97-98% of the population. This suggests that the unavailability of polony on retail shelves did not have a significant impact on protein consumption. This may be due to the fact that not many of the participants consumed polony. There was no significant change in polony consumption between the two groups and those that consumed the polony in post-recall group might be due to the high cost of discarding food (Liguori et al., 2022). Less than 10% of the study sample had consumed polony even before it was recalled from the retail stores. This finding was supported by the finding that polony was not one of the main protein sources commonly reported in the dietary intake survey, accounting for only 5.8% of daily protein intake on average amongst the proportion that consumed it. In contradiction to this, a study conducted among children aged 2-5 years in the North West province (South Africa) identified polony as a commonly consumed food (Korff et al., 2020). It is possible that polony could be reserved in households for consumption by young children or school-going children instead of adults.

The 10 main foods commonly consumed were identical for both the pre- and post-recall groups (rice, granulated sugar, commercial bread, chicken, full cream milk, potatoes, onion, mixed vegetables, tea/coffee, and cooking oil). The most commonly consumed staple foods were rice and bread. Vegetable consumption was less frequently reported by the participants, with potatoes, onions, and mixed vegetables being the most commonly reported vegetables. This reliance on staple foods may be due to their relative low costs supported by the exemption of value added tax (VAT) on bread, rice and maize meal (VALUE ADDED TAX ACT No. 89 of 1991; Part B of

Schedule 2), ability to fill the stomach, and therefore a preferred food choice by poor households (Mchiza et al., 2015).

Chicken was the preferred protein source amongst study participants, and is the most commonly consumed meat for both pre and post-recall groups. This finding is similar to other studies and may be due to the expensive price of red meat in South Africa making chicken the more affordable available alternative (Mchiza et al., 2015; Oldewage-Theron & Kruger, 2008; Vermeulen, 2020; Swart & Sambu, 2022). There was low consumption of fruit and vegetables, particularly green leafy vegetables. Even though fruits and vegetables are exempted from value-added tax (VAT) in South Africa (Peyton et al., 2015; Independent panel of experts for the review of zero rating in South Africa, 2018), they are still not consumed often or in large quantities. This phenomenon may be due to the fact that fruits and vegetables are expensive relative to their perishability and short life span. There is coexistence of informal and formal food outlets within communities (Kroll et al., 2019) and as such low-income communities utilize big-bulk spending from supermarkets by purchasing combos of staple foods with options of vegetables in bigger packages and make use of spaza shops for day-to-day foodstuffs such as milk, bread, etc (Peyton et al., 2015).This study sample from a low-income community and therefore not different. Potatoes and onions are the commonly reported vegetables, which supports the notion that it may be because of their ability to be stored for longer periods plus potatoes can be prepared and eaten in various forms (Vermeulen, 2020).

Although the mean dietary diversity score (DDS) for the South African population has been increasing it still remains inadequate (<5). There is consensus that formal urban areas have higher mean DDS compared to informal areas and that black South Africans in particular have lower mean DDS compared to white South Africans (Govender et al., 2017; Mchiza et al., 2015;

Oldewage-Theron & Kruger, 2008) and this may be a depiction of food insecurity amongst poor black South Africans (Mchiza et al., 2015; Swart & Sambu, 2022). Similarly, in this study over two-thirds (88.2%) of the study sample did not achieve adequate dietary diversity. This suggests that the participants did not have adequate variation in their diet. Even worse, the diversity in the diet of study participants could be poorer than the DDS findings indicated, as the diversity score does not reveal whether the participants consumed healthy or unhealthy foods within the food groups they consumed. To counter this gap the Global Diet Quality Project aims to develop a more descriptive tool that will consider consumption of foods high in nutrients of concern (Global Diet Quality Project, 2022).

Micronutrient deficiencies are prevalent in developing countries including South Africa due to poverty and food insecurity experienced by many of the population (Friede et al., 2012; Govender et al., 2017). Based on the 24-hour recalls collected in this study, on the day before the investigation over half of the study sample in this study consumed inadequate vitamin A and vitamin B12, and over two-thirds of the sample had inadequate vitamin E and iron consumption. The overall inadequate micronutrient consumption found in this study is an indication of poor dietary patterns and is in line with other studies that have shown similar results in South Africa (Govender et al., 2017; Oldewage-Theron & Kruger, 2008; Shisana et al., 2013). Inadequate intake of micronutrients may lead to malnutrition and consequently to different diseases including NCDs, compromised immunity, blood diseases, and impaired vision amongst others (Govender et al., 2019).

The most consumed food groups in this study included grains, meat, and dairy. This could be due to the fact that consumers can purchase large quantities of grains, cheap weighed frozen meat, and discounted dairy products. Sammon and Ndebia (2019) agree that in South Africa consumer's

dietary patterns may be influenced by the ability of the consumers to buy in bulk to store and use for over a long period of time (Sammon & Ndebia, 2019). Even though grains were commonly consumed by participants in this study, 94.6% of males and 83.1% of females had consumed inadequate fibre. Consequently, insufficient intake of fibre may lead to increased blood cholesterol, increased risk of colon cancer, insulin resistance, and increased risks of NCDs (Scholtz et al., 2001; O'Keefe et al., 2015).

Food expenditure is lower in low-income households and as a result, less variety of diet is acquired and low-quality foods are purchased to compensate insufficient funds (Oldewage-Theron and Kruger, 2008; Vermeulen, 2020). In this study, the sample consumed little variation of food, and green leafy vegetables were not even in the top 10 of the most consumed foods. The poor fruit and vegetable intake in the study sample likely contributed to the high number of participants who consumed inadequate micronutrients. Insufficient micronutrient intake is associated with non-communicable diseases (NCDs) such as type-2 diabetes, cancer, liver diseases and degenerative brain diseases (Fedacko et al., 2022), putting this study sample at higher risk of developing NCDs.

5.4 Household procurement factors and food security

The rise of food prices and inflation rates contribute to the high levels of food insecurity in South Africa (Mudau & Mahlatsi, 2022). The lack of employment reduces buying power, and has direct implications on food security as it reduces household's food access (Bernstein, 1994; IPC Global Partners, 2021). A significant number in this study sample are unemployed participants. A lack of employment opportunities and income likely influenced study participant's ability to afford food, as indicated in this study the most (17.7%) reported experienced hunger was lack of resources to get food. Lack of employment opportunities and a lack of agricultural land has led to widespread poverty (Adeoluwa et al., 2021; Pereira, 2013). In this study it was shown that the higher the

household income the lower the degree or extent of hunger experienced. This is evident as none of the households earning over R4000 experienced severe hunger according to the household hunger score. Although the expansion of the child support grant in the past quarter of a century has enabled many households to reduce the extent of hunger suffered by children and adults, it does not necessarily mean that it has enabled them to afford adequate nutritious food or make effective improvements in their dietary habits (Agostino et al., 2016). The commonly reported social grant in this study was the child support grant as 48% of the households depended on this grant as part of their household income.

5.5 Water, sanitation and hygiene

Access to water, proper sanitation and good hygiene at food production sites as well as at household level are important factors in combating outbreaks such as the listeria outbreaks. Focus has been aimed at controlling food handling by ensuring safe personal hygiene, safeguarding cross-contamination, thorough cooking, correct storage and avoiding consumption of food stuff from unsafe sources (Medeiros et al., 2001; Thaivalappil, 2019). In order for food handling and personal hygiene to be realized at household levels, access to water remains an important factor.

In this study, most of the households (45.4%) sourced their water inside the dwelling while 26.1% sourced their water within the yard. This somewhat impedes the majority (54.6%) of the participant's ability to adhere to hygiene practises such as washing surface areas and washing raw foods. To add, almost two-thirds (61.7% and 67.0%) of the pre-recall and post-recall groups respectively were unemployed, and over half of the households were living with a monthly household income of less than R4000. This suggests that the majority of both groups are unlikely to have the means to afford basic hygiene products such as sanitizers and hand soaps to disinfect surface areas in food preparation areas.

A significant number of participants (28.4%) reported sourcing water from a shared tap or municipal water-tankers or rain water. This may be because the dwellings are informal and do not have proper water and sanitation facilities. These water sources are commonly shared community water sources. This may be a conducive situation for pathogens to thrive as the water may be carried by buckets from the source to the house and over time the bucket might be contaminated in its life-cycle (Walden et al., 2005). Thaivalappil et al (2020) infer that the overall true handwashing behaviours are lower than reported because the analysis is based on self-reported measures rather than observations (Thaivalappil et al., 2020).

In 2018, the residents of Cape Town were experiencing water shortages because of drought and were less than three months away from taps being turned off completely in what was termed "day-zero". During this period residents had to reduce water usage by half (Enqvist & van Oyen, 2022). Some households used chemicals or boiled water to treat water due to safety concerns. Langa Township is a low-income area and almost two thirds of participants in this study were unemployed. Very few households would have been able to purchase bottled water for cooking and drinking purposes. To add, the municipality required residences to reduce water usage and this could have hindered hygiene practises such as washing hands, washing utensils and/or food. It could have also potentially influenced dietary choices. For example, households may avoid cooking foods which require a lot of water or they may cook few foods so as to lower water usage and/or reduce electricity use in an effort to reduce expenditure. The water meters were adjusted per household (throttled) and some households need to cater for back-yarders renting shack in the properties or large families may have found it harder to have water access (Enqvist & van Oyen, 2022). This may have allowed pathogens to spread and dietary intake subsequently to change within the communities.

Storage and refrigeration remain an important aspect in food supply chain to preserve shelf-life and provide consumers with safe food. It is reported that 40% of food products require refrigeration and 9% of those foods are lost due to spoilage because of lack of refrigeration (Duret et al., 2019; James & James, 2010). In this study about 19.1% of the study participants did not have a refrigerator or freezer. Polony and other processed meat products require refrigeration for proper safe storage to limit any pathogenic growth. The lack of refrigeration poses a risk in households that do not have proper cold storage (Martínez-Martínez et al., 2023).

Even though refrigeration may be present in households, correct operating temperatures of refrigerators remain an important aspect in combating listeria and other pathogens. Previous studies have pointed out that lack of thermometers in home refrigerators to monitor actual operating temperatures may be problematic, as well as lack of knowledge about correct storage temperatures (Thaivalappil et al., 2020). In a study conducted in Mexico (a developing country like South Africa), over 70% of household refrigerators operate above 5 degrees Celsius which increases spoilage and foodborne illness (Martínez-Martínez et al., 2021). Furthermore, refrigeration depends on consistent electricity supply to function. Even though the majority of households in both groups in this study had electricity access, electricity remains expensive in South Africa. Refrigeration alone accounts for 15% of the consumed electricity (Duret et al., 2019). In Cape Town half of all households are low-income households and they only represent 25% of residential energy demand compared to high income households (25%) who represent 50% of household energy demand (Williams et al., 2020). The demand for electricity grew faster between 2010 and 2018 and that has put pressure on production and infrastructure (Kabeyi & Olanrewaju, 2023). In South Africa, load shedding was introduced as a system implemented when electricity supply does not meet the electricity demand due to failures in electricity generating plants. As a

result, certain areas in the country are switched off for few hours from the power grid to accommodate the deficit. The demand and other factors have raised the price of electricity in South Africa and as such the usage is low in low-income households due to its expensiveness. The effects of load-shedding of electricity to food safety and food wastage amongst others needs to be studied. When electricity supply is not continuously available, safe refrigeration temperatures cannot be maintained. These fluctuation in the temperature of the stored foods may affect quality, shelf-life and food safety may be compromised due to the potential risk of pathogen growth.

5.6 Policy implications and recommendation

In South Africa, food safety regulations fall under three government departments namely; Department of Health (DOH), Department of Agriculture, Forestry and Fisheries (DAFF) and Department of Trade and Industry (DTI). Food safety regulations are also enforced through by-laws at a municipal level. There is often poor coordination amongst the various actors (Boatemaa et al., 2019), thus different municipalities have different financial capacities; poor municipalities have less environmental health practitioners to conduct food safety monitoring at municipality levels. To add, environmental health practitioners are not only responsible for food safety but also water and air quality. As a result, environmental health officers only have the capacity to visit a few manufacturing companies and retailers once a year at most (Department of Health, 2014).

At the time of the listeria outbreak, the then Minister of Health, Dr Aaron Motsoaledi, acknowledged that there are some flaws in the South African food system, in particular the lack of environmental practitioners (Crouth, 2018). In South Africa, food safety management rests primarily on self-regulation by the manufacturing companies. These companies may not

necessarily consistently send all of their samples during production for pathogenic assessment, instead sending samples irregularly. This results in it taking months to identify the source of the contamination during outbreaks (Boatemaa et al., 2019). To improve food safety, it should be mandatory for manufacturers to test samples within their premises or shared laboratories for small scale producers and each batch produced per day of production must be recorded and samples kept, and these results should be shared with the environmental health practitioners. This will improve monitoring and encourage transparency between companies and environmental health practitioners (Crouth, 2018). Furthermore, issues of food safety monitoring and enforcement should not rest on local government but rather be under national government so that the poor municipalities are also serviced. A national database of all food manufacturing companies should be kept and all records pertaining to food safety audits, risk assessments and pathogen tests uploaded for monitoring.

During the listeria outbreak, there was an ongoing drought in Cape Town. The drought impacted the Cape Town population and had implications for families, in particular poor households, such as those residing in Langa. The right to water is enshrined in our constitution act 108 of 1997 (Republic of South Africa, 1996) however in practice access to clean and safe water remains a privilege to some and in times of drought this becomes evident as only those with financial resources can make other means to access water. The government needs to put interventions in place to improve access to safe water for all, and to assist poor communities that already are hindered from accessing water in their informal settlements (Muller, 2014).

To improve dietary quality, the government needs to improve the formal and informal food environment of poor communities by improving access to healthy foods and improving variety by coordinating (Ambikapathi et al., 2021) with producers and exporters to subsidize wholesome

foods as well as fruits and vegetables. To add, increasing agricultural production by using sustainable techniques may also be beneficial to the low-income households (Grote, 2014). The issues of electricity load-shedding and expensiveness needs to be resolved so that household food storage improves and businesses are not negatively impacted. The improvement of socio-economic status remains one of the most important aspects for the ability of families to afford healthy and safe foods as food security increases with increase in household income (Mannaf & Uddin, 2012). Accordingly, socio-economic status could be improved by improving the country and regional economies by ensuring employment, spreading investment throughout the country and region to avoid over saturation of businesses that offer employment in one area which may lead to over population, high immigration as well as internal migration, which consequently increases levels of food insecurity and low dietary diversity (Crush & Tawodzera, 2017).

5.7 Conclusion.

To sum up all that has been discussed, the Langa community is poor, living in unsatisfactory conditions and consuming a nutritionally inadequate diet. This study has found that during the outbreak of listeria this community was consuming a nutritionally inadequate diet. Even though there were participants that consumed polony in both the pre- and post-recall groups, intake was low, even before the withdrawal of polony from the point of sales.

In the post-recall group, polony was still consumed even after awareness about listeria outbreak and therefore a theory of behavioural change needs to be used in the future when establishing an intervention to an outbreak or any event that may require individuals or groups to change their behaviour. In essence, the listeria outbreak did not have a significant effect on the study sample's dietary quality or dietary intake patterns, as the dietary quality was poor before the outbreak and

continued so even during the outbreak. However, it did highlight numerous health disadvantages experienced by poor communities.

5.8 Limitations of the study

The study by design is a natural experiment and only observed the effect of listeria outbreak and therefore cannot be used to assess the cause. To add, results from this study cannot be generalised to the public as it does not represent all the economic groups in the country. Furthermore, the study is limited also as it only assesses adult diet, excluding children. The effect of polony recall might have been felt more in children than adults. Lastly, the scope of this study did not afford the researcher the opportunity to explore other aspects of the participants food decision making and their interpretation of the listeriosis outbreak.

5.9 Recommendations

The Department of Health needs to often update the list of pathogens for surveillance by food industry and this should be done seasonally and be guided by trends in foods safety locally and abroad. Environmental health practitioners should not only be under local government but also at national level as small municipalities may lack financial power to employ sufficient human resources. Furthermore, food safety regulations should be thoroughly enforced and monitored.

5.10 Suggestions for further research

The researcher proposes more in-depth studies to assess population behaviour during outbreaks and pandemics with focus on dietary patterns. This may help to develop informed interventions during emergency situations to safeguard against food and nutrition insecurity.

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APPENDICES

APPENDIX 1: RESEARCH PROPOSAL

UNIVERSITY OF THE WESTERN CAPE

Faculty of Community and Health Sciences

RESEARCH PROPOSAL

Title:	The influence of 2018 listeria outbreak on the nutrition quality and dietary patterns of Langa township
Student Name:	Sikhumbule Kagiso Joni
Student Number:	3881332
Type of Thesis :	Full Masters Thesis
Degree:	MSc Nutrition
Department:	Dietetics and Nutrition
Supervisor:	Prof E C Swart
Date:	July 2019

10 Keywords: Dietary patterns, nutrient intake, protein source, processed meat, ready-to-eat, listeria, dietary patterns, adults, food security, polony

ABSTRACT

In South Africa polony was identified as the source of listeriosis in early March 2018. Polony serves as a protein source for many poor households in South Africa. Protein sources are generally expensive but necessary as essential amino-acids, the building blocks of protein, cannot be produced by the human body. The aim of this study is to investigate the effect of the removal of polony from the food retail on 4 March 2018, as the alleged source of the listeriosis outbreak, on overall nutrient intake, dietary patterns and protein sources of the Langa community in Cape Town.

In this study a natural experiment (NE) method is used as research design. This method is an observational study that makes use of naturally occurring situations to provide answers to specific questions. Secondary data from the ROFE project will be used in this study as the removal of polony took place when the ROFE project had completed 1000 of the 2500 participants in the study sample. The ROFE project in Langa used a standardized and validated 24-hour recall method to record the dietary intake of 2500 participants (aged 18 to 39 years) in a door-to-door household survey. Socio-demographic characteristics of participants were recorded through a questionnaire recorded digitally using cellphones. In addition, national sales figures of processed meat from Euromonitor International will be explored to determine if similar patterns observed in Langa were recorded for national food purchases.

The foods consumed by participants will be converted to nutrients using the MRC Food quantities manual and the MRC Food composition tables. SPSS will be used for data analyses. Descriptive statistics will be used to present the most commonly consumed food sources (with an emphasis on protein sources), its frequency and portion size consumed. Independent t-tests will be used to determine if consumption patterns (food sources, frequency and portion size consumed) were significantly different before and after the listeriosis outbreak and for categorical variable layers (age, sex, socio-economic status, food security status, household composition such as presence of children). One way ANOVAs will be performed to determine differences in nutrient intake (continuous variables) before and after the outbreak. Food purchase data obtained from Euromonitor International will be presented graphically as per capita volume of sales to indicated consumption patterns of different food products over time.

1 INTRODUCTION

The Center for Health Protection states that listeriosis is a global public health concern as an emerging infection due to its outbreak occurrences throughout the world (CHP, 2010). Riggio, Wang, Kniel and Gibson (2019) further adds that one in 10 people in the globe is infected with food borne illness as a direct consequence of pathogenic contaminants (Riggio, *et al.,* 2019*).* Scallan et al. (2011), states that 1 in 30 Americans is diagnosed with foodborne diseases instigated by at least one of 31 known pathogens and 90% of the foodborne disease is accounted for by listeria, salmonella, norovirus, E.coli, Campylobacter, Toxoplasma and Clostridium perfringens (Scallan et al, 2011). Europe and United States of America (USA) reportedly had the largest of foodborne infection outbreaks in the world caused by listeria and other pathogens between 1991-2002. In Europe, countries such as England, Wales, Denmark, Belgium, Germany, Holland, Switzerland and Finland also reported increases in occurrence of listeriosis between 2000-2006 (Tilsala-Timisj 2015).

In South Africa, the first report of listeriosis occurred between 1977 and 1978 with only 14 cases in Johannesburg (Manganye et al. 2018). Since then there were no alarming occurrences. However, from 2017 to 2nd of March 2018 South Africa had the largest listeriosis outbreak in the world. There were approximately 1000 cases with approximately 200 deaths (Manganye et al. 2018)

The impact of Listeria on ready-to-eat (RTE) foods is significant even in small outbreaks. Listeriosis outbreaks is estimated to cost the USA approximately 2 billion a year at 1.27-1/28 million United States Dollars (USD) per individual case (Ryu et al. 2013). It is also deemed the 3rd highest cause of death in foodborne related deaths.. In 2002, the USA second largest poultry manufacturer had to recall around 13000 metric tons of RTE foods from retailers due to listeriosis and that was the largest meat recall in the history of USA (Food Safety Authority of Ireland, 2005).

1.1 Problem statement

Food security is a state to which all persons; at any given time have physical and economical means to access adequate, safe and nutritious food stuff that caters for their dietary needs and food preferences in order to sustain a healthy life. Furthermore, food security has four pillars which include; food availability, food accessibility, food dissemination and food utilization. When any of these four pillars are not met then a country's food security is compromised (Koch, 2011).

Food availability includes reliable access to adequate food supply that is safe and nutritious. The world population is expected to be at 9 billion by 2050. As such food supply must meet demands to ensure food security however that cannot be achieved without global food safety (King et al. 2017). Food safety is an important aspect of food security (Curtis and Halford 2014). To this end World Health Day 2015 emphasized food safety for food and nutrition security (Uyttendaele, Boeck, and Jacxsens 2016).

1.2 Purpose of the study

The purpose of the study is to assess the effect of the 2018 listeria outbreak in South Africa (and subsequent removal of all polony products from supermarket shelves) on the dietary patterns, protein sources and nutrient intake of the Langa community in Cape Town.

1.3 Significance of the study

The study's significance lies in understanding the impact of food safety with regards to food and nutrition security. The study will help understand the depth of use of cold meats, particularly polony products, in the township thus contributing to our understanding of the food and nutrient diversity of the community, specifically around protein sources. Food manufacturers may use the information to inspire new products which are appropriate for low income households with limited resources such as refrigeration. It may also inform the development of appropriate nutrition education and information on food sources and alternatives.

1.4 Research question

The research question that led to this study was:

- ✓ What was the effect of the 2018 listeria outbreak (and specifically the removal of all polony from the shelves of all retailers) on food consumption and nutrient intake in a low-income community?

  This question will be answered through these sub questions:

- ✓ What was the range and frequency of consumption of specific food products, with specific reference to protein sources, before and after listeria outbreak?
- ✓ What was the nutrient intake of participants before and after the listeria outbreak?
- ✓ What is are the primary source of protein and other specific nutrients before and after the listeria outbreak?
- ✓ What are the cold-meat sales figures nationally one year before and one year after listeria outbreak?

1.4 Aim of the study

The aim of this study is to assess the effect of the 2018 listeria outbreak in South Africa (and subsequent removal of all polony products from supermarket shelves) on the dietary patterns and nutrient quality of Langa community in Cape Town.

1.5 Research objectives

1.5.1 To describe the range and frequency of consumption of specific food products by participants before and after listeria outbreak

1.5.2 To describe the nutrient intake of participants before and after the listeria outbreak and subsequent removal of polony from shelves in supermarkets

1.5.3 To assess the primary sources of specific nutrients (with a focus on protein sources) consumed by participants before and after the listeria utbreak.

1.5.4 To explore the sales figures three months before and three months after the listeria outbreak to understand if the patterns observed in Langa community is similar to national trends

2 LITERATURE REVIEW

2.1 Listeria

Noordhout et al (2014) defines listeriosis as the bacterium listeria monocytogenes, a foodborne pathogen that result in human listeriosis. The pathogen is one of the twelve variety species under the genus listeria (Jamali and Lin 2014). This bacterium is known to be more prone to individuals with lower immune system. These include pregnant women, the elderly, Human Immune deficiency virus (HIV)/ AIDS positive, cancer and persons who had an organ transplant. Haas et al (1989) asserts that listeria genus comprises of a cluster of rod-shaped gram-positive bacteria of which some are infectious with severe health consequences to both

human and animals (Haas *et al*., 1989). These genus includes species of listeria monocytogenes, listeria livanovii, listeria seeligeri, listeria welshimeri, listeria mocua and listeria grayi (Ryu *et al*., 2013).

Listeria environment

Listeria is found to survive in natural environments such as soil, water, air and vegetation. It is commonly carried by animals of both domestic and wild habitats. The mostly consumed animals which are common reservoirs include cattle and sheep, however, humans are also known to be a common contributor with feces particularly those working in listeria exposed environments such as abattoirs and biological laboratories (CHP, 2010).

Lappi et al (2004) infer that assortments of RTE can support the growth of listeria post processing (Lappi et al. 2004). Unprocessed milk, vegetables, and RTE foods have also been alluded to be linked to outbreaks in the world (CHP, 2010). Furthermore, the food may be contaminated during the processing stage or even post-processing then magnify during storage. Soft cheese, cold meats, hotdogs, smoked seafood and cooked crustaceans are some of the common foods of transmition of L-monocytogenes to humans (CHP, 2010).

Chakraborty, Hain and Domann (2000) suggest that listeria genus can survive under extreme and diverse conditions (Chakraborty, Hain, and Domann 2000) including environments with low PH, low temperatures and high salt concentrations (Ryu *et al,*2013).

Listeria monocytogenes

Listeria monocytogenes is a listeria genus species which is characterized as virulent to humans and a haemolytic. This listeria is a food borne pathogen with low prevalence rate but higher mortality rate and other severe illness. This bacterium can be found in raw and processed foods, particularly RTE foods (Ryu *et al,* 2013). These foods are eaten without further heating which creates a desireable living condition for the pathogen to grow and multiply (Tilsala-timisj 2015).

Carriers of Listeria

Listeria genus is generally carried by human intestinal tract upon consumption of listeria contaminated food, the bacteria gains access to the human and animal intestinal gut by avoiding

immunological defenses however the point of entry differs from host to host (Chakraborty, Hain and Domann, 2000:168). The presence of listeria genus on human intestinal tract may not necessarily be an indication of a person being sick or ill. These bacteria are then released outside through feces.

2.2 Dietary Patterns

A dietary pattern is defined as the amount and variety of foods and the combination of such foods and beverages in a diet thus the frequency to which they are consumed (Shisana *et al,* 2013). Persons require a wide variety of nutrients for the body to metabolize and function as intended. Dietary requirements differ from person to person due to different physiological bodily needs. However, such nutrients are dependent on the dietary pattern of an individual which is influenced by various factors. To add, changes in one's patterns may be categorized as being qualitative and quantitative changes (Sammugam and Pasupuleti 2018).

World wide a nutritional transition, influenced by urbanization and globalization has been observed. As such, a traditional diet is lost due to urban exposure and a western diet is adopted (Bourne et al 2002). Fat consumption has increased while carbohydrates consumption has gone down both in rural and urban settings. To add, sugar and sweetener consumption is also increasing in the developing countries while the consumption of cereals, fruits and vegetables consumption are still insufficient. As a consequence, overweight and obesity, None-Communicable diseases (NCDs) and other health problems become prominent (Hawkes, 2006).

Dietary transition is perpetuated by globalization which itself is linked to changes in income and lifestyle. Globalization affects the food availability and food access through influence on production, acquisition and logistics. As consequence to this food cultures are broken and new culture is established that subsequently changes dietary pattern and nutrition (Hough and Sosa, 2015).

The rate of change in diet is rapidly accelerating. For example, South America and Asia are experiencing changes in diet so much that there are concerns over increases in high energy dense foods coupled with little physical activity (Popkin, 2002). Furthermore, the global nutrition transition results in fetal nutritional insufficiency. The world shifts from whole unprepared food to processed and packaged foods in convenience stores (Popkin *et al*, 2012).

Protein consumption

Health practitioners are emphasizing the significance of dietary and lifestyle factors to prevent NCDs. All macro and micro nutrients are important to be acquired from a diet. Protein is described as the expensive nutrient of any diet but a necessity for human consumption. However, protein consumption in developing countries is often inadequate compared to the required amounts as the availability of protein in developing countries is limited. Lastly, protein is obtained from two sources, namely; animal and plant source (Schonfeldt and Hall, 2012).

Animal protein is obtained from dairy products, meat, fish, eggs and dishes made of animal by products. The dairy products include milk, yoghurt, cheese and more. While meats include that of poultry and all meats (Altorf-Van Der Kuil, Engberink, Geleijnse, Boer, & Monique Verschuren, 2012). Animal-based foods contain highest concentration of protein per energy thus its quality is regarded as excellent (Schönfeldt & Hall, 2012).

Plant based protein is protein derived from plants such as rice, bread, nuts, legumes and more. To add, plant-based protein is incomplete in a numbers of amino acids. However, they consist of none-nutrients which binds and facilitate metabolism of protein (Schönfeldt & Hall, 2012).

South Africa's red meat consumption is declining along with the world consumption while there's an increase in white meat and protein derived from meat (Scholtz, Vorster and Matsego, 2001). Prices and perceived health issues associated to it such as high saturated fat often comes with the animal protein contributes to the decline. However, FAO (2009) report an increase in protein consumption in other developing countries (FAO, 2009). South Africa has a relatively higher population living poor, as such, food prices force them to nutritionally inadequate foods even though healthy alternatives are available but expensive (Temple et al, 2011). Dietary diversity is still significantly lower such that when none-nutritive foods are not included, the dietary diversity in Cape town is still lower compared to Johannesburg (Frayne, Battersby-Lennard, Fincham, & Haysom, 2009:20). People source these foods from supermarkets, small shops and informal shops, restaurants and fast food. However small and informal shops are the most frequently visited while supermarkets are the least. In a study conducted on first year female students 60% to 80% of most frequently consumed baked wheat foods, pickled vegetable, banana and mangoe, and processed beef product and chicken as source of protein (Mchiza et al, 2015).

Temple et al (2011) infer that there is evidence that USA and France economy restrict the low-income population to unhealthy foods. High fat and high sugar foods are the cheapest sources

of protein while fruit and vegetable, fish and lean meat are far more expensive (Temple *et al, 2*011). Meat has played largest part of developed countries diets from history and in present as sources of protein. The USA and UK meat source includes poultry, pig, sheep and cattle while India, middle east is goats and camels. As such, people consume over half of total meat as meat products such as pie, sausages and patties (Kearney, 2010).

3. THEORETICAL FRAMEWORK

This study will be grounded in ecological systems theory, also referred to as the bioecological model which was developed by Urie Bronfenbrenner (Härkönen, 2007). However, instead of the traditional bioeconoligical model, the "inverse" adaptive systems model proposed by Swinburn et al. (2019) in the Lancet Global obesity syndemic paper, will be used. The adaptive systems model (Figure 2) suggests the inter-relationships between systems are multiple, change over time, and involve several interacting, reinforcing, and balancing causal feedback loops, as well as the fact that non-linear associations exist between causes and effects. Reinforcement of feedback loops leads to virtuous or vicious cycles, depending on the outcome. Balancing feedback loops counteract the directions of change that form the basis of homoeostasis in this complex adaptive systems.

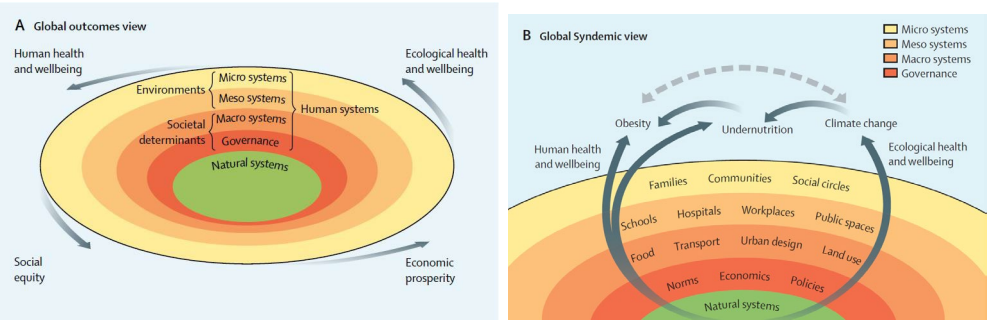

Figure 1: Adaptive systems model proposed by Swinburn et al. (2019)

4. METHODOLOGY

The research design and methodology which is to be used in this study will be discussed and described in this section. A synopsis detailing the data collection procedures, included and excluded participants and analysis of data will be discussed.

4.1 Research design

In this study a natural experiment (NE) method research design is used. This experiment is an observational study that makes use of naturally occurring situations to provide answers to specific questions (Messer and Boslaugh 2012). The natural experiment compares data before and after an event and thus allows a thorough evaluation of effects to an event. Such events may include elections, natural and human disasters and policy implementation (Mathison 2011). Mckenna and Morrison (2009) assert that NE cannot determine the cause of the outbreak however can explore the effects of that particular outbreak. To add, it provides answers to questions that would otherwise not be achievable on planned event as the researcher cannot influence the occurrence (Mckenna and Morrison, 2009). The advantages of using NE design is that it is pragmatic and cost-effective when data is readily available. However, a limitation is that the NE does not study the cause of the event but rather the effects of that event.

In this study the dietary intake of adults aged 18-39 years before and after the removal of polony (the alleged cause of the listeriosis outbreak) from all food retail stores, will be compared to investigate the possible effect of this intervention on the nutrient intake of the study population, and specifically the sources of protein most commonly consumed before and after the event.

4.2 Study setting

The study will use secondary data that was collected during February to March 2018 in Langa community in Cape Town, in the Western Cape South Africa. The Western Cape is the 4th largest of the nine provinces of South Africa and a third most populated with an estimated 6.6million occupants (Census, 2011). The provincial capital of the Western Cape is Cape Town and about two-thirds live in the metro. Langa is one of the oldest townships of Cape Town, created for black Africans[1] in 1927 as an alternative to the Ndabeni location (Musewa 1993) . The township has a population of 52401 (Census, 2011).

4.3 Study population

The study population included all households in Langa through a door-to-door survey. The natural experiment was made possible when the removal of all polony products from shelves of retail stores was announced on 4th March 2019 by the Minister in Department of Health Dr Aaron Motsoaledi due to listeriosis outbreak and investigation by the Department of Health identified polony as the carrier food item. At that stage the data collection on the project

"Researching the Obesogenic Food Environment" also known as ROFE (registration number BM17/8/20), in Langa had completed about 1000 of the intended 2500 households. This provided the opportunity to explore the alternatives that the research participants will use in the absence of polony from the market.

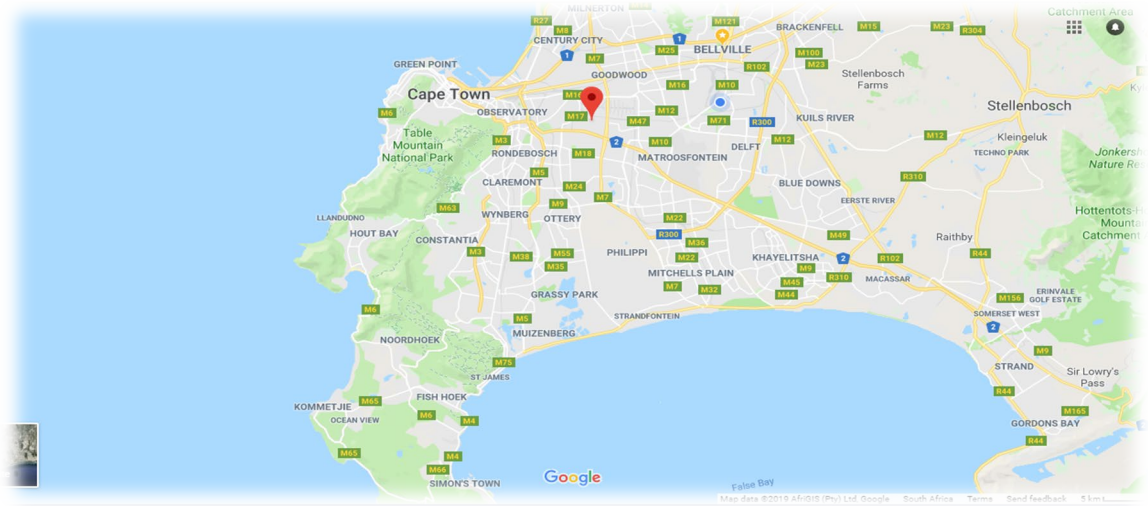

Figure 2: Location of Langa within the Cape Peninsula (Google Maps)

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[1] The racial description used as it appears in historical document.

4.4 Sample design and size

The ROFE study followed a door-to-door approach and in each household one participant between the ages of 18 to 39years old was invited to participate following an informed consent.

Exclusion criteria:

- ✓ Under 18years and over 39years.
- ✓ None Langa residents (i.e. individuals less than a month being a none-resident).

4.5 Data collection methods and tools

General socio-demographic information and detailed dietary intake information was collected from each consenting participant using the language of their choice. Field workers were trained in data collection techniques and was fluent in both English and isiXhosa since the target population spoke at least one or both the languages. Fieldworkers worked in pairs with one person collecting the general socio-demographic information and the other person collecting

the dietary intake information. The socio-demographic information was collected digitally on mobile phones using Open Data Kit (ODK) software accessible on internet through www.Opendatakit.org. This software allows free collection and managing of data (Opendatakit n.d). The dietary intake information was obtained using a 24hr recall (Gorshkov, 1989:63).

Fieldworkers completed the questionnaires personally and ensured reliability and validity by double checking that each questionnaire was correctly completed. Prior to saving and uploading the sociodemographic info on ODK, it was double checked for any errors.

During completion of the 24hour recall questionnaire a file with pictures of commonly consumed portion sizes as well as a 24hour recall measurement kit with commonly used utensils were used to assist participants to recall the volumes or amounts of foods and beverages consumed.

National food purchasing patterns will be explored usingEuromonitor International propriety data. Euromonitor International is a global independent market research company that focuses on variety of market products and services in the world thus researching consumer preferences, trends, marketing, product development and open market opportunities (Euromonitor International.nd).

4.6 Data Analyses

For analyses of the data, the researcher will make use of the South African Food Data System (SAFOODS) known as the MRC food composition tables to convert the 24hr recall information to nutrient intake data. SAFOODS is a compilation of information on macronutrients and micronutrients composition of foods (MRC n.d).

The Euromonitor data will be downloaded in Microsoft Excel spread sheet and analysed using SPSS software for descriptive data and then presented in tables and graphs as per capita volume of sales to indicated consumption patterns of different food products over time. SPSS Statistics will also be used to analyse the dietary intake data. Descriptive statistics will be used to present the most commonly consumed food sources (with an emphasis on protein sources), its frequency and portion size consumed. Independent t-tests will be used to determine if consumption patterns (food sources, frequency and portion size consumed) were significantly different before and after the listeriosis outbreak and for categorical variable layers (age, sex, socio-economic status, food security status, household composition such as presence of children). The t-test is an inferential test design to establish hypothesis by exploring differences

between two groups on some variables of interests to the researcher. The two groups will be before and after the recall of polony from retail shelves.

One way ANOVAs will be performed to determine differences in nutrient intake (continuous variables) before and after the outbreak.

4.7 Validity and reliability.

Validity refers to the degree of the measuring tools correctness and effectiveness in achieving objectives of the research while reliability is described as the extent to which the measuring tool produces the same results under similar environmental factors (Sun et al. 2010). Sichier and Everhart (1998) suggests that 24hour recall showed correlations in a validity study in Brazil diet Sichier and Everhart, 1998). Schatzkin et al (2003) adds that 24hour recall may slightly overestimate protein consumption, however that does not rule the instrument as invalid. Systematic measurement errors may occur during 24hr recall however these errors are managed through quality control by training interviewers, providing respondents with bowls and measuring tools, picture files showing food and portions, standardized calibration, food models and the use of actual food samples commonly consumed in that particular region (Gorshkov, 1989:64)

4.8 Confidentiality

The researcher will be utilizing secondary data, and will only have access to an anonymised data set thus no personal information will be available to the researcher. Furthermore, the researcher will keep all information such as Microsoft excel spreadsheets with the data highly classified and password protected in Microsoft OneDrive (n.d). Permission to use the data for secondary data analyses has been granted by the Principle investigator. (Attached)

4.9 Contribution of the researcher

The researcher served as a team leader in the primary study, performing 24hour recall himself. Subsequent to the data collection, the researcher performed the coding and quantification of the 24hour recall information towards the nutrient analyses being conducted using the electronic database on nutrient composition of foods as contained in the Food Composition Table of the South African Medical Research Council (MRC). The researcher performed double checking and quality assurance on all coding sheets of 24hr recalls.

4.10 Limitations

Limitations facing the researcher include high cost of data from EuromonitorData from Euromonitor can also not be broken down or simplified into information on Langa township alone. Therefore, Euromonitor data will be explored at national level only.

5. ETHICS

The researcher is aware of the principles of research ethics and protection of Human Research Participants. As this study will use secondary data, the researcher did not obtain consent from participants themselves, but the researcher worked as a fieldworker on the ROFE project and thus is aware that consent forms coupled with information sheets were given to the participants in the primary research. To add, participants were made aware of their rights to withdraw from the research at any given point. Furthermore, these sheets were written in both isiXhosa and English to ensure that participants clearly understand the questions to be asked. Lastly, the primary research was granted approval by the Biomedical Research Ethics Committee of the University of the Western Cape with ref BM17/8/20. The researcher is also requesting ethics approval for the secondary data analyses for his research project from the Senate Higher Degrees and the Human Science Research Ethics committee. Lastly, the researcher will not require ethics approval for Euromonitor International data as it is propriety data.

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APPENDIX 2:

HOUSEHOLD QUESTION FOR ROFE PROJECT

RESEARCHING THE OBESOGENIC FOOD ENVIRONMENT

HOUSEHOLD QUESTIONNAIRE

dateint	Date of interview	DD / MM / YY 7			☐☐/☐☐/1
teamid	Team identifier	☐☐	intid	Interviewer identifier	☐☐
ctryid	Country	01. South Africa 02. Ghana			☐☐
eaid	Area identifier	01 Khayelitsha 02 Mt Frere urban 03 Langa rural 04 Accra 05 Kumasi 06 Kumasi			☐☐
hh	Household identifier	☐☐	GPS	GPS coordinates	

Hello, my name is _____. I work for the UWC. We are interested in learning about your family, your household environment and food in your house. Who is the person in your household who is most knowledgeable about purchasing and preparing most of the food for your family? For example, we would like to know how often you usefully eat the different types of food items. May we speak to this person?

(Do not interview a household member <18 years of age.)

If this person is available:

- *Share the information sheet with this person and ask him/her to complete the Consent Form. Complete the Household Questionnaire.*
- *Explain that you would also like to speak to one individual about what they ate the day before, and measure the weight and height of this person. Complete the consent forms for this person. Remember to obtain ascent if the person is between 8-18 years. Complete the Dietary intake / Anthropometric measurements.*

If this person is not available:

- *Schedule a second visit to return to complete the Household Questionnaire when the person knowledgeable about food in the household is available.*

On the second visit:

- *If the person knowledgeable about food is available, ask him/her to complete Consent Form and Household Questionnaire. If that person is not available, ask the next most knowledgeable person. Share the information sheet and ask him/her to complete Consent Form and the Household Questionnaire;*
- *Explain that you would also like to speak to one individual about what they ate the day before, and measure the weight and height of this person. Complete the consent forms for this person. Remember to obtain ascent if the person is between 8-18 years. Complete the Dietary intake / Anthropometric measurements.*

Cons	Written consent obtained?	Yes……1 No……2	If **yes**, begin If **no**, end
visitno	Number of attempts to visit household (up to one return visit) *Record at the time of completing the interview or after second household visit*		☐
outhh	Outcome of HH questionnaire *Fill in only after questionnaire has been completed for this household.*	Completed.....1 Refused.....2 No household member at home or no adult respondent at home at time of visit(s).....3 Household member incapacitated or intoxicated……..4 Other: _____.....99	If 3 or 4, retur later for a second visit.
		Supervisor check	Initial for yes _____

HOUSEHOLD ROSTER

Now we would like some information about persons who usually stay in your household. This will include anybody who sleeps in this household for at least 4 nights of the week and eats from the same pot of food.

Start by listing the head of the household.

Line number	A. Name or initial of person	B. Sex	C. Age *(in years OR months).*		D. Currently attending school or college?	E. Highest educational level (grade) completed
			Years *(Record in years if >5 years*	Months (*Record in months if <60 months*		

01	Head of Household	M / F	☐☐		Yes……1 No…….2	0	5	7	12	>12
02		M / F	☐☐	☐☐	Yes……1 No…… 2	0	5	7	12	>12
03		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
04		M / F	☐☐	☐☐	Yes……1 No…… 2	0	5	7	12	>12
05		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
06		M / F	☐☐	☐☐	Yes……1 No…… 2	0	5	7	12	>12
07		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
08		M / F	☐☐	☐☐	Yes……1 No…… 2	0	5	7	12	>12
09		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
10		M / F	☐☐	☐☐	Yes……1 No…… 2	0	5	7	12	>12
11		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
12		M / F	☐☐	☐☐	Yes……1 No…… 2	0	5	7	12	>12
13		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
14		M / F	☐☐	☐☐	Yes……1 No…….2	0	5	7	12	>12
hh1a	*Just to make sure that I have a complete listing:* Are there any other persons such as small children or infants that we have not listed? *If YES, add name to table.*									
hh1b	Are there any other people who may not be members of your family, such as domestic servants, lodgers, or friends who usually live here and share the same pot of food for at least 4 days of the week? *If YES, add name to table*.									

Note: Add a new page if more people in the household		
Lnr	Line number of respondent *(WRITE IN THE NUMBER FROM THE HOUSEHOLD ROSTER)*	☐☐

Check the roster regarding completion!

SHORT BIRTH HISTORY			
N°	QUESTIONS	ANSWERS	SKIPS
bh1	Altogether, how many live births have there been in your household in the last 5 years? Please include any baby who cried or showed other signs of life. *(WRITE IN THE NUMBER.)* *(IF 'NONE', RECORD 00. IF 'DON'T KNOW', RECORD 88.)*	☐☐	If **00** or **88**, skip to **household characteristics** module.
bh2	Is this child / are these children still alive? *(CIRCLE ONLY **ONE** ANSWER.)*	All alive.....1 One or more has died in the past 5 years.....2 Don't know……88	

HOUSEHOLD CHARACTERISTICS			
N°	QUESTIONS	ANSWERS	SKIPS
hc1	Does your household have electricity? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……..1 No……2	

hc2	What fuel does your household mainly use for cooking? *(CIRCLE ONLY **ONE** ANSWER.)*	Electricity.....1 LPG.....2 Natural gas.....3 Biogas.....4 Kerosene / Parafin.....5 Coal / Lignite.....6 Candles.....7 Firewood.....8 Straw / Shrubs / Grass.....9 Animal dung.....10 Sun/solar cooker……..……..11 No food cooked in household.....12 Don't know.....88 Other: _____ ….....99	
hc3	Does your household or anyone in the household have … ? ***(PROMPT FOR EACH ITEM**; RECORD ALL ITEMS IN THE HOUSEHOLD.)* *(CIRCLE ONLY **ONE** ANSWER FOR EACH ITEM.)*	A. Radio (other than a car radio) Yes…….1 No……...2	

	Does your household or anyone in the household have … ? ***(PROMPT FOR EACH ITEM**; RECORD ALL ITEMS IN THE HOUSEHOLD.)* *(CIRCLE ONLY **ONE** ANSWER FOR EACH ITEM.)*		
		B. Television Yes……..1 No…… ...2	
		C. DVD player Yes……..1 No……...2	
		D. MNet-DSTV subscription Yes……..1 No……...2	
		E. Air conditioner Yes……..1 No……...2	

		F. Computer / desktop / laptop Yes……..1 No……...2	
		G. Vacuum cleaner / floor polisher Yes……..1 No……...2	
		H. Dishwashing machine Yes……..1 No……...2	
		I. Tumble dryer Yes……..1 No…… ...2	
		J. Home telephone (landline) Yes……..1 No…… …...2	
		K. Deep freezer Yes……..1 No…… …...2	
		L. Refrigerator / combined fridge/freezer Yes…...1 No..……..2	
		M. Cooking stove (electric) Yes……..1 No……...2	
		N. Cooking stove (gas) Yes……..1 No……...2	
		O. Microwave oven Yes……..1 No……...2	
		P. Built-in kitchen sink Yes……..1 No……...2	
		Q. Home security system Yes……..1 No……...2	
		R. Home theatre system Yes……..1 No……...2	
		S. Bicycle or tricycle Yes……..1	

		No……..2	
		T. Motorcycle, scooter, auto-rikshaw, car, truck, jeep, or tractor Yes……..1 No……...2	
		V. Canoe or fishing nets Yes……..1 No……...2	
		W. Animal-drawn cart Yes……..1 No……...2	
		X. Domestic worker Yes……..1 No……...2	
		Y. Hot water running from a geyser Yes……...1 No……...2	
		Z. Cell phone Yes……..1 No……...2	
		AA. 2 cell phones in household Yes……...1 No……....2	
		BB. 3 or more cell phones in household Yes…….1 No…....2	
hc4	Does this household or a household member owns the house? If not, do they rent it or live there without paying rent or live there temporarily? *(CIRCLE ONLY **ONE** ANSWER.)*	Owns the house……..……..1 Rents the house ..……..…2 Uses without paying rent …….... 3 No dwelling …….... 4	
hc5	How many rooms in this house are used for sleeping? (WRITE IN THE NUMBER)	☐☐	
hc6	In the past year has anyone been paid to clean house or do laundry for this household? (CIRCLE ONLY **ONE** ANSWER.)	Yes, daily.....1 Yes, weekly ..... 2 Yes, monthly .....3 Yes, quarterly 4	

		Yes, annually ……..... 5 No …….... 6 Don't know.....88 Other: _____ …..... 99	
hc7	Does any member of this household own any land?	Yes ……1 No ……..……2	If **2**, skip to **hc11**
hc8	What is the total amount of land owned by household member(s) together?	Total amount of land ……hectares	
hc9	Do you grow anything on the land?	Yes ……..1 No ……..……2	If **2**, skip to **hc11**
hc10	How much do you grow per year on the land?	Grains in bags …… How many months does this last? …… Vegetables (how many months do you have vegetables for the hh)…… …… Fruit (how many months do you have fruit for HH)…	
hc11	Does any member of this household owns live-stock?	Yes ……..1 No ……..……2	If **2**, skip to **hc15**
hc12	How many heads of large sized live-stock (eg. cattle, horses, oxen) are currently owned by the household in total? *(ONLY COUNT ADULT/GROWN ANIMALS)*	Total number of large sized live-stock……	
hc13	How many medium sized live-stock (eg. sheep, goats, pigs) are currently owned by the household? *(ONLY COUNT ADULT/GROWN ANIMALS)*	Total number of medium sized live-stock……	
hc14	How many small sized live-stock (eg. chicken, ducks, rabbits) are currently owned by the household? *(ONLY COUNT ADULT/GROWN ANIMALS)*	Total number of small sized live-stock……	
hc15	*WHAT IS THE MAIN MATERIAL OF THE FLOOR OF THE DWELLING?* *(OBSERVATION.)*	Natural floor Earth / sand.....1 Dung.....2 Rudimentary floor	

	*(CIRCLE ONLY **ONE** ANSWER.)*	Wood planks.....3 Palm / bamboo.....4 Finished floor Parquet / polished wood.....5 Vinyl / asphalt strips.....6 Ceramic tiles.....7 Cement.....8 Carpet.....9 Other: _____ 99	
hc16	*WHAT IS THE MAIN MATERIAL OF THE ROOF OF THE DWELLING?* *(OBSERVATION.)* *(CIRCLE ONLY **ONE** ANSWER.)*	Natural roofing No roofing.....1 Thatch / palm leaves.....2 Sod.....3 Rudimentary roofing Rustic mat.....4 Palm / bamboo.....5 Wood planks.....6 Plastic ….....7 Finished roofing Metal.....8 Calamine / cement fiber..... 9 Ceramic tiles.....10 Cement.....11 Roofing shingles.....12 Other: _____ 99	
hc17	*WHAT IS THE MAIN MATERIAL OF THE EXTERIOR WALLS OF THE DWELLING?* *(OBSERVATION.)* *(CIRCLE ONLY **ONE** ANSWER.)*	Plastic / Cardboard……..... 1 Mud or mud and cement ..... 2 Corrugated iron / zinc..... 3 Prefab ..... 4 Bare brick or cement blocks…….... 5 Plaster / finished..... 6 Other: _____ 99	

WATER, SANITATION, AND HYGIENE (WASH)			
N°	QUESTIONS	ANSWERS	SKIPS
w1	What is the main source of drinking water for the members of your household? *(CIRCLE ONLY **ONE** ANSWER.)*	Piped water Piped into dwelling.....1 Piped to yard / plot.....2 Public tap / standpipe.....3 Tube well / borehole.....4 Dug well Protected /covered well.....5 Unprotected / open well.....6 Water from spring Protected spring.....7 Unprotected spring.....8 Rainwater.....9 Tankertruck.....10 Cart with small tank.....11 Surface water River / stream ……12 Dam ……...13 Lake / Pond .....14 Water vendor / Bottled / sachet .....15 Don't know.....88 Other: _____ 99	
w2	Where is that water source located? *(CIRCLE ONLY **ONE** ANSWER.)*	In own dwelling……1 In own yard/plot……2 Elsewhere……3	If **1 or 2**, skip to **w4**
w3	How long does it take to go there, get water and come back?	Minutes…… ☐☐☐	

	(WRITE IN THE NUMBER.) *(IF 'DON'T KNOW', RECORD 888)*		
w4	Do you **usually** do anything to your drinking water to make it safer to drink? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……1 No…….. 2	If **No**, skip to **w6**
w5	What do you **usually** do to the water to make it safer to drink? *(DO **NOT** PROMPT. PROBE "ANYTHING ELSE?")* *(CIRCLE YES FOR EACH ITEM MENTIONED AND NO FOR EACH ITEM NOT MENTIONED.)*	A. Boil Yes / No	
		B. Add bleach / chlorine Yes / No	
		C. Strain through a cloth Yes / No	
		D. Use a water filter Yes / No (ceramic / sand / composite ...)	
		E. Solar disinfection Yes / No	
		F. Let it stand and settle Yes / No	
		G. Don't know Yes / No	

		H. Other: _____ Yes / No	
w6	What kind of toilet facility do members of your household usually use? *(DO **NOT** PROMPT.)* *(CIRCLE ONLY **ONE** ANSWER.)*	Flush / pour floush toilet Flush to piped sewer system.....1 Flush to septic tank.....2 Flush to pit latrine.....3 Flush to elsewhere.....4 Flush, don't know where.....5 Pit latrine Ventilated improved pit latrine.....6 Pit latrine with slab.....7 Pit latrine without slab / open pit.....8 Composting toilet.....9 Bucket toilet.....10 Hanging toilet / hanging latrine.....11 No facilities / bush / field.....12 Don't know.....88 Other: _____ 99	
w7	Do you share this facility with other households? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes……1 No…….. 2	
w8	How do you dispose your household waste? (DO NOT PROMPT.) (CIRCLE ALL ANSWERS MENTIONED.)	Composting …….....1 Recycle some items .....2 Burning …….....3 Municipal garbage pick-up.....4 Dump in rivers, streams .....5 Dump in forest …….....6 Dump on open land.....7	

		Don't know.....88 Other: _____ 99	

HEALTH SERVICES ACCESS			
N°	QUESTIONS	ANSWERS	SKIPS
hs1	How long does it take to travel to the nearest primary health care facility? *(A. WRITE IN THE NUMBER.)* *(B. CIRCLE THE UNIT.)* *(IF 'DON'T KNOW', RECORD 88.)*	A. Duration ☐☐☐ B. Minute(s)……..1 Hour(s).....2 Day(s).....3	If **A** is **88**, skip to **income** module.

HOUSEHOLD INCOME			
N°	QUESTIONS	ANSWERS	SKIPS
hi1	How many of the following social grants are received in this household? *(FILL IN THE **NUMBER** OF PERSONS RECEIVING EACH SPECIFIC GRANT. FILL IN 0, IF NOBODY RECEIVES A GRANT, 88= Don't know*	Child support grant..…… ☐☐ State Old age pension..…… ☐☐ Disability grant.……..… ☐☐ Foster care grant,,…… ☐☐ Other _____ ☐☐	
hi2	How many people contribute to the total income (money) in this household? *(CIRCLE ONLY **ONE** ANSWER.)*	None……1 1 person……..2 2 persons……3 3-4 persons……4	

		5-6 persons……...5 More than 6 persons…….……6 Don't know……88 Other: _____.....99	
hi3	What is the total household income per month before deductions (including wages, rent, grants, sales of vegetables, etc.) of everybody in the household added together? If you can tell me the amount off hand please do so, otherwise I will read out various income brackets. Please stop me when I say the amount that you think represents the total monthly income of the household. *(CIRCLE ONLY **ONE** ANSWER.)*	Less than R3001…….……1 R3001-4000……..2 R4001-5000……..3 R5001-R7500……4 R7501-R10,000……5 R10,0001-R15,000……..6 R15,001-R20,000……7 R20,0001-R30,000……..8 R30,0001-R40,000……..9 R40,001 or more……10 Don't know…….. 88	

"I would like to ask some questions about the availability of food in your household over the last month."

HOUSEHOLD HUNGER SCALE (BALLARD ET AL. 2011)			
N°	QUESTIONS	ANSWERS	SKIPS
hh1	In the past month, was there ever no food to eat of any kind in your house because of lack of resources to get food?	Yes ……..1 No ……2	If no, skip to hh2
hh1a	How often did this happen in the past month?	Rarely (1-2 times) ….……1 Sometimes (3-10times) …2 Often (>10 times) ……..3	
hh2	In the past month, did you or any household member go to sleep at night hungry because there was not enough food?	Yes ……..1 No ……2	If no, skip to hh2

hh2a	How often did this happen in the past month?	Rarely (1-2 times) ……1 Sometimes (3-10times) …2 Often (>10 times) ……..3	
hh3	In the past month. Did you or any household member go a whole day and night without eating anything at all because there was not enough food?	Yes ……...1 No ……2	If no, skip to hh2
hh3a	How often did this happen in the past month?	Rarely (1-2 times) ……1 Sometimes (3-10times) …2 Often (>10 times) ……..3	

LIVED POVERTY INDEX (AFRIBAROMETER – MATTES, DULANI & GYIMAH-BOADI 2016)			
N°	QUESTIONS	ANSWERS	SKIPS
lpi1	Over the past year, how often, if ever, have you or anyone in your family: Gone without enough food to eat? *(CIRCLE ONLY **ONE** ANSWER)*	Never .....0 Just once or twice ……1 Several times ……2 Many times ……3 Always ……4 Don't know……..……88	
lpi2	Over the past year, how often, if ever, have you or anyone in your family: Gone without enough clean water for home use? *(CIRCLE ONLY **ONE** ANSWER)*	Never .....0 Just once or twice ……1 Several times ……2 Many times ……3 Always ……4 Don't know……88	
lpi3	Over the past year, how often, if ever, have you or anyone in your family: Gone without medicines or medical treatment? *(CIRCLE ONLY **ONE** ANSWER)*	Never .....0 Just once or twice ……1 Several times ……2 Many times ……3	

		Always ……4 Don't know……88	
lpi4	Over the past year, how often, if ever, have you or anyone in your family: Gone without enough fuel to cook your food? *(CIRCLE ONLY **ONE** ANSWER)*	Never .....0 Just once or twice ……1 Several times ……2 Many times ……3 Always ……4 Don't know……88	
lpi5	Over the past year, how often, if ever, have you or anyone in your family: Gone without a cash income? *(CIRCLE ONLY **ONE** ANSWER)*	Never .....0 Just once or twice ……1 Several times ……2 Many times ……3 Always ……4 Don't know……88	

CHECK THE QUESTIONNAIRE & THANK THE RESPONDENT**

APPENDIX 3:

DIETARY ASSESSMENT QUESTIONNAIRE FOR ROFE PROJECT

RESEARCHING THE OBESOGENIC FOOD ENVIRONMENT

24 HR RECALL QUESTIONNAIRE

dateint	Date of interview	d d / m m / y y 1 8 / /	day	Day of the week (yesterday) being recalled	Sun Mon Tues Wed Thurs Fri 1 2 3 4 5 6
teamid	Area identifier	0 3 Langa	intidd	Interviewer identifier	.....
hh	Unique number	Interviewer id / sequence hh /	Inr_di	Respondent line number_diet	Interviewer id / sequence hh / line no / /
Sex	Sex	M / F	age	Age of respondent	

ALL INFORMATION WILL BE TREATED CONFIDENTIALY

WHAT FOOD AND DRINKS	HOW WAS IT PREPARED? WHAT WAS ADDED?	HOW MUCH WAS EATEN	Brand name of packaged/ processed foods
Breakfast time (waking up to about 9 o'clock)			
Mid-Morning (09h00 – 12h00)			
Lunch Time (12h00 – 14h00)			
Afternoon (14h00 – 17h00)			

Supper Time (17h00 – sunset)			
After supper, at bedtime and through the night			

dsp1	Was this a usual day in terms of eating? *(CIRCLE ONLY **ONE** ANSWER.)*	Yes…….....1 No…….....2	Skip to individual characteristics if answer is yes
dsp2	If not, what was the reason?		

CHECK THE QUESTIONNAIRE & THANK THE RESPONDENT FOR PROVIDING INFORMATION ON YESTERDAY'S FOOD INTAKE. PROCEED WITH SSB CONSUMPTION QUESTIONNAIRE.

SUPERVISOR INITIAL FOR CHECKING 24HR RECALL	

INITIAL FOR CODING OF 24HR RECALL	

INDIVIDUAL CHARACTERISTICS

hh	Unique number	Interviewer id / sequence hh □□ □□□ /	lnr_di	Respondent line number_diet	Interviewer id / sequence hh / line no □□ □□□ □ / /
Sex	Sex	M / F	age	Age of respondent	□□

No.	QUESTIONS	ANSWERS	SKIPS
gc1	How many of the children in this household are your own?	□□	
gc2	Do you have any other	□□	

	children who are alive who are not currently living with you in this household?		
gc3	What is your employment status?	Unemployed…… 1 Self-employed…….. 2 Wage earner…… 3 Part-time employment…….. 4 Casual worker……... 5 Other (specify)…… 99	
gc4	What is your marital status?	Single…….. 1 Married …….. 2 Widowed and not remarried…… 3 Divorced and not remarried …….. 4 Married but separated …… Living together…… 5 Other (specify)…….. 99	Skip to Question he1 if respondent is male
gc5	FOR FEMALE RESPONDENTS How long ago was your last pregnancy?	Never pregnant…….. 77 ☐☐ Currently pregnant ……..... 0 Time since last pregnancy in A. years ☐☐ or B.months	Skip to question he1 if time since last pregnancy is >= 2 years / never
gc6	FOR FEMALE RESPONDENTS	Yes …… 1 No…….. 2	Only ask question if time

	Are you currently breastfeeding?		since last pregnancy is <2years

No.	QUESTIONS	ANSWERS	SKIPS
he1	Has a professional ever diagnosed you with one of the following diseases? *(PROMPT FOR EACH ITEM; CIRCLE ONLY ONE ANSWER FOR EACH ITEM)*	Diabetes Mellitus…… Yes……1 No……..2	
		Heart disease……. Yes……1 No……..2	
		High cholesterol……..…….. Yes……1 No……..2	
		Hypertension/high blood pressure……. Yes……1 No……..2	
		Cancer…… Yes……1 No……..2	
		Overweight / Obesity…… Yes……1 No……..2	
he2	Do you currently smoke?	Yes…… 1 No, but smoked previously…….. 2 Yes, occasionally…….. 3 No, never smoked…… 4	
he3	What do you smoke most of the time?	Cigarettes…… 1 Pipe……. 2 Hookah pipe…….. 3 Marijuana ……..	

		4	
he4	Do you ever drink any alcohol?	Yes…… 1 No……. 2	
he5	Do you ever exercise?	Yes…… 1 No……. 2	
he6	How many days a week do you usually do at least 20 minutes the following type of exercise?	A. Walking ……..…. ☐ B. Moderate exercise…… ☐ C. Vigorous exercise ……. ☐	
he7	For how many hours in an average week, do you watch movies / television / series/ play electronic games	<1 hour per week…… 1 1-3 hrs / week……. 2 4-7hrs / week……. 3 8-14hrs / week (2hrs/day)…… 4 15-21hrs / week (3hrs/day)…….. 5 >21hrs/week…… 6	
he8	How do you perceive your own weight?	Underweight…… 1 Normal weight……. 2 Overweight…….. 3 Obese…….. 4	

he9	Is the following statement true or false when you shop for food?	I pay attention to the information on a package like “no sugar added”, “unsweetened”	True……..1 False…….2
he10		I am aware that nutrition information is printed on the back of a food package.	True……..1 False…….2
he11		I understand the nutrition information printed on the back of the food package.	True……..1 False…….2

7. KNOWLEDGE ATTITUDE AND PERCEPTION

(RIvard et al 2012; Madiba et al 2017; Vital Strategies)

I would like to ask you some questions about your understanding of foods and health. Please remember that there is no right or wrong answer, I am just trying to get an understanding of your perception.

No.	QUESTION	ANSWERS	SKIPS
sb1	When you think of the term "sugary drinks" which ones come to mind? ***(DO NOT PROMPT. PROBE… ANYTHING ELSE?)*** *(CIRCLE YES FOR EACH ITEM MENTIONED AND NO FOR EACH ITEM NOT MENTIONED)*	A. Bottled water (still, sparkling, flavoured) Yes.....1 No……..2 B. 100% fruit juice (eg. Liquifruit, Ceres, Appletiser) Yes.....1 No……..2 C. Nectars or canned juices that contain fruit (eg. Tropicana) Yes.....1 No……..2 D. Milk (full cream, low fat, fat free) (unflavoured) Yes.....1 No……..2 E. Milk (sweetened and flavoured) (eg. Nesquick, Steristumpie, Yogisip) Yes.....1 No……..2 F. Soda or soft drinks (eg. Coca Cola, Sprite, Ginger beer Iron Brew, Dry lemon, Kingsley) Yes.....1 No……..2 G. Diet soda / artificially sweetened beverages (eg. Coca Cola Light, Tab) Yes.....1 No……..2 H. Sweetened Iced Tea (eg. BOS, Lipton ice tea, Fuze) Yes.....1 No……..2 I. Coffee/tea with sugar (incl. cappuccino, frapuccino) Yes.....1 No……..2 J. Energy drinks (eg. Red Bull, Monster, Dragon) Yes.....1 No……..2 K. Sports drinks (eg. Energade, Powerade, Lucozade) Yes.....1 No……..2 L. Powdered drinks (eg. Game) Yes.....1 No……..2 M. Cordials and concentrates (eg. Oros) Yes.....1 No……..2 N. Other specify ……. Yes.....1 No……..2	

No.	QUESTION		ANSWERS				SKIPS
			Not sugary (1)	Some what (2)	Sugary (3)	Don't Know (99)	
sb2	***(PROMPT FOR EACH ITEM)*** *(MARK ONLY ONE ANSWER FOR EACH ITEM)*	A. Bottled water (still)					
		B. Bottled water (sparkling)					
		C. Bottled water (flavoured)					
		D. 100% fruit juice (eg. Liquifruit, Ceres, Appletiser)					
		E. Nectars or canned juices that contain fruit (eg. Tropicana)					
		F. Milk (full cream, low fat, fat free) (unflavoured)					
		G. Milk (sweetened and flavoured) (eg. Nesquick, Steristumpie, Yogisip)					
		H. Soda or soft drinks (eg. Coca Cola, Sprite, Ginger beer, Iron Brew, Dry lemon, Kingsley)					
		I. Diet soda / artificially sweetened beverages (eg. Coca Cola Light, Tab, Diet Sprite)					
		J. Sweetened Iced Tea (eg. BOS, Lipton ice tea, Fuze)					
		K. Coffee/tea with sugar (incl. cappuccino, frapuccino)					
		L. Energy drinks (eg. Red Bull, Monster, Dragon)					
		M. Sports drinks (eg. Energade, Powerade, Lucozade)					
		N. Powdered drinks (eg. Game)					
		O. Cordials and concentrates (eg. Oros)					

		P. Alcohol (beer)					
		Q. Alcohol (wine)					
		R. Alcohol (spirits)					
		S. Alcohol (ciders)					

No.	QUESTION		ANSWERS	SKIPS
sb3	**NOTE: For the purpose of this survey, what we mean by sugary drinks, is all soda or carbonated drinks, energy drinks, sports drinks, flavoured milk or fruit concentrates/nextars or powders for preparing soft drinks. All of them are high in either natural or added sugar**. To the best of your knowledge, does the consumption of sugary drinks increase the risk of suffering from …..? *(PROMPT FOR EACH DISEASE)* *(CIRCLE ONLY ONE ANSWER FOR EACH DISEASE)*	A. HIV	Not at all ….1 A little……..2 Somewhat..3 A lot …….4 Not sure/dk.5	
		B. Diabetes	Not at all ….1 A little……..2 Somewhat..3 A lot …….4 Not sure/dk.5	
		C. High blood pressure	Not at all ….1 A little……..2 Somewhat..3 A lot …….4 Not sure/dk.5	
		D. Obesity	Not at all ….1 A little……..2 Somewhat..3 A lot …….4 Not sure/dk.5	
		E. Dental problems	Not at all ….1 A little……..2 Somewhat..3 A lot …….4 Not sure/dk.5	

		F. Cancer Not at all ….1 A little……..2 Somewhat..3 A lot …….4 Not sure/dk.5	
sb4	To the best of your knowledge, does obesity increases the risk of suffering from…?	HIV Not at all……1 Just a little …2 Somewhat….3 A lot……4 Not sure…..99	
		Diabetes (Sugar diabetes) Not at all……1 Just a little …2 Somewhat….3 A lot……4 Not sure…..99	
		High blood pressure Not at all……1 Just a little …2 Somewhat….3 A lot……4 Not sure…..99	

sb4	To the best of your knowledge, does obesity increases the risk of suffering from…?	Dental problems Not at all……1 Just a little …2 Somewhat….3 A lot……4 Not sure…..99			
		Cancer Not at all……1 Just a little …2 Somewhat….3 A lot……4 Not sure…..99			
sb5	Are you aware of the new Health Promotion Levy (also called Sugary Beverage Tax)?	Yes…….. 1 No…… 2			
sb6	Do you support the taxation of foods that are less healthy or unhealthy?	Strongly oppose…….. 1 Oppose…… 2 Support…… 3 Strongly support……. 4			
sb7		Yes	No	Sometimes	

	Government introduced a new tax on sugary sweetened beverages which came into effect on 1 April 2018. Has this tax had any effect on your purchasing intentions, and if so what effect has it has? (PROMPT. MARK ONLY ONE ANSWER FOR EACH OPTION)	C.I switched to untaxed drinks				
		B. I have cut back on my sweetened beverage consumption				
		A. I have continued to consume the same drinks. The tax has had no impact at all.				
sb8	*If you have cut back or switched to untaxed drinks (option C or B above), which drinks do you drink more of….? (DO NOT PROMPT) (MARK YES IF AN OPTION IS MENTIONED. MARK NO IF OPTION IS NOT MENTIONED)*		A. Diet soda		Yes……1 No……..2	
			B. Fruit juice		Yes……1 No……..2	
			C. Water		Yes……1 No……..2	
			D. Milk		Yes……1 No……..2	
			E. Alcohol		Yes……1 No……..2	
			F. Other (specify) ……		Yes……1 No……..2	

8. SSB CONSUMPTION AND ACQUISITION

During the past month how often did you (personally) consume any of the following beverages? (*please check the relevant box*) Please read the food category to participants. If they respond positively (i.e. yes we consume this) then ask about the volume most commonly consumed and how often consumed. *Please remember there is no right or wrong answer. We would like to get the most accurate description of the beverages you consumed over the last month. Please tell me about your own consumption of beverages. I would like you to tell me if you drank any of the items that I am going to mention to you. You can also look at the pictures to identify the beverages you drink. If you drink these items, please tell me how often you drink it, and the volume you usually consume.*

Beverage unit MOST commonly consumed									
01	200ml	03	440ml	05	750ml	07	1.5l	09	other specify…
02	330ml	04	500ml	06	1l	08	2l		

Code	Food Item	Unit most often consumed	Never <1/mo (A)	1-3/ mo (B)	1/ wk (C)	2-4/ wk (D)	5-6/ wk (E)	1/ day (F)	2-3/ day (G)	≥4/ day (H)
bev1	Water from a tap, not commercial									
bev2	Bottled water (unflavoured) (still, sparkling)									
bev3	Bottled water (flavoured)									
bev4	100% fruit juice (e.g. Liquifruit, Ceres, Appletizer)									
bev5	Nectars or canned juices that contain fruit (e.g. Tropica, Cabana, Halls, Elvin, Dalys, Take5)									
bev6	Cordials/concentrates (e.g. Oros, Fusion, Wild Island)									
bev7	Milk unflavoured and unsweetened (e.g. full cream/low fat/fat free/ amasi)									
bev8	Milk products sweetened & flavored (e.g. Nesquik, Steristumpi, Yogisip)									
bev9	Magheu									
bev10	Regular soda or soft drinks (e.g. Coca Cola, Sprite, Fanta, Stoney Ginger Beer, Cream Soda, Dry Lemon, Jive, Twizza, Refresh)									
bev11	Diet soda/artificially sweetened (e.g. Coca Cola light, Tab, Sprite Zero)									
bev12	Energy drinks (e.g. Score, Red Bull, Monster, Play, Dragon)									
bev13	Sports drinks (e.g. Energade, Powerade, Lucozade)									
bev14	Powdered drinks (e.g. Game)									
bev15	Sweetened iced tea (e.g. BOS Lipton, Fuze)									
bev16	Coffee/tea with sugar (bottled or served; including cappuccino etc)									
bev17	Coffee/Tea without sugar									
bev18	Frozen ice-lollies (e.g. Bompies /JC's)									

Code	Food Item	Unit most often consumed	Never <1/mo (A)	1-3/ mo (B)	1/ wk (C)	2-4/ wk (D)	5-6/ wk (E)	1/ day (F)	2-3/ day (G)	≥4/ day (H)

bev19	Alcohol Wine									
bev20	Alcohol Beer									
bev21	Alcohol Spirits									
bev22	Alcohols Ciders (e.g. Smirnoff Spin)									
bev23	Traditional beer (Umqombothi)									
bev24	Other (specify):									

No.	QUESTION		ANSWER
bev25	Have you changed your beverage consumption because of the drought in the Western Cape?		Yes……1 No……..2
bev26	If yes, please tell me what you drink more or less of as a result of the drought…. B. Drink less of ….(specify)	A. Drink more of…(specify)	
bev27	Now that the rains have started in the Western Cape this year, have you changed your beverage consumption?		Yes……1 No……..2
bev28			

	If yes, please tell me what you drink more or less of as a result of the drought…. B. Drink less of ….(specify)	A. Drink more of… (specify)	
bev29	Did we interview you in February/ March 2018		Yes……1 No……..2

THANK THE PARTICIPANTS FOR THEIR TIME SHARE TOKEN OF APPRECIATION WITH THE HOUSEHOLD

APPENDIX 4:

INFORMATION SHEET FOR ROFE PROJECT

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: codes): +27-21-959 2132/2402 Fax: +27-21-959 2872
E-mail: cswart@uwc.ac.za

INFORMATION SHEET

Project Title: Health Promotion Levy (HPL) Evaluation (Langa)

What is this study about?
This is a research project being conducted by the School of Public Health at the University of the Western Cape. We are inviting you to participate in this research project because you live in Langa (between the ages of 18-39). The purpose of this research project is to understand how the implementation of the Health Promotion Levy implemented as of 1 April 2018 affects what people in Langa eat. This information will help us understand people's eating habits and how it could contribute to health issues.

What will I be asked to do if I agree to participate?
You will be asked to participate in an interview which will take about 40 minutes of your time. *We will be asking you about what foods you have eaten, and also about things that you have in your home which let us know how well-off you are compared with others, and about what kinds of lack you have experienced.*

Would my participation in this study be kept confidential?
The researchers undertake to protect your identity and the nature of your contribution. To ensure your anonymity, ***your name will not be included on the surveys and other collected data; a code (using initials only) will be placed on the survey and other collected data. Through the use of this identification key, the researcher will be able to link your survey to your identity, but only the researcher will have access to the identification key.*** To ensure your confidentiality, we will ***use identification codes only on data forms, and use password-protected computer files.*** If we write a report or article about this research project, your identity will be protected.

In accordance with legal requirements and/or professional standards, we will disclose to the appropriate individuals and/or authorities information that comes to our attention concerning child abuse or neglect or potential harm to you or others. In this event, we will inform you that we have to break confidentiality to fulfil our legal responsibility to report to the designated authorities.

What are the risks of this research?
There may be some risks from participating in this research study. The questions may cause you to feel embarassed or sad about your living situation or the food you eat in order to get by. All human interactions and talking about self or others carry some amount of risks. We will nevertheless minimise such risks and act promptly to assist you if you experience any discomfort, psychological or otherwise during the process of your participation in this study.

APPENDIX 5:

CONSENT FORM FOR ROFE PROJECT

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27-21-959 2760 Fax: +27-21-9592872
E-mail: rswart@uwc.ac.za

CONSENT FORM

Title of Research Project: **Health Promotion Levy (HPL) Evaluation (Langa)**

The study has been described to me in language that I understand. My questions about the study have been answered. I understand what my participation will involve and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits. I understand that no audio-recordings will be produced from the interview with me.

Participant's name ....

Participant's signature .....

Date .....

APPENDIX 6:

ETHICS APPROVAL FOR ROFE PROJECT

OFFICE OF THE DIRECTOR: RESEARCH
RESEARCH AND INNOVATION DIVISION

Private Bag X17, Bellville 7535
South Africa
T: +27 21 959 4111/2948
F: +27 21 959 3170
E: research-ethics@uwc.ac.za
www.uwc.ac.za

07 August 2018

Prof CE Swart and Prof D Sanders
Dietetics and Nutrition
Faculty of Community and Health Sciences

Ethics Reference Number: BM18/6/2

Project Title: Association of the implementation of the South African Health promotion levy (HPL) with dietary intake and consumption of sugar-sweetened beverages (SSBs) in adults aged 18-39 years living in Langa.

Approval Period: 03 August 2018 – 03 August 2019

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the extension of the research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

The permission from the Provincial DoH must be submitted for recordkeeping purposes.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

PROVISIONAL REC NUMBER -130416-050

APPENDIX 7:

ETHICS APPROVAL FOR THIS STUDY

UNIVERSITY of the WESTERN CAPE

60 YEARS of hope, action & knowledge

15 October 2020

Mr SK Joni
Dietetics and Nutrition
Faculty of Community and Health Sciences

Ethics Reference Number:	HS19/7/3
Project Title:	The influence of listeria outbreak on the nutrition quality and dietary patterns of Langa townships.
Approval Period:	30 September 2020 – 30 September 2023

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report by 30 November each year for the duration of the project.

The permission to conduct the study must be submitted to HSSREC for record keeping purposes.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Director: Research Development
University of the Western Cape
Private Bag X 17
Bellville 7535
Republic of South Africa
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

NHREC Registration Number: HSSREC-130416-049

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

APPENDIX 8:

PERMISSION TO USE SECONDARY DATA FOR THIS STUDY

UNIVERSITY of the WESTERN CAPE

FACULTY OF COMMUNITY AND HEALTH SCIENCES

DEPARTMENT OF DIETETICS AND NUTRITION

6 July 2019

The Chairperson
Higher Degrees Committee
Faculty of Community and Health Sciences
University of the Western Cape
Robert Sobukwe Road
BELLVILLE
7535

Dear Sir

PERMISSION TO DO SECONDARY DATA ANALYSES ON DATA FROM LANGA

This is to confirm that Mr S K Joni has been granted permission to use the dietary intake data from Langa that was generated under the ROFE study approval (BM17/8/20) for his Masters dissertation. The data collected in Langa also served as baseline for the study on "Association of the implementation of the South African Health promotion levy (HPL) with dietary intake and consumption of sugar-sweetened beverages (SSBs) in adults aged 18-39 years living in Langa" (BM18/6/2).

Mr Joni served as team leader during data collection in Langa (February & March 2018). He also formed part of the team of fieldworkers who coded and quantified the dietary intake data and he was the quality assurance on the latter, thus double checking correctness of the coding and quantification of all other fieldworkers.

Kind regards

RINA SWART
Co_PI ROFE (Researching obesogenic food environments)
PI HPL evaluation

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APPENDIX 9:

TRAINING MANUAL FOR DIETARY INTAKE ASSESSMENT 24HR RECALL

https://foodsecurity.ac.za/publications/dietary-intake-assessment-24-hour-recall/