# Iodine content of salt used in The National School Nutrition Programme at Mopani and Vhembe Districts in Limpopo Province, South Africa.

**By**

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**BSc in Nutrition (UNIVEN)**

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## DECLARATION

**I Ramugondo Mpho (11571508),** hereby declare that the dissertation for the Master of Science in Public Nutrition degree at the University of Venda, hereby submitted by me, has not been submitted previously for a degree at this or any other university, that it is my own work in design and execution, and that all reference material contained therein have been duly acknowledged.

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04/09/2020
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Date

# DEDICATION

My daughter Marubini, my grandmother Elisa, my mother Mishumo, my husband Moagi, my aunt Phophi, my niece Masindi and my neighbour Rhandzu for their encouragement and support.

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## ABSTRACT

**Background:** The National School Nutrition Programme (NSNP) aims to foster better quality education by enhancing children's learning capacity, encouraging regular attendance and punctuality, addressing micronutrient deficiencies and alleviating short term hunger. Iodine is one of the micronutrient which is used in NSNP in the form of iodised salt. Iodine deficieny affects an estimated 60 million school- age children in the developing world and is also associated with low test scores and cognitive function.

**Aim:** The main aim of the study was to determine the iodine content of salt used in the NSNP.

**Methodology:** A cross sectional study was conducted. The researcher aimed at describing the iodine content of salt used in schools and the iodine nutrition knowledge of the food handlers in various schools in the Mopani and Vhembe districts. The study was conducted in selected schools of Mopani and Vhembe districts receiving NSNP. The target population was food handlers employed in schools receiving NSNP from the two districts. A total of 318 schools were visited and 359 food handlers were interviewed. The salt samples were collected and analysed using standard procedures. The demographic information and the iodine nutrition knowledge were obtained using a validated questionnaire.

**Results:** A total of 318 salt samples (Mopani=159 and Vhembe=159) were collected and analysed, representing 100% of successfully analysed. The study comprised of 359 (Mopani=200 and Vhembe=159) food handlers from two districts. Almost two thirds (64%) of the participants in Mopani district and 82.4% in Vhembe district had grades 8-12 as their highest level of education, while 4% and 5% had tertiary education in Mopani and Vhembe districts respectively. The mean iodine content was 36.53ppm and 34.24ppm in Mopani and Vhembe districts respectively which signifies adequately iodised salt. Almost three quarters (71%) of salt samples in Mopani and 65% in Vhembe were adequately (15-64ppm) iodised in this study. The results of the study suggest that almost half (47.5%) of the participants in Mopani and 34% in Vhembe had poor iodine nutrition knowledge as they could not answer the questions in the knowledge test correctly. Only 27% of the participants in Mopani and 30% in Vhembe had good knowledge.

**Conclusions-** There are still salt samples that are inadequately iodised or not iodised at all used in the preparation of meals for NSNP in the two districts. Such instances make the programme designed to eliminate IDD fail. It can be deduced that without public awareness on the importance of iodine in the human body, the universal iodine programme will be unsuccessful.

**Key words: Iodine, Food handlers, National School Nutrition Programme**

**LIST OF ABRREVIATIONS**

**AIS-** Adequately Iodised Salt

**AIDs-** Acquired Immune Deficiency syndrome

**AMPK**-Activated Protein Kinase

**BMR** –Basal Metabolic Rate

**BP**- Blood Pressure

**CS-** Convenience sampling

**DIT-** Diitryosine

**DoE-** Department of Education

**DoH-** Department of Health

**ETUFD-** Education Training Unit for Democracy

**FBDG-** Food Based Dietary Guidelines

**GCP**- General Clinical Practice

**GAIN-** Global Alliane of Improved Nutrition

**HPT**- Hypothalamus Pituitary Thyroid

**HIV-**Human Immuno Virus

**ICCIDD-** International Council for Control of Iodine Deficiency Disorders

**IDD-** Iodine Deficiency Disorders

**ID-** Iodine Deficiency

**IOM** -Institute of Medicine

**IQ**- Intelligence Quotient

**Kg**- Kilogram

**Mg**- Milligram

**MIT**- Monoiodotryrosin

**MRC-** Medical Research Council

**MD-** Mopani District

**MUSIC-** Managing Universal Salt Iodization Communication

**NFCS-FB-** National Food Consumption Survey Fortification Baseline

**NSNP-** National School Nutrition Program

**NWU-**North West University

**ppm**- parts per million

**PAMM-** Program Against Micronutrient Malnutrition

**PPARs** - Perixisome Proliferator Activated Receptors

**PUFA**- Polyunsaturated Fatty Acids

**TSH**- Thyroid Stimulating Hormone

**TH**-Thyroid Hormone

**TRs**- Thyroid receptors

**SAC**- School Attending Children

**SANFCS- South** African National Food Consumption Survey

**SANHES**- South African National Health Survey

**SR** – Simple Random sampling

**SMART**- Specific Measurable Achievable Realistic and Time bound

**SPSS**- Statistical Package Social Science

**UNICEF-** United Nations Children's Fund

**USA-** United States of America

**USI-** Universal Salt Iodization

**WFP-** World Food Program

**WHO-** World Health Organization

**VD** - Vhembe District

## DEFINITION OF OPERATIONAL TERMS

**Food handlers-** In this study refers to people employed by the school governing body to prepare food for school children.

**Iodine-** Is used as a trace element in the study which is added to salt needed by the thyroid gland in the body.

**Iodine deficiency disorders-** refers to disorders which results from the lack of iodine in the body .

# CHAPTER 1
# INTRODUCTION

## 1.1. BACKGROUND OF THE STUDY

The National School Nutrition programme (NSNP) aims to foster better quality education by enhancing children's learning capacity, encouraging regular attendance and punctuality addressing micronutrient deficiencies and alleviating short-term hunger (Education Training Unit for Democracy (ETUfD, 2010). According to Department of Education (DoE, 2009), school menus should offer tasty and adequate meals which must fulfil at least 30% of the daily nutritional needs of learners per meal. Furthermore, the DoE indicated the importance of serving a balanced meal which is composed of protein, starch, vegetable, with fats and oils used in moderation as well as iodated salt and seasoning which must be used in moderation. Meals provided to learners follow the Food Based Dietary Guidelines (FBDG) as stipulated by the Department of Health, which offer a variety of food items including fresh vegetables and fruit (NSNP Annual Report, 2013/14). Inadequate intake of a variety of food items such as fruits and vegetables may result in micronutrient deficiencies.

According to World Food Programme (WFP, 2010), the effects of micronutrient deficiencies of iron, vitamin A, iodine and zinc are amongst the most devastating in terms of impaired development and mortality of children. Iodine deficiency affects an estimated 60 million school-age children in the developing world and is also associated with lower test scores and cognitive function (Bundy *et al*., 2006). Studies of iodine deficiency indicate that between 35 to 70 percent of school-aged children in developing countries may be iodine deficient (Zimmerman *et al*., 2008).

Iodine is one of the essential trace elements required for human health, however it is present in an uneven and mostly insufficient quantities in the environment around the globe (Fisher *et al*., 2011). It is also an essential component of thyroid hormones, thyroxine (T4) and triidothyronine (T3), necessary for normal growth and development of the brain, and nervous system from infancy and througnhout life (Fisher *et al*., 2011). These hormones are also involved in the synthesis and degradation of carbohydrates, protein and fat, depending on the level of excretion and they participate in the regulation of the daily activities of every cell (Roman, 2012).

If the environment is iodine-content adequate, people have no difficulty in obtaining the required small amounts of the iodine through water and food (Gallagher, 2012). Iodine content in vegetables, fruits and grains varies according to the iodine content of the soil and water used in growing them, while content in animal products depends on the iodine content in the diet of the animals, which may have included iodine supplementation (Zimmermann, 2011; Gallagher, 2012). Iodine enters the food chain in the form of chemicals used in agriculture and food industries. The low iodine content in the environment is the result of climate change (floods, erosions, glaciations among others) which removes iodine from soil and deposit it into the sea (Zimmermann, 2011; Pearce *et al.,* 2013).

Inadequate dietary intake of iodine results in iodine-deficiency disorders (IDDs). IDDs may occur at any age and include abnormalities such as goiter, while causing conditions, such as abortion, still birth, hypothyroidism, cretinism, impaired cognitive function and development as well as retart physical growth (Hetzel, 2000). The most significant consequences of iodine deficiency are those that affect the normal development in the fetus and young as they may be irreversible (Hetzel, 2000). Consumption of food rich in goitrogenic substances (sweet potatoes, cabbage, soybeans and cassava) can contribute to the development of these disorders as goitrogens competitively inhibit the uptake of iodine by thyroid cells (Pearce *et al.,* 2013).

According to Laurberg (2012), iodised salt is an important source of iodine in many countries. Worldwide, the most effective strategy to control iodine deficiency has been found to be universal salt iodization (Zimmermann, 2009). The success of this intervention depends largely on the level of iodine mandated and the quality of monitoring and enforcement (Harton, 2010). Harton (2010) points out that the trend towards improved iodine status of populations in developing countries may reflect improved implementation and enforcement of salt iodisation regulation.

Evidence of improved outcomes from the iodisation of table salt was seen in primary school children in four communities of the Western and Eastern Cape provinces (South Africa) within one year of the programme’s implementation (UNICEF, 2010). The positive effect of iodine supplementation on the cognitive performance of children lends further supports for the need for adequate iodine nutrition in school-aged children for intellectual functioning (Zimmerman, 2012). There has been a substantial progress in the last decade towards the elimination of iodine deficiency, however, continued efforts are needed to cover at-risk population and salt iodisation programmes need to be strengthened and maintained in order to reach the goal of eliminating IDDs (Anderson *et al*., 2005). These efforts can be realised if salt, both agricultural and table are constantly analysed for iodine content. These include retailer salt, household salt and salt used in NSNP.

### 1.2 PROBLEM STATEMENT

Iodine deficiency remains a major global threat to the health and development, because it is the most common cause of preventable mental impairment worldwide and School Aged Children (SAC) are particularly suspects (Kartono *et al.,* 2017). The SAC has been used to approximate the iodine status of the general population in countries where salt is the primary vehicle for iodine because it is a convenient population that is easy to reach through school-based surveys (Doggui *et al.,* 2016).

Most studies conducted at SAC focused on the median urinary iodine of the school children and the salt content used in the households leaving out the analysis of the salt used in the NSNP (Syed, 2015). A study conducted in the Vhembe district showed that the risk for iodine deficiency in six to twelve-year-old primary school children in Mutale and Vuwani areas was mild, with median urinary excretion being 82µg/L (Solomon et al., 2014). What is interesting to note from this study is that the iodine status of primary school learners was similar in both areas, Vuwani and Mutale. The coverage of the use of iodized salt in households was also equally poor in Vuwani (16.4%) and Mutale (20.2%) (Solomon et al., 2014).

The global success story of universal salt iodisation now reaching 86% of the population in low- and middle-income countries and is considered one of the most successfully public health achievements in the past fifty years (Syed, 2015). Although political prioritisation of nutrition has improved globally, IDD elimination appears to have been "crowded out" by other nutrition priorities such as obesity, stunting and emergency nutrition (Coding, 2016). Additionally, many governments feel that the "Job is done" as urinary iodine levels indicates optimal iodine status at a national level (Coding, 2016). The problem is that IDD quickly returns if salt iodisation is not sustained and in most countries like Australia, Tunisia, Cambodia the waning of political commitment had occurred before sustainable USI programs where fully established (Coding, 2016).

In order to prevent IDD to return it is recommended to regularly monitor the iodine status of the SAC, to ensure optimal iodine status of the population including to avoid the iodine deficiency and iodine excess (Kartono *et al*., 2017). National Food Consumption Survey Fortification Baseline (NFCS-FB, 2005) has reported on the iodine content of retailer and household salt but no studies have been conducted on the iodine content of salt used in the NSNP. Therefore, it is imperative to determine the iodine content of salt used in the NSNP in Mopani and Vhembe districts to obtain a clear reflection of the iodine concentration to which leaners are exposed to, at school level.

## 1.3 RESEARCH QUESTION

What is the iodine content of salt used in the NSNP?

## 1.4 AIM OF THE STUDY

The primary aim of the study was to determine the iodine content of salt used in the NSNP. The secondary aim was to determine the iodine nutrition knowledge, of food handlers, on the usage of iodised salt.

## 1.5 OBJECTIVES OF THE STUDY

To meet the main aim of the study, the following objectives were set:

1.5.1 To determine the iodine content of salt used in the NSNP.

1.5.2 To compare the iodine content of salt in the two districts (Mopani and Vhembe).

1.5.3 To assess the knowledge of the food handlers at various schools, in these two districts on the usage of iodised salt.

## 1.6 SIGNIFICANCE OF THE STUDY

The research findings may help food suppliers to adhere to the policy stipulated by the DoE. The research findings may also guide policy makers in the Departments of Health and Education on measures to be taken to eradicate the IDDs in Limpopo, South Africa. The research findings may enable salt producers to ensure that the correct amount of iodine is added to salt at production site. The findings may help improve the nutrition knowledge of food handlers. The research findings may guide health professionals to include nutrition education during the training of food handlers.

## 1.7 STRUCTURE OF THE THESIS

**Chapter 1** outlines the aim of the study and problem statement. The objectives and the significance of the study are outlined in this chapter.

**Chapter 2** will focus on the literature review related to the topic.

**Chapter 3** represents the research method and techniques used for selecting the sample, the study **design, data collection and data analysis.**

**Chapter** 4 present the results of the study.

C**hapter 5** discusses the results of the study.

**Chapter 6** deals with conclusions drawn from the study and make the recommendations from the drawn conclusions.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 OVERVIEW

Institute of Medicine (2001) indicated that iodine is an essential trace mineral required for the synthesis and production of thyroid hormones, which regulate many important functions in the body, including enzyme activity and protein synthesis. Iodine deficiency (ID) occurs when iodine intake falls below required levels to maintain adequate thyroid hormone production (Wong *et al.,* 2011). Delange (1994) and Hetzel (1983) pointed out that ID may occur at any age.

Vandrpas and Reyes (2017) indicated that globally ID is the most common preventable cause of brain disorders in children. Iodine deficiency causes psychomotor delay and lower intellectual functioning resulting in impaired cognitive development and mental retardation in children (Vandrpas & Reyes 2017). In addition, Doggui *et al.* (2016) earlier reported that ID effects range from small neurological changes to impaired learning ability as well as performance in school seen in poor performance on formal tests of psychomotor functions.

Abedelhaffez and Hassan (2013) indicated that iodine stimulates thyroid hormone which is essential for brain development. Furthermore, Rovet (2013) and Zhang *et al.* (2014) added that in brain development thyroid hormone stimulates processes such as neuronal proliferation, migration, growth of axons/dendrites, synapse formation and myelination. Regular monitoring of salt and iodine content of salt will ensure a satisfactory maintenance of normal iodine nutrition (Hetzel, 2000).

The literature review will focus on, iodine chemistry, iodine distribution in the human body, metabolism of iodine functions of thyroid hormone in the human body, sources of iodine, daily requirements of iodine, consequences of IDD, strategies used to eliminate IDD, iodine situation in the world, impact of universal salt iodisation in South Africa, managing Universal salt iodization communications, monitoring and evaluation of salt iodization program, iodine nutrition knowledge and summary of literature review.

## 2.2 IODINE CHEMISTRY

Kaiho (2017:7-14) defined iodine as "a chemical element with a symbol I and atomic number 53z''. O'Kane *et al.* (2018) indicated iodine as a trace element which is naturally available in foods and has been added as dietary supplements in some food items. Weast (1984) pointed out that iodine has atomic mass of 126.9044. Lee *et al.* (2017) indicated that iodine is the heaviest of the stable halogens, it exists as a lustrous, purple-black non-metallic solid at standard conditions that sublimes readily to form a violet gas. On the periodic table iodine falls under period 5, group 17 (halogens), p-block and is a reactive non-metal (Weast, 1984).

## 2.3 IODINE DISTRIBUTION IN HUMAN

Iodine plays a crucial role in the human body and is required in small amount (Zimmermann 2009). Iodine is mostly concentrated in the thyroid gland (Farhana & Shaiq, 2010). The healthy human adult body contains 15-20 mg of iodine of which 70-80% is stored in the thyroid gland (Khurana, 2006). Pal (2007) indicated that iodine enters the circulation as plasma inorganic iodide which is cleared from the circulation by the thyroid and kidney. Several studies showed that iodine is used by the thyroid gland for the synthesis of thyroid hormones (thyroxine (T4) and triiodothyronine (T3) (Widmaier *et al.,* 2016; Pal, 2007; FAO, 2002).

About 60µg of iodine needs to be trapped daily to maintain an adequate supply of thyroid hormones for normal body function (Skeaff & Thompson, 2018). Furthermore, the efficiency of trapping mechanism of iodine is regulated by thyroid stimulating hormone (TSH) which depends on the availability of iodine and the thyroid gland's activity (Widmaier *et al.,* 2016).

WHO/UNICEF/ICCIDD (2007) highlighted that the amount of iodine excreted in urine correlates well with the iodine intake, thereby serving as an estimate marker of iodine intake. Previous studies indicated that less than 10% of human iodine is lost via egestion, excretion in faeces, sweat and breastmilk (Eastman & Zimmermann, 2018).

## 2.4 METABOLISIM OF IODINE

Iodine is crucial in the synthesis of thyroid hormones which are T4 and T3 (Bowen, 2003). These hormones play a very important role in normal growth and development (Milanesi & Brent, 2017). The regulation of these thyroid hormones and metabolism allows for adequate thyroid hormone action in tissues, despite significant fluctuations in iodine supply (Ganongs, 2010; Velasco et al., 2016). However, the synthesis and secretion of thyroid hormone depends on the integrity of the thyroid follicular structure as well as the uptake of iodine (Susarla *et al.,* 2012; Bernier *et al.,* 2006). Iodine trapping is the first step in the metabolism of iodine (Farhana

& Shaiq, 2010). According to Farhana and Shaiq (2010) the process commences with the uptake of iodine from the capillary into the follicular cell of the gland by an active transport system. Khurana (2006) indicated that this occurs against chemical and electrical gradients by sodium/iodine symporter protein found in the basolateral membrane of the follicular cell, the energy required by this process is linked to ATPase dependent Na+, -Kpump.

Farhana and Shaiq (2006) described that synthesis and secretion of thyroglubin is the second step. Khurana (2006) and Pal (2007) explained that the synthesis starts on the rough endoplasmic reticulum as peptide units of molecular weight 330,000 (the primary translation product of its messenger RNA). Furthermore, Khurana (2006) and Pal (2007) indicated that later these units combine into a dinner, followed by addition of carbohydrate moieties, after which the molecule contains about 140 tyrosine residues, which serve as substrate for the synthesis of thyroid hormones.

According to Khurana (2006) and Pal (2007) the third step is the oxidation of iodine wherein the iodine within the follicular cell moves towards the apical surface of the plasma membrane, to enter the follicular lumen. This is followed by organification of the thyroglobulin, wherein iodination of the tyrosine residues present within the thyroglubin molecular occurs. Iodination first occurs at position 3 to form monoiodotyrosine (MIT) and then at position 5 to form diiodityrosine (DIT) (Bowen, 2003). Figure 1a and 1b described the synthesis of thyroxine and chemical structure of tyrosine and thyroid hormone. Gibson (2005) and Zevenbergen (2015) described the enzyme, thyroid peroxidase through two sequential reactions, catalyzes thyroid hormone synthesis. The organification of iodine occur first with tyrosines on thyroglobulin are iodinated to form mono- and di-iodotyrosines (Gibson, 2005; Zevenbergen, 2015). Several studies earlier reported that iodination of tyrosine is followed by coupling reaction whereby, two molecules of DIT couple with one molecule of DIT to form Triiodothyronine (T3) hormone (Bowen, 2003; Khurana, 2006; Pal, 2007).

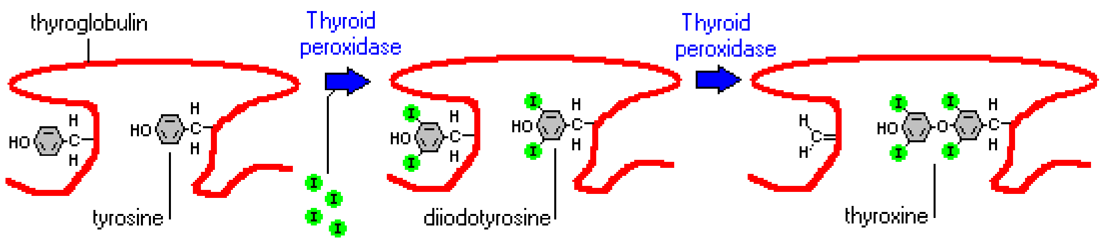



**Figure 2.1a: Synthesis of thyroxin (Bowen, 2003)**

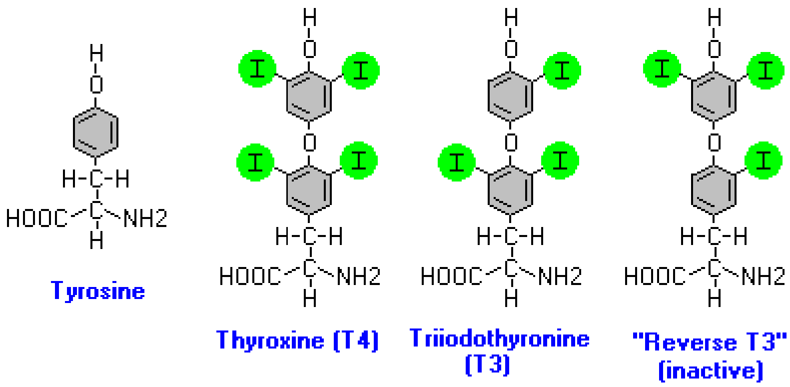



**Figure 2.1b: The chemical structure of tyrosine and the thyroid hormones (Bowen, 2003)**

## 2.5 FUNCTIONS OF THYROID HORMONES IN THE HUMAN BODY

This section will focus on the following sub-heading: central nervous system, calorigenic, fat metabolism, skeletal muscle, cardiovascular system, role of thyroid hormone in bone growth and metabolism and sources of iodine.

### 2.5.1 Central Nervous System

Thyroid hormones are essential for brain development through specific time windows influencing neurogenesis, neuronal migration, neuronal and glial cell differentiation, myelination and synaptogenesis (Bernal, 2007). However, the actions of thyroid hormone are mostly due to interaction of the active hormone T3 with nuclear and regulation of gene expression. Pop *et al.* (1999) indicated that maternal thyroid function during early pregnancy is an important determinant of early fetal brain development because the fetal thyroid is unable to produce T4 before 12 to 14 weeks. According to Morreale (2001) a decrease in maternal circulating thyroxine during the first trimester, whether accompanied by increased circulating thyroid-stimulating hormone, may well result in irreversible mental and psychomotor impairments.

On the other hand, in developing central nervous system any deviations in the activities of the thyroid hormones can impair the development and functions of the nervous and microglial cells (Duntas and Maillis, 2013; Noda, 2015). These impairments might increase the risk of mental/psychiatric disorders in infants growing into adults (neurological and behavioural defects) (Thompson and Potter, 2000; Noda, 2015). In addition, these changes are irreversible and permanent (Di Liegro, 2008; Henrichs *et al.,* 2010; Noda, 2015). Haddow *et al*. (1999) and

Henrichs *et al.* (2013) has emphasized the importance of routine screening for hypothyroidism during pregnancy as it increases IQ scores of children born to mother with serum thyrotropin concentrations at or above the $98^{th}$ percentile by approximately four points.

### 2.5.2 Calorigenic

Beigi and Edelman (2019) earlier indicated that the calorigenic action of thyroid hormones thyroxin(T4) and triidothyromine (T3) is exerted on many tissues (skeletal and cardiac muscle, liver, kidney). Furthermore, it was indicated that administration of thyroid hormone produces an increase in the number of size and oxidative and phophorylative capacity of mitochondria of mammalian skeletal muscle (Beigi and Edelman, 2019). Several studies highlighted that it is well established that thyroid hormone status correlates with body weight and energy expenditure (Fox *et al.,* 2008; Iwen *et al.,* 2013; Knudsen *et al.,* 2005). Hyperthyroidism, excess thyroid hormone, promotes a hyper-metabolic state characterised by increased resting energy expenditure, weight loss, reduced cholesterol levels, increased lipolysis and gluconeogenesis (Brent, 2008; Motumura and Brent,1998). Conversely, Brent (2012) reported that hypothyroidism, reduced thyroid hormone levels, is associated with hypo-metabolism characterised by reduced resting energy expenditure, weight gain, increased cholesterol levels, reduced lipolysis and gluconeogenesis.

Redman *et al.* (2016) indicated that thyroid hormones increase the rate of absorption of carbohydrates from the gastrointestinal tract, an action that is probably independent of their calorigenic action. According to Robertson (2018) in hyperthyroidism, plasma glucose level arises rapidly after a carbohydrate meal and sometimes exceeding the renal threshold. However, Redman *et al.* (2016) added that it falls again at a rapid rate and plays an important role in maintaining optimal energy levels of the body by ensuring the efficient utilization of calories, without allowing them to be deposited as excess fats. Jenzer and Sadeghl (2017) further added that thyroid hormone regulates metabolism and the body's ability to burn carbohydrates and fats for energy.

### 2.5.3 Fat metabolism

Moreno *et al.* (2008) indicated that the processes and pathways mediate intermediatary metabolism of carbohydrates, lipids and proteins are all affected by thyroid hormones. In a study conducted by Webb (2004) it was highlighted that excess of thyroid hormones leads to a mix of deleterious (increased heart rate, muscle wasting and osteoporosis), beneficial effects of cholesterol, lipoprotein A and weight loss. In the same study it was further indicated that these actions are mediated by nuclear thyroid hormone receptors (TRs) (Webb, 2004). In addition, TRs interact with other nuclear receptors including peroxisome proliferator activated receptors (PPARs), TR-PPAR interactions are of importance in regulation of lipid metabolism (Senese *et al.,* 2014). Several studies indicated that T3 increases lipid metabolism both by binding to TRα and TRβ through different underlying mechanism (Wilkstom *et al.,* 1998; Senese *et al.,* 2014; Gloss *et al.,* 2001).

### 2.5.4 Skeletal muscle

Kim *et al.* (2010) pointed out that skeletal muscle is widely distributed and represents approximately 40% of human body mass. Several studies had indicated that in skeletal muscle thyroid hormone (TH-thyroxine or T4 and triidothyrone or T3) participate in contractile function, metabolism, myogenesis and regeneration (Simonides and van Hardveld, 2008; Dentice *et al.,* 2012; Salvatore *et al.,* 2014). According to Ortega *et al.* (2016) serum thyroxine levels depend on the hypothalamus-pituitary-thyroid (HPT) axis which, in turn responds to several changes in homeostasis. Boelen *et al*. (2017) found that specific tissue concentration of thyroid hormone (TH) in skeletal muscle depend on local levels of TH transporters, TH receptors and deiodinase activity. Two different studies indicated that T3 increases the PH in L6 myoblasts from rat skeletal muscle culture via phospholipase c and intracellular calcium mobilization (Incerpi *et al.,* 1999*;* D'Arezzo *et al.,* 2004). Furthermore, Irrcher *et al.* (2008) added that T3 modifies the kinase activity and Activated Protein Kinase (AMPK), which are important in mitochondrial biogenesis on skeletal muscle fibres.

### 2.5.5 Cardiovascular System

Thyroid hormones modulate every component of the cardiovascular system necessary for normal cardiovascular development and function (Grais and Sowers, 2014). However, Yen *et al.* (2006) mentioned that thyroid hormones also regulates several plasma-membrane ion transporters at both the transcriptional and posttranscriptional levels thus coordination the electrochemical and mechanical responses of the myocardium. Klein and Ojama (2001) indicated that the major effects of thyroid hormones on the heart rate are mediated by triodothyronine (T3). The study conducted by Kahaly and Dillmann (2005) further highlighted that T3 increases the force and speed of systolic contraction and the speed of diastolic relaxation. In a study conducted by Bassett, Harvey and Williams (2003) it was pointed out that cardiovascular signs of hyperthyroidism include tachycardia, widened pulse pressure, marked increase in cardiac output and impaired cardiovascular and respiratory exercise capacity.

### 2.5.6 Role of thyroid hormone in bone growth and metabolism

According to Bassett, Harvey and Williams (2003) thyroid hormone (T3) is essential for the normal development of endochondrial and intramembrous bone and plays an important role in the linear growth and maintenance of bone mass. While Mosekilde *et al*. (2018) indicated that childhood T3 deficiency result in retardation of skeletal development and growth arrest whereas T3 excess leads to accelerated growth and bone formation. However, Galliford *et al*. (2005) indicated that in adult thyrotoxicosis, there is increased bone remodelling, characterised by an imbalance between bone reabsorption and formation, which results in net bone loss and increase risk foe osteoporotic fracture. Furthermore, bone loss in thyrotoxicosis has been regarded as a direct consequence of thyroid hormone excess acting locally on bone (Harvey *et al., 2002*). In a study conducted by Waung *et al.* (2012) it has been proposed that TSH may be a direct negative regular of bone turnover acting via TSH receptor on both osteoblasts and osteoclasts.

## 2.6 SOURCES OF IODINE

Table 2.1 indicate the iodine content of food. It is important to note that availability of iodine in foods varies in different regions of the world (Murray *et al*., 2008). Haldimann *et al*. (2000) explained that the variation is due to that the iodine uptake of food plants is in proportion to the iodine present in the environment depending on the locality were the food is produced. WHO (2007) estimated that about 90% of iodine is obtained from food consumed then the remainder is from water. Moran *et al.* (2002) pointed out that the iodine is available in traces in water, food and common salts. Iodine found in sea water is 0.2mg per litre, sea weeds and spongy shells are rich in iodine (Aquaron *et al*., 2002). Zimmermann (2009) mentioned that the rich sources of iodine are sea fish, green vegetables and leaves like spinach and fruits grown in iodine-rich soil and water, dairy products, meat and fortified maize meal or flour and cereals. According to Dasgupta *et al*. (2008), the majority of salt intake comes from processed foods and most food manufactures uses agricultural salt.

Aquaron *et al*. (2002) indicated that mineral supplements contain iodine in the form of potassium iodide or sodium iodide. Minton (2008) added that it is important for people to use iodine supplement if they are not regularly getting adequate iodine amounts from food. Furthermore, Sebotsa *et al.* (2003) reported that the use of iodized salt coupled with iodised oil (lipiodol is iodised poppy seed oil) supplementation effectively controls iodine deficiency disorders.

**Table 2.1: Iodine content of food (Kapil, 2007)**

| FOOD | QUANTITY | Iodine(µg) |
|---|---|---|
| Salt iodized | 1 teaspoon | 400 |
| Bread regular process | 1 slice | 35 |
| Haddock | 75g | 104-145 |
| Cheese, cottage, 2% fat | ½ cup | 26-271 |
| Shrimp | 75g | 21-37 |
| Egg | 1 | 18-26 |
| Cheese, chedder | 30g | 5-23 |
| Ground beef | 75g cooked | 8 |

## 2.7 DAILY REQUIREMENTS OF IODINE

Childhood is a stage in which habits and eating patterns are acquired and the correct diet is necessary so that growth is optimal and to avoid malnutrition deficiency (Iodine global Network, 2017). According to Andersson *et al*. 2012 globally, almost 30% of school children have a suboptimum dietary iodine intake. The US Institute of Medicine recommends the iodine intake of 90 µg daily under 4 to 6 years of age (Trumbo *et al.,* 2001). WHO (2007) recommends 120 µg daily for those aged 6 to 12 years. On other hand EFSA estimates that adequate iodine intake for children between 4 and 10years of age is 90 µg/day (Arrizabalaga *et al.,* 2018) Daily requirements of iodine suggested by the World Health Organisation (WHO) and by the Unites States (US) Institute of Medicine ranges from 90 to 150µg/day (WHO/UNICEF/ICCIDD, 2007; US Institute of Medicine, 2001). US Institute of Medicine (2001) indicated that iodine requirement is higher in pregnancy and lactation (250-290µg/day) due to increased maternal thyroid hormone production. Eastmen and Zimmermann (2018) indicated that the level of iodization of salt must be sufficient to cover the requirements, considering the potential losses from point of production to the point of consumption including shelf life. Table 2.2 shows WHO/UNCEF/ICCID iodine recommended dietary intake.

**Table 2.2 WHO/UNCEF/ICCID iodine recommended dietary intake (WHO/UNICEF/ICCIDD, 2007)**

| Population group | Intake (µg/day) |
|---|---|
| Children 2-6yrs | 90 |
| Pre-school children 0-59moths | 120 |
| Adults, SAC 6-12yrs | 150 |

| | |
|---|---|
| Pregnant and lactating women | 250 |

## 2.8 FACTORS AFFECTING IODINE REQUIREMENT

There are several factors that influence iodine requirements in the body. Iodine bioavailability is one of the factors that influence iodine requirements in the body. Miller and Ammerman (1995) reported that iodine is available in plant tissues predominately as inorganic iodide and is readily absorbed in this form in most parts of the intestine. Hurrel (1997) define bioavailable iodine as nutrient absorbed from the food and utilized by the body to produce thyroid hormones. Very few studies were done on iodine bioavailability since 1973 (Miller and Ammerman, 1995). Foo *et al.* (1999) earlier reported that all organic iodine is absorbed. In addition, about 85to 90% of iodine absorbed is excreted directly in the urine. According to Aquaron *et al. (*2002) the major factor controlling the amount of bioavailable iodine in the diet is the level of iodine in the soil, access to sea foods and access to food fortified with iodine.

On the other hand, Hurrel (1997) reported that food components do not appear to greatly influence iodine absorption but can reduce its utilisation to produce thyroid hormones iodine. Hurrel (1997) indicated two major types goitrogens which are: those that yield thiocyanates which block the transport of iodine into the thyroid gland and those that that yield oxazolidine-2-thiones, which inhibit the iodinization of thyroglubin and the coupling of the iodotyrosine residues. The goitrogenic substances or their precursors are widespread in food supply especially in plants of the Brassica species such as cabbage, kale, cauliflower, broccoli, rapeseed turnip and the staple food such as cassava and millet (Zimmermann *et al*., 2008). In addition, livestock can transfer goitrogens to milk. Teas *et al.* (2004) reported that eating too much of these foods inhibits the availability of iodine to the body from the food and thus leads to the development of goitre.

It is important to note that some micronutrients play a vital role in the utilization of iodine when synthesizing thyroid hormone (Bryan *et al*., 2004). Williams (2010) reported that selenium is part of the deiodidase enzymes which is responsible for converts T4 to T3 in the liver. In addition, Williams (2010) further indicated that selenium deficiencies increase thyroid size in iodine deficient individuals. Kohrle (1999) had reported that combination of iodine and selenium deficiencies may cause myxoedematous. On the other hand, Bratter and Nagretti (1996) reported that high selenium intake also affects thyroid function by reducing the production of T3 to T4.

Zimmermann *et al.* (2008) reported that retinoid interfere with iodine metabolism while vitamin A deficiency aggravates thyroid dysfunction caused by iodine deficient diets. Zimmermann and Kohrle (2000) earlier reported that iron deficiency impair thyroid hormone synthesis by reducing activity of heme-dependent thyroid perioxidase. Zimmerman *et al.* (2000) reported that combining iodine and iron supplements can reduce goitre more rapidly than iodine alone. Therefore, it is important to give iron supplementation as part of intervention as it improves the efficacy of iodine supplementation. Gaitan (1999) had reported that industrial pollutant like perchlorate decreases iodine transport into the thyroid gland. Laurberg, Nohr and Pedersen (2004) earlier reported that smoking competes with iodine for active transport into the secretory epithelium of the lactating breast. Zimmermann *et al*. (2008) reported that disulphides from coal processes are known to reduce thyroidal iodine uptake.

## 2.9. CONSEQUENCES OF IDD

This section will focus on the following sub-heading: goitre, endemic cretinism and hypothyroidism. The iodine deficiency disorders by age group are shown in table 2.3 (Farhana & Shaiq, 2010).

**Table 2.3 The iodine deficiency disorders by age group (Farhana and Shaiq, 2010)**

| Physiological groups | Health consequences of iodine deficiencies |
|---|---|
| All age groups | Goitre<br>Hypothyroidism<br>Increased susceptibility of the thyroid gland to nuclear radiation. |
| Foetus | Abortion<br>Stillbirth<br>Congenital anomalies<br>Perinatal mortality |
| Neonate | Infant mortality<br><br>Endemic cretinism |
| Child and adolescent | Impaired mental retardation<br>Delayed physical development |
| Adults | Impaired mental function<br>Iodine-induced hyperthyroidism<br>Overall, iodine deficiency produces subtle but widespread adverse effects in a population, including decreased educability, apathy and reduced work productivity, resulting in impaired social and economic development. |

### 2.9.1 Goitre

Felig and Frohman (2001) define goitre as the cellular growth and proliferation characterised by swelling or hyperplasia of the thyroid gland. Tonacchera *et al.* (2000) reported that goitre is characterised by diffuse thyroid enlargement, that becomes nodular from progressive accumulation of new thyroid follicles. In addition, goitre in children from iodine-deficient areas is diffusely enlarged, whereas in older adults it tends to be multinodular (Tonacchera *et al.*, 2000).

WHO, UNICEF and ICCIDD (2007) indicated that school-going children aged 6 to 12 years are the preferred group for goitre assessment as they are easily accessible. According to Bleichordt and Born (1995), the technique used to assess goitre is that the subject to be examined stands in front of the examiner, who looks carefully at the neck for any sign of visible thyroid enlargement. In addition, WHO/UNICEF/ICCIDD (2007) recommends that the examiner palpates the thyroid by gently sliding their own thumb along the side of the trachea (windpipe) between the cricoid cartilage and the top sternum were the size of the thyroid gland is examined. WHO (2007) reviewed and gave new guidelines for goitre grading. The goitre grades and description are shown in table 2.4 (WHO, UNICEF and ICCIDD, 2007).

**Table 2.4 Goitre grades and description (WHO/UNICEF/ICCIDD, 2007)**

| Grade | Description |
|---|---|
| Grade 0 | No palpable or visible goitre |
| Grade 1 | A goitre that is palpable but not visible when the neck is in the normal position (i.e., the thyroid is not visibly enlarged). |
| Grade 2 | A swelling in the neck that is clearly visible when the neck is in a normal position and is consistent with an enlarged thyroid when the neck is palpated. |

Goitre is said to be endemic when the prevalence in a population is >5% and in most cases, goitre can be treated with iodine supplementation (Anderson *et al*., 2005). In 1990, 655 million (12%) of the world population were affected by goitre (Bernal and Nunez, 2000). WHO stated that goitre prevalence amongst the population of the world is still estimated to be 15.8% (WHO, 2002; Biswa *et al.,* 2012). According to Andersson *et al*. (2004) the total goitre prevalence in general population is estimated to be 15.8% varying between 4.7% in America to 28.3% in Africa. In a Turkey national survey, the goitre prevalence had been calculated as 30.3% (Erdogan *et al*., 2001). A complete review on iodine deficient disorder which was conducted in 2012 reported that the African continent harbours the highest burden of goitre rate which was between 4.7 to 28% (Biswa *et al.,* 2012). In addition, this means that goitre is still an underestimated health concern in European countries. In a study conducted in Germany it was found that 68% of people who were screened for ultrasonographic thyroid screening had thyroid nodules (Triggiani *et al*., 2009).

Different studies in the world had reported that prevalence of goitre in children 6-12 years was 22.3% in Southern Sudan, 11.4% in Rajasthan and 20.5% in India (Elnour *et al*., 2000; Misra *et al*., 2007; Signh *et al*., 2010). Regarding school children, the prevalence of goiter varies in the world ranging from 5,5% to 35.9% (Chandra *et al.,* 2016; Elnour *et al.,* 2000). The prevalence of total goitre rate among six to twelve-year-old children about 4% (National Institute of Nutrition, 2003). According to Assey *et al*. (2009) the prevalence of goiter in Tanzania was at 6.9%. Jooste *et al.* (2000) reported that the first case of goitre in South Africa was reported in 1927. A study conducted in South Africa after the iodisation programme, found that 25.6 % of the children aged 6 to 12 years population had goitre (Jooste *et al.,* 2000). Following the introduction of mandatory salt iodisation, improvement in endemic goitre was reported in South Africa (Jooste *et al*., 2000; Jooste *et al*., 2001).

### 2.9.2 Endemic Cretinism

According to Qian *et al*. (2005) endemic cretinism is the extreme clinical manifestation of severe hypothyroidism during foetal, neonatal and child stages of development. In addition, cretinism is characterised by severe irreversible mental retardation, short stature, deaf-mutism, spastic dysplasia and squints (Qian *et al*., 2005).

Trumpff *et al*. (2013) indicated that there are two types of cretinism which are neurological cretinism and myxedematous cretinism. Neurological cretinisim is characterised by mental retardation, deaf mutism, squint spastic diplegia, and disorders of stance and gait (Chen and Hetzel, 2010). Myxoeematous cretinism is less common and characterised by less severe mental retardation, dwarfism (Chen and Hetzel, 2010). Hynes *et al.* (2013) earlier reported that children of mothers with mild gestational iodine deficiency were found to have reductions in spelling, grammar and English literacy performance despite growing up in iodine replete environments.

In severely endemic areas cretinism may affect up to 5 to 15% of the population (Mishra, 2010). Chen and Hetzel (2010) stated that mild mental retardation (IQ 50-69) is found in 5 to 15% of children living in areas of endemic cretinism and these children are referred to as cretins. In a study conducted by Cui *et al*. (2016) in China, 216 cases of endemic cretinism patients from 16 countries of Southern Xinjiang were confirmed, including 122 males and 94 females aged between 11 to 20 years. The prevalence of cretinoids in severe endemic goitre areas, may be ten-fold more than fully manifested cretins (WHO, 1996). Furthermore, WHO (1996) and Hetzel (2005) indicated that 2.2 billion people worldwide are at risk of iodine deficiency disorders, of these 1 to 10% have been reported to have cretinism. Several studies earlier reported that the prevalence rates of endemic cretinism range from 1.2% to 6% with

Central Africa recording the highest rate (Thilly *et al*., 1997; Bellis *et al.,* 1998; Konde *et al.,* 1994).

Gross nuerological defects were described in 10% of patients with cretinism in the Kivu area of Democratic Republic of Congo. In the West Ivory Coast, the prevalence of cretinism was reported to be 1.5% (Koume *et al.,* 1998). Sankar *et al*. (1998) indicated that India was 3.46% with a total of 617 endemic cretins identified.

### 2.9.3 Hypothyrodism

Kester *et al*. (2004) defined hypothyroidism as a severe and prolonged iodine deficiency that may lead to a deficient supply of thyroid hormones. Therefore, when the thyroid levels are too low the body cells cannot get enough thyroid hormone, causing the body processes to slow down (Kester *et al*., 2004). According to WHO (2007) hypothyroidism remains a leading cause of preventable mental retardation globally. In iodine deficient population, there is reduced school performance in children, which later leads to reduced economic productivity and quality of life in adulthood (Bleichrodt and Born 1994; Hetzel, 2005). The prevalence of hypothyroidism in the developed world is about 4 to 5% (Hallowell *et al*., 2002; Hoogendoorn *et al*., 2006).

The NHANES (1999 to 2002) survey reported that in the United States of America 3.7% of the population were reported to have hypothyroidism (Aoki *et al.,* 2007). Other studies conducted in Europe, Japan and USA have reported prevalence that ranges between 0.6 and 12% per 1000 women and between 1.3 and 12% per 1000 in men (Vanderpump, 2005). In a study conducted in India hypothyroidism was found to be a common form of thyroid dysfunction affecting 10.9% of the study population (Unnikrishnah *et al*., 2013). A South African study recorded a high in incidence of thyroid dysfunction in a subset of 163 patients and of which 27.6% of the thyroid dysfunction was hypothyroidism (Ross *et al*., 2005). According to Council for Medical Schemes (2013), prevalence of hypothyroidism in South Africa increased from 9.7 to 13.7% per 1000 beneficiaries between the period of 2006 to 2011.

## 2.10 STRATEGIES USED TO ELIMINATE IDD

This section will focus on the following sub-heading: salt iodization, supplementation and the use of Iodophors.

### 2.10.1 Salt iodisation

Salt iodisation was first introduced in 1920 in the United States (Marine and Kimball, 1920). In Switzerland the global expansion of this strategy did not take place until the 1990s when the World Health Assembly adopted Universal Salt Iodization as the main strategy to eliminate IDD (Marine and Kimball,1920; Burgi *et al.,* 1990). WHO (2001) recommended to add 20 -40 mg of iodine per kg of salt in order to meet iodine requirements assuming that the average consumption of salt per capita is 10g per day. Jooste and Zimmermann (2008) reported that ICCIDD was formed in 1985 and its long-term goal was to eliminate iodine deficiency globally by the year 2000. Although the goal of virtually eliminating IDD by the year 2000 was not achieved, WHO showed that in 1999, about two thirds of the total population had access to iodised salt at that time (WHO/UNICEF/ICCID, 1999).

Salt industry plays an indispensible role in the global campaign against Iodine deficiency disorders by producing salt (Gautam, 2007). According to Jooste (2003) iodisation of salt is the cornerstone of preventing and controlling iodine deficiency disorders (IDD). Sustainable control of IDD requires appropriate iodine fortification to reach the entire population, usually salt iodation (UNICEF/WHO, 1993). WHO (2001) pointed out that effective salt iodisation is a prerequisite for the sustainable elimination of iodine deficiency disorders. Furthermore, Assey (2009) highlighted that the advantage of supplementing with iodated salt is that it is used by all sections of community irrespective of their social and economic status.

Steyn *et al.* (1955) reported that in South Africa optional salt iodisation was introduced in 1954 at a level of 10 to 20 ppm. Furthermore, Steyn *et al.* (1955) indicated that during 1954 there was unequal access of iodised salt at household level and low level of awareness of the health benefit of iodised salt. According to Jooste *et al.* (1997), a new regulation of mandatory iodisation of table salt was introduced in South Africa at the end of 1995. The revised regulation replaced optional with mandatory salt iodization in order to increase iodine concentration of iodised salt from 10 to 20 ppm to 40 and 60 ppm iodine in the form of potassium iodate (Jooste *et al.,* 1997). Dunn (2000) reported that since the introduction of mandatory salt iodisation there have been favorable increase in the iodine content of retailer salt and the coverage of adequately iodised household salt in South Africa. In addition, Dunn (2000) indicated that there should be a guard against complacency which has led to the downfall of previously successful programmes.

### 2.10.2 Supplementation

This section will explore different iodine supplementation programmes that have been used, which includes iodised oil, iodised water, iodised bread and the use of iodophors.

#### *2.10.2.1 Iodised oil*

Azizi (2007) reported that the use of iodised oil was initiated by Clarke *et al.* (1960), shortly thereafter McCullagh and Hanessy (1963) reported the reduction of goitre rate in controlled trials of iodinated oils given to tramuscularly to gotorious subjects. Doses of iodised oil given once or at repeated intervals may also be an effective intervention for vulnerable groups until an effective iodised salt programme can be implemented (WHO/UNICEF/ICCID 2007). Angermayr and Clar (2018) indicated that iodised oil is an effective means of decreasing goitre rates and improving iodine status in children. An impact evaluation study conducted in 1991 in three goitre-endemic districts after 5 years of implementing iodine supplementation through IOC distribution in Tanzania showed 57% and 28% reduction in visible and total goitre prevalence, respectively (Kavishe and Mushi, 1993). Ingenbleek *et al.* (1997) defined lipiodol as iodised oil in which iodine atoms are bound to the unsaturated carbon- carbon bonds in polyunsaturated fatty acids (PUFA). In addition, Ingenbleek *et al.* (1997) reported that lipiodol is well tolerated and effective, unfortunately, the seed-oil used is that expressed from the opium poppy.

#### *2.10.2.2 Iodised water*

Iodised water was found to be effective in children below six years (Wu *et al*., 2002). Kim *et al.* (2006) pointed out that the use of water iodinator depends heavily not only on good maintenance and monitoring but also on community participation/awareness This indicates that overall, the iodine deficiency disorders programme did improve due to the iodine content in the school water system. In addition, Kim *et al.* (2006) indicted that iodination of water is effective in killing most microorganisms. According to Sutrisna *et al.* (2018), a study conducted in Indonesia revealed that the estimated non-packaged drinking water iodine to the regional average for iodine intake variable did not reach higher than 11% of the RNI for iodine for any sub-group.

#### *2.10.2.3 Iodised bread*

Skeaff and Cooper (2013) reported that some countries has adopted a strategy whereby a limited number of food stuffs are fortified due to the decrease intake of iodised salt and an increase intake of processed foods. This strategy also appeals the food industry as importing restrictions in some countries can make widespread fortification of food difficult (Jooste and Charlton, 2003). Skeaff and Cooper (2013) indicated that due to the re-emergence of iodine deficiency in New Zealand, the government introduced the mandatory fortification of bread with iodised salt in 2009 and thus has improved the iodine status of the school children. Fortification of bread has been shown to have an impact on the iodine status of school-age children (Skeaff and Cooper, 2013; Vandevijvere *et al.,* 2012). In the USA and Europe, bread contains a significant amount of iodine due to iodised salt being used in the baking process (Jooste and Zimmerman, 2008). Furthermore, Jooste and Zimmerman (2008) reported that South Africa used iodised salt in baking bread.

#### *2.10.2.4 The use of Iodophors*

Odlaug (1981) indicated that iodophors is one of the most popular forms of iodine compounds used today. Durani and Leaper (2008) pointed out that the idophors are used for cleaning, disinfecting equipment/surfaces, in water treatment and as skin antiseptic. In addition, Thompson (2004) indicated that iodophors have been used in the dairy industries for sanitizing milking machines and other equipment.

## 2.11 IODINE SITUATION IN THE WORLD

Andersson (2012) reported that global iodine nutrition has markedly improved over the past decade and the number of the iodine deficient countries decreased from 54 in 2003 to 32 in 2011. Furthermore, Andersson (2012) pointed out that despite remarkable progress, 1.88 billion people of the global population, including 241 million school children, still have insufficient dietary iodine intake. According to WHO (2008) it is still a challenge for the identified national iodine programmes to reach economically disadvantaged groups, to convince food industry and small-scale salt producers to iodise their salt. Walker *et al.* (2007) indicated that to reach the above-mentioned groups a strategy will be to strengthen national coalitions that include iodine scientists, national ICCIDD focal points government partners, national and international agencies, the health sector and salt producers.

In 2008, with a grant from the Bill and Melinda Gates foundation, the Global Alliance of Improved Nutrition (GAIN) and UNICEF formed the USI Partnership Project to intensify business-oriented towards the global elimination of iodine deficiency (UNICEF, 2008). Nahar, 2016 pointed out that the goal of the partnership project was to increase household iodised salt coverage in 13 priority countries in order to achieve a combined household coverage of 85%. According to UNICEF (2016) the 13 initial project countries were Bangladesh, China (seven provinces), Egypt, Ethopia, Ghana, India, Indonesia, Niger, Pakistan, the Phillippines, Russia, Senegal and Ukraine. The results illustrated that coverage with iodised salt varied considerably between countries, with considerable national progress seen in Uganda and India (UNICEF, 2016). Central Statistical Agency of Ethiopia (2017) reported that sustained progress has also been made in Ethopia in which data from 2011 found that less than 16% of household coverage salt with inadequate iodine. The first national survey in Jamaica suggested that iodine deficiency is currently not a public health concern in the country despite the country lacking national policy on salt iodisation (Global Fortification Data Exchange, 2018).

Nahar (2016) indicated that there should be effective quality assurance and regular monitoring of iodization in areas of widespread artisanal salt production. According to Hussein (2018) Sudan has opened the state of the art salt iodisation factory as a multi-lateral efforts to bring adequately iodised salt to the country and eliminate iodine deficiency. Global Fortification Data Exchange (2018) reported that as steps are taken to limit population on sodium intakes to reduce high blood pressure, there should be salt iodisation standards to ensure that iodine levels in the salt remain optimal as salt consumption decreases.

**2.12 IMPACT OF UNIVERSAL SALT IODISATION IN SOUTH AFRICA**

Jooste (2000) reported that, mandatory iodisation of table salt in South Africa was introduced with the encouragement of international agencies such as the United Nations Children's Fund (UNICEF) and the International Control Council for Iodine Deficiency Disorders (ICCIDD) at the end of 1995. A study conducted in South Africa before the introduction of mandatory iodisation showed that despite the price of iodised and non-iodised salt being identical, a low proportion of low socio-economic households (4.3% & 25%) use iodised salt (Charlton *et al*., 2013). Following the initiative mandatory iodisation of salt it was found, that there was unequal access to iodised salt Jooste *et al.* (1997). As a compromise to accommodate technical difficulties experienced in the salt iodization industry in achieving the required iodine level, the regulation was revised in 2007 to widen the required iodisation range from 40 to 60ppm to 35–65 ppm (Charlaton *et al.*, 2016).

The Iodine Global Network (2015) indicated that remarkable progress in the elimination of iodine deficiency has been seen in South Africa since the introduction of mandatory iodisation. Furthermore, WHO (2014) indicated that data on the iodine status of the South African women and children ages 6 to 9 years were found to have optimal iodine status which indicated a well-functioning salt iodisation programme. A study conducted by Charlton *et al.* (2016) found that in a sample of South African adults, those with a salt intake within the WHO recommended range of less than 5g/day had suboptimal iodine intakes, whereas those with higher salt intakes were shown to have adequate intakes.

Charlton *et al. (*2014) highlighted that at the same time as salt iodisation efforts are being celebrated, there is a global focus on salt reduction efforts to lower population-level blood pressure. In addition, Charlton *et al.* (2014) indicated that there is a risk that sodium reduction may impact adversely on iodine intakes and result in populations being at risk of inadequate iodine intakes unless fortificant levels of iodine in salt are revised accordingly.

## 2.13 MANAGING UNIVERSAL SALT IODISATION COMMUNICATIONS (MUSIC)

Chuko *et al.* (2015) described MUSIC as a planning tool to assist national program managers and planners in navigating the last mile to USI. Chuko *et al.* (2015) further added that MUSIC framework is based on a re-assessment of two core assumptions that drove the initial success of USI programmes to 75% coverage of adequately iodated salt (AIS). Mahammed *et al.* (2015) reported that in India a national Coalition for sustained iodine intake was launched to improve the overall programme management and coordination, and to improve the efficiency in monitoring the flow of iodised salt. According to Knowles *et al.* (2018) internal quality control and strengthened government regulatory monitoring are the targeted iodine interventions that need to be taken up and sustained. In addition, Chuko *et al.* (2015) pointed out that MUSIC applies a supply side framework to analyse the challenges facing USI programmes and to develop SMART (Specific, Measurable, Achievable, Realistic and Time Bound). Rah *et al.* (2013) indicated that the present status of the USI programme together with the challenges being faced towards achieving USI are classified in five categories: ensuring political commitment, forming partnerships and coalition, ensuring availability of adequately iodised salt, strengthening the monitoring system, maintaining continuous advocacy, education and communication.

## 2.14 MONITORING AND EVALUATION OF SALT IODISATION PROGRAMME.

Monitoring of any health intervention is essential, to check that it is functioning as planned and to provide the information needed to take corrective action if necessary (WHO, 2001; Knowles *et al.,* 2018). According to WHO (2001) salt iodisation programmes like any other health interventions, require an effective system for monitoring and evaluation. Assessing the severity of IDD and monitoring the progress of salt iodisation programs are cornerstones of a control strategy (Zimmermann, 2004). Iodine deficiency can re-appear if salt iodisation is interrupted as a result of demobilisation of the public health authorities or the lack of interest of the salt industry (De Benoist *et al.,* 2003).

The challenge is to apply the IDD indicators using valid and reliable methods while keeping cost at a minimum (WHO, 2001). The re-emergence of IDD in developed countries is a cause of concern, particularly regarding sub-clinical mental impairment (Zimmermann, 2009; Li and Eastman, 2012). In addition, several studies reported that it is important to formulate clearly the questions to which the answers are needed during monitoring and evaluation, as different countries use different methods (WHO, 2001; Chuko *et al.,* 2015; Rah *et al.,* 2013). Furthermore, universal salt iodization programmes are fragile and depend on a strong long-term commitment from national governments, donors, consumers and the salt industry (Charlton *et al.,* 2018). Charlton *et al.* (2018) pointed out that with South Africa undergoing salt reduction, strategies needs to be closely monitored to prevent the re-emergence of iodine deficiency.

## 2.15 IODINE NUTRITION KNOWLEDGE

Knowledge of iodine nutrition is a process-indicator often neglected in salt iodisation programmes because of the usual emphasis placed on its impact on iodine and goitre status. Mallard and Houghton (2014) indicated that public health education campaigns regarding iodised salt consumption was conducted during the earlier years (1989 to 1994) of implementation of the universal salt iodisation programme. In addition, Mallard and Houghton (2014) highlighted that there has been little or no knowledge dissemination to the public regarding iodised salt consumption via various mass media measures which can be essential in raising levels of public awareness. A study in six towns of the Northern Cape Province in South Africa showed that only 26% of mothers correctly knew the health benefits of iodised salt (Jooste *et al*., 2005). Jooste and Zimmermann (2008) reported that in the same study, Knowledge was very poorer in low socio-economic households where respondents were considerably less well-informed about aspects of iodine nutrition compared to high socio-economic households. A study conducted in South Africa before the introduction of mandatory iodisation showed that despite the price of iodised and non-iodised salt being identical, a low proportion of low socio-economic households (4.3% & 25%) use iodised salt (Charlton *et al*., 2013).

Coding *et al*. (2014) pointed out that in-order to sustain and further increase the use of iodised salt the public needs to be appropriately informed about the causes, consequences and prevention of iodine deficiency. According to Katongo *et al.* (2017) limited iodine nutrition knowledge is one of the challenges faced by the governments in attaining USI. Practical knowledge/understanding of universal salt iodisation and iodine deficiency must be built into the curriculum at all levels of education (CEE workshop, 2016). In addition, CEE workshop (2016) indicated that this would help to ensure that the next generation will grow up understanding and accepting the value of exclusive iodised salt supply.

Coding *et al*., 2014 indicated that nutrition knowledge should be provided to every community through public health programmes and health care providers should be involved in monitoring the quality of iodised salt. Charlton *et al*. (2013) further indicated that creating awareness must be done in conjunction with the periodic monitoring of the adherence of salt producers to the iodisation legislation.

## 2.16 SUMMARY OF LITERATURE REVIEW

Iodine is required by the body to synthesise thyroid hormones. Bioavailability of iodine in the body depends on the sources of iodine consumed. Studies indicated that low intake of iodine results in various iodine deficiency which affects the day to day activities of the individual. School children have been reported to be the most vulnerably affected by iodine deficiency diseases. Iodine consumption of iodine from different sources, including iodised salt in processed foods should be monitored in order to make necessary adjustments to iodisation levels to ensure optimal iodine intake thought the population.

Literature showed that the aim of universal salt iodisation (USI) is to ensure quality assured iodisation of all salt for human and animal packaging. USI has been reported as an important strategy that brought success in reducing IDDs in South Africa. Without on-going monitoring to ensure that iodisation practices comply with the legal standards, progress against iodine deficiency could stall.

Different studies suggested that continuous awareness of the consequences of iodine deficiency among government, salt producers and the public is important and recognising that salt iodisation and salt reduction are compatible. Several studies showed that the Key factors in sustaining optimal iodine nutrition includes: Government commitment to USI, includes re-enforcement of mandatory legislation and programme ownership. Furthermore, regular monitoring of iodine status to identify programmes that are not working and require remedial action and data on the coverage of iodised salt has helped in processed foods and condiments in contribution to the iodine intake in several countries.

# CHAPTER 3
# METHODOLOGY

## 3.1 OVERVIEW

In this chapter the research methodology used to collect data is described. These include study design, sampling, measurements, selection of field worker, data collection procedure, quality control, statistical analysis and ethical considerations.

## 3.2 STUDY DESIGN

The study design was cross-sectional conducted in selected schools of Mopani and Vhembe districts, Limpopo Province. The researcher aimed at describing the iodine content of salt used in schools and the iodine nutrition knowledge of the food handlers in various schools in the Mopani and Vhembe districts. A cross-sectional study denotes the collection of data on exposure and outcome at one point in time (Polit and Hungler, 2013). Cross-sectional studies are appropriate for describing the iodine content of salt used in NSNP and the iodine nutrition knowledge of food handlers. A quantitative research methodology was used. A quantitative study tends to be highly structured investigation that yields numerical information amenable to statistical analysis (Polit and Hungler, 2013).

### 3.3 STUDY POPULATION AND AREA

The study was conducted in selected schools of Mopani and Vhembe districts receiving NSNP. The target population was food handlers employed in schools receiving NSNP from the two districts.

The study was conducted in Mopani and Vhembe districts of Limpopo Province, South Africa. Mopani district is situated in the north-eastern part of the Limpopo Province. It is the second biggest of the five districts in Limpopo province. It is comprised of five local municipalities namely Ba-Phalaborwa, Greater Giyani, Greater Letaba, Greater Tzaneen and Maruleng. According to the 2016 community survey it has an estimated population of 1159185 of whom the majority speak Tsonga and Northern Sotho. There are 16 urban areas (towns and townships), 354 villages (rural settlements) and a total of 125 wards. In Mopani district, there are 562 schools on the NSNP.

The Vhembe District is a category C municipality located in the northern part of the Limpopo Province. It is comprised of four local municipalities namely Musina, Thulamela, Makhado and Collins Chabane. According to 2011 census, the district had an estimated population of 1294722 of whom the majority speak Tshivenda and Tsonga and the settlement pattern is largely rural with approximately 774 dispersed villages. In Vhembe district, there are 968 schools on the NSNP. Figures 3.1 and 3.2 indicate maps which clearly shows the demarcations of Mopani and Vhembe districts.


**Figure 3.1: Mopani district (Local government, 2016)**


**Figure 3.2: Vhembe district (Local government, 2016)**

### 3.4 SAMPLING

Mopani and Vhembe districts were conveniently selected. Simple random sampling was used to select schools that were included in the sample. These schools served as sampling frames for the food handlers.

A list of schools (both secondary and primary) was obtained from Departments of Education in Vhembe and Mopani districts. Each school was assigned a number and these numbers were placed in a container and the researcher picked one number at a time from the container while blind folded. In Mopani, there were 562 schools on the NSNP whereas in Vhembe there were 968 schools. Initially the Slovin formula was applied to determine the sample size for each district and it yielded 234 in Mopani and 283 in Vhembe. Because of budgetary constraints the researcher could not afford the analysis for 517 salt samples. therefore the researcher combined the 562 and 968 to make a total of 1530. The formula was then applied to yield 317.The following formula was used in the study to calculate the sample size: $n= N/ (1+ (N \times e^2))$ where:

n= sample size

N=total number of schools

e=the accepted level of error

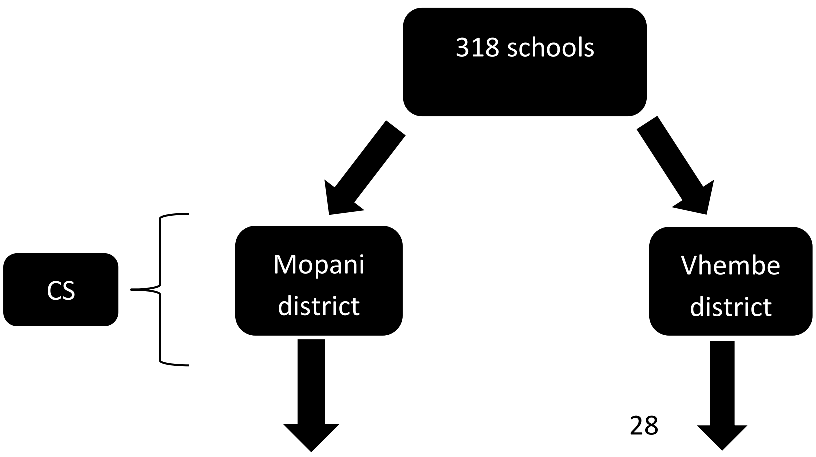
$n= N/ (1+ (N \times e^2))$

$n=1530/ (1+ (1530\times0.05^2))$

$n=1530/4.825$

$n=317$

As the resultant sample size was an odd number according to the equation, it was then converted to an even number 318. The sample size was divided into two which resulted in 159 schools in each district. All food handlers from the selected 318 schools were included in the study (figure 3.3). However in Mopani districts, principals of some schools insisted that more two food handlers be interviewed which increased the number from 159 to 200.



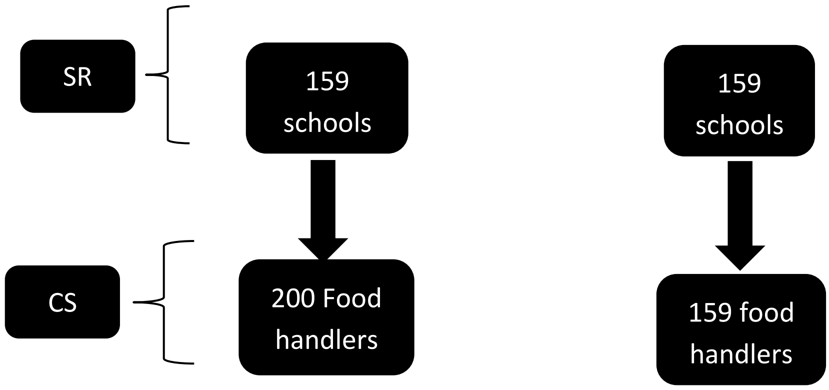



**Figure 3.3. Flow diagram of the sample size (CS= convenience sampling; SR= simple random sampling)**

### 3.5 INCLUSION AND EXCLUSION CRITERIA

Food handlers in schools receiving NSNP in the Mopani and Vhembe districts, 18 years and above, appointed formally by the school governing body and trained before assuming duties as a food handlers were included in the study.

Relatives who were standing in for food handlers on the day of data collection and volunteers were excluded from the study. The reason for the exclusion was the fact that they did not receive training.

### 3.6 SUBJECT RECRUITMENT

**First visit**

After permission to conduct the study from the provincial Department of Education letters seeking permission to sample schools were distributed to circuit managers. The circuit managers gave the researcher letters to submit at selected schools as proof that the procedure was followed when requesting permission to use schools as a sampling frame. The researcher distributed recruitment letters to selected schools indicating the following: the aims, objectives, and the procedure of the study (Appendix 2).

**Second visit**

Once the permission was granted by the school principals, the researcher screened the food handlers who were available on the day of the visit for eligibility. Those who suited the eligibility criteria were briefed about the aim and procedures of the study. The food handlers were given consent forms (Appendix 3) together with the information sheets (Appendix 3) to sign if they agreed to participate in the study. The researcher asked the food handlers to return the consent forms the following day and submit them to the principal's office. The researcher collected the consent forms from the principal on the day of data collection.

**Third visit**

The researcher gave more explanation and clarity to the food handlers who needed it before they could consent to participate.

## 3.6 MEASUREMENTS

The variables that were measured in this study included iodine content of salt, general questions on iodine and Iodine nutritional knowledge of the food handlers.

### 3.6.1 Laboratory investigations

Three hundred and eighteen salt samples from the schools used for preparing food for learners were collected using small plastic bags with zip-lock seals. The salt was purchased by service providers who provide food for NSNP in various schools. the Two tablespoons of salt were collected from each school and was stored in a plastic bag with a zip-lock seal and the plastic bags were stored safely in a cool dry place until analysis.

Salt iodine concentrations were determined in iodine laboratory at the North-West University (NWU) in Potchefstroom by means of *iCheck* test method. A total of 318 salt samples were analysed representing 100% successfully analysed samples. The procedure is outlined below:

**First step:** The salt was diluted with distilled water. The sample per analysis was 1.0mL, the concentration range was >3ppm (mg/kg) and the minimum dilution factor was 1:3.

**Second step:** The sample was injected in the ready to use reagent vial and if the solution changed colour to purple it indicated that iodine was present.

**Third step:** The diluted solution was then analysed using the photometric determination of iodine colorimetric reaction, the units displayed on the *iCheck* test device were in mg/L and the linear range was set on 1.0-13.0 mg/L, time per analysis was <10 minutes. The table 3.1 below indicates the interpretation of the salt analysis.

The independent t- tests to compare the means of the two districts was set at $p<0.05$. The iodine content of salt data was expressed by medians.

**Table 3.1 Interpretation of iodine content of salt (Kartano *et al.,* 2016)**

| Interpretations | Iodine level indicators |
|---|---|
| <5ppm | Non-iodised |
| 5-14.9ppm | Inadequately iodised |
| 15-64.9ppm | Adequately iodised |
| ≥65-79.9 | More than adequately iodised |
| ≥80ppm | Excessively iodised |

### 3.6.2 Survey questionnaire

An existing validated survey questionnaire on knowledge of iodine in the South African adult population (Jooste, Upson and Charlton, 2005; SANFCS, 2005) was used to gather information on iodine nutrition knowledge of food handlers. The questionnaire had three sections, namely, section A (demographic information), section B (general questions on salt fortification) and section C (Iodine Nutrition Knowledge). Iodine nutrition knowledge scores was interpreted using the table 3.2 below (Appendix 5).

The questionnaire was translated into the local languages (Tshivenda and Xitsonga) by the researcher (Appendix 5A and 5B). An expert from the Department of Languages was consulted to translate the questionnaire back to English and the two were compared. After the comparisons, corrections were made and the final questionnaire was pre-tested. The translation was done to cater for people with low literacy level and ease with which the participants will understand the questions.

**Table 3.2 Iodine nutrition knowledge scores (Zebida H, accessed [online] 2019/03/9)**

| Scores | Level of knowledge |
|---|---|
| 0-29.9% | Poor |
| 30-49.9% | Fair |
| 50-69.9% | Good |
| 70-89.9% | Very good |
| 90-100% | Excellent |

### 3.7. DATA COLLECTION PROCEDURE

Data was collected at the school sites from May 2017 to March 2018. The following arrangements were made to ensure that data collection was a success:

### 3.7.1 Physical arrangements

The researcher collected the signed consent forms from the principal's office before the interviews. The interviews for food handlers were conducted in the kitchen where the salt were kept. The researcher asked the principal for two chairs and a table which were brought to the kitchen. The researcher introduced herself and explained the aims, objectives, and procedures of the study to the food handlers. In some schools of Mopani district, principals insisted that more than two food handlers be interviewed.

#### *3.7.1.1 Field worker*

A nutritionist was recruited as a field worker. The field worker was responsible for assisting the researcher with interviews. The researcher trained the field worker and the methods of data collection were standardised . The field worker was recruited based on her field work experience, communication skills and for her good general practice. In addition, the nutritionist was trained on various interviewing techniques.

#### *3.7.1.2 Researcher's responsibilities*

The researcher was responsible for training the field worker and to standardise methods of data collection. Additionally, the researcher coded the questionnaire, consent forms and information sheet for each school, collected the salt samples and interviewed the food handlers. The researcher also arranged transport for data collection and drafted the fieldwork schedule.

## 3.8. QUALITY CONTROL

Validity of a measurement instrument is the extent to which the instrument measures what it is intended to measure while reliability is the consistency with which a measuring instrument yield a certain result when the entity being measured has not been changed. Both validity and reliability then reflect the degree to which we may have errors in our measurements (Schneider & White, 2004).

To ensure external validity of the iodine content of salt analyses, the North-West University (NWU) in Potchefstroom laboratory participates in an international quality control programme run by the center for disease Control and Prevention in Atlanta USA. Iodine content of salt measurements at the NWU laboratory agree exceptionally well with inductively coupled plasma mass spectrometry measurements that are internationally accepted as the gold standard in the analysis of iodine content concentrations.

Internal reliability of iodine content analysis is measured in terms of the variation observed with repeated analysis of the same sample expresses as the coefficient of variation. For validity, commercial standard solutions were used for the construction of a calibration curve and at least two samples from a large pool of salt samples were also included in each batch of salt samples analyses to check for possible laboratory drift over the various batches analysed.

### 3.9 STATISTICAL ANALYSIS

The data was entered into Microsoft excel spread sheet and transferred to the Statistical Package of Social Science (SPSS). The data was analyzed using SPSS version 25 and it was expressed as means and standard deviation and median and Interquartile ranges. Categorical data was expressed as frequencies. To compare differences between Mopani and Vhembe districts independent *t*-tests were used. The $p < 0.05$ was considered statistically significant.

### 3.10 INSTITUTIONAL APPROVAL

The study proposal was presented to th e school of Health sciences and it was approved and sent to ethics committee. The Ethics Committee of the University of Venda approved the study and a clearance certificate was issued (SHS/16/NUT/01/1011). The letter seeking permission to conduct the study together with the ethical clearance certificate and the research proposal were submitted to the Provincial Department of Education. Once permission was granted by the provincial Department of Education, a list of schools was obtained from the district Departments of Education in the Mopani and Vhembe.

### 3.11 ETHICAL CONSIDERATIONS

There were no direct benefits to individual participants or community where the study was conducted. During participants' recruitment food handlers who agreed to participate were given consent forms to sign. A consent form included the aim of the study, all data and samples that were collected. It further indicated that participating in the study was by participant's individual choice and they could withdraw at any stage of data collection without being penalized (Appendix 3).

The data generated from the study was stored in a computer database in a manner that maintains participants' confidentiality. For data verification and quality concerned purposes regulatory authority and/ or UNIVEN Ethics Committee members may be allowed to access participant data under the condition of strict confidentiality.

# CHAPTER 4
# RESULTS

## 4.1 OVERVIEW

This chapter provides the results of the iodine content of salt used in the NSNP at Mopani and Vhembe districts. The frequencies of various groups and variables in the study are presented. The study comprised of 359 (Mopani=200 and Vhembe=159) food handlers from two districts.

A total of 318 salt samples (Mopani=159 and Vhembe=159) were collected and analysed, representing 100% of successfully analysed. This chapter presents results on demographic information, iodine content of salt, general questions on salt fortification and iodine nutrition knowledge. Table 4.1 summarises the number of schools visited, the number of food handlers interviewed and the number of salt samples collected.

**Table 4.1 Number of total sample in Mopani and Vhembe district**

| Items | Mopani | Vhembe |
|---|---|---|
| Food handlers (questionnaires) | 200 | 159 |
| Salt samples | 159 | 159 |
| Number of schools | 159 | 159 |

## 4.2 SOCIO-DEMOGRAPHIC INFORMATION

Forty-one percent of participants in Mopani and 42.8% in Vhembe were within the age range 36-45 years (table 4.2).

Almost two thirds (64%) of participants in Mopani district and 82.4% in Vhembe district had grades 8-12 as their highest level of education, while 4% and 5% had tertiary education in Mopani and Vhembe districts respectively (table 4.2).

Marital status of study participants ranged from single to living with a partner with 44% and 41.5% being single in Mopani and Vhembe districts respectively. Nearly half (48%) and 43.4% of the participants were married (table 4.2).

A total of 82.5% of participants in Mopani and 66% in Vhembe districts had household income ranging from R1001 to R2000. A few of participants from Mopani (1.5%) and Vhembe (1.9%) reported household income of less than R1000.00 (table 4.2).

In terms of the number of children study participants had, 44.5% in Mopani and almost half (47.8%) in Vhembe had 3 to 4 children. Nearly all participants (94% in Mopani and 95.6% in Vhembe) had children in the schools they were appointed as food handlers (table 4.2).

**Table 4.2 Socio-demographic information of participants**

| Socio-demographic information | Mopani n(%) | Vhembe n(%) |
|---|---|---|
| **Age** | | |
| 18-25 | 6(3.0) | 3(1.9) |
| 26-35 | 60(30.0) | 52(32.7) |
| 36-45 | 82(41.0) | 68(42.8) |
| 46 and above | 52(26.0) | 36(22.6) |
| **Level of education** | | |
| Never attended | 13(6.5) | 6(3.8) |
| Grade 1-7 | 51(25.5) | 14(8.8) |
| Grade 8-12 | 128(64.0) | 131(82.4) |
| College/tertiary | 8(4.0) | 8(5.0) |
| **Marital Status** | | |
| Single | 88(44.0) | 66(41.5) |
| Married | 96(48.0) | 69(43.4) |
| Divorced | 4(2.0) | 11(6.9) |
| Living with partner | 12(6.0) | 13(8.2) |
| **Household income** | | |
| Less than R1000 | 3(1.5) | 3(1.9) |
| R1001-R2000 | 165(82.5) | 105(66.0) |
| R2001-R3000 | 31(15.5) | 40(25.2) |
| R3001-R4000 | 0 | 6(3.8) |
| R4001-R5000 | 1(0.5) | 5(3.1) |
| **Do you have the child at school** | | |
| Yes | 188(94.0) | 152(95.6) |
| No | 12(6.0) | 7(4.4) |
| **No of children** | | |
| None | 7(3.5) | 3(1.9) |
| 1-2 | 58(29.0) | 48(30.2) |
| 3-4 | 89(44.5) | 76(47.8) |
| 5 or more | 46(23.0) | 32(20.1) |

## 4.3 IODINE CONTENT OF SALT

A total of 318 (Mopani=159 and Vhembe=159) salt samples were collected from schools and analysed for iodine content. The mean iodine content was 36.53ppm and 34.24ppm in Mopani and Vhembe districts respectively which signifies adequately iodised salt. There was no significance difference observed between the two districts (p=0.428) (table 4.3).

**Table 4.3 Iodine content Mean values for Mopani and Vhembe district**

| District | Mean ± SD (N=159) | Median (N=159) | P-Value |
|---|---|---|---|
| Mopani | 36.53 ± 27.88ppm | 31.65ppm (IQR: 23.50 - 43.30ppm) | 0.428 |
| Vhembe | 34.24 ± 23.46ppm | 32.56ppm (IQR:14.41 - 51.51ppm) | |

### 4.3.1 Iodine levels of salt

Almost three quarters (71%) of salt samples in Mopani and 65% in Vhembe were adequately iodised. Of 318 samples collected, 9% and 11% from Mopani and Vhembe were not iodised respectively. A few samples from Mopani (8%) and Vhembe (4%) were excessively iodised (table 4.4).

**Table 4.4. Iodine content of salt categories**

| Iodine content categories | Mopani district n(%) | Vhembe district n(%) |
|---|---|---|
| < 5ppm (non-iodised) | 14(9) | 18(11) |
| 5-14ppm (inadequately iodised) | 13(8) | 25(16) |
| 15-64ppm (adequately iodised) | 113(71) | 104(65) |
| 65-79.9ppm (more than adequately iodised) | 7(4) | 6(4) |
| ≥ 80ppm (excessively iodised) | 12(8) | 6(4) |
| Total | 159 | 159 |

## 4.4 GENERAL QUESTIONS ON IODINE FORTIFICATION

Of the 359 participants in this study, 67.5% in Mopani and 78% in Vhembe reported that they buy salt used in their households in supermarkets (such as *Pick 'n pay, Shoprite, and Spar*), at pension pay points, and from street vendors/hawkers whereas 29.5% in Mopani and 11.3% in Vhembe buy from spaza shops. Very few participants (1.3%) purchased salt directly from salt producers (table 4.5).

Majority of participants in Mopani (91%) and Vhembe (96.9%) reported that schools never run out of salt while a few (Mopani = 7.5%; Vhembe = 1.9%) indicated that salt is purchased from nearby shops if the schools run out (table 4.5).

Participants were asked if they add more salt to food because it is iodated, 61% in Mopani and 42.1% in Vhembe indicated that they do not add more salt. A total of 29.5% in Mopani and 56% in Vhembe did not know what iodated salt is (table 4.5).

As indicated in table 4.5, more than half (53.5%) of the participants in Mopani and 31.4% in Vhembe district indicated that they did not have concerns about iodine being added to salt. Few of the participants in Mopani (8.5%) and Vhembe (1.9%) indicated that they were concerned about iodine being added to salt.

Forty-one percent of participants in Mopani district and 35.2% in Vhembe district reported that they store salt in a plastic bag which the salt is packaged in. On the other hand, 30% of the participants in Mopani district and 42.1% in Vhembe district reported that they store salt in any container with/without a lid (table 4.5).

More than half of the participants in both districts (Mopani = 56%; Vhembe = 51.6%) did not know how to identify iodised salt, while a few in Mopani (2%) and Vhembe (1.9%) indicated that salt is iodised if it is brown in colour (table 4.5).

As indicated in table 4.5, 50.5% of the participants in Mopani and 44.6% in Vhembe reported that they add salt during cooking. Few participants (1.5%) in Mopani add salt while eating. A total of 45% of the participants in Mopani and 55.3% in Vhembe reported that they add salt at the start of cooking.

Eighty percent of the study participants in Mopani and 41.5% in Vhembe indicated that it is important to fortify salt with iodine whereas the remaining 20% and 58.5% from Mopani and Vhembe respectively said it is not important.

**Table 4.5. General questions on the salt fortification**

| **Where do you usually buy or obtain the salt that is used for food in your house?** | **Mopani n(%)** | **Vhembe n(%)** |
|---|---|---|
| Purchase in a shop like Pick 'n Pay, Shoprite, Spar, General Store, Pension pay point etc. | 135(67.5) | 124(78.0) |
| Agricultural coarse salt obtained from farmer, employer, cooperation or elsewhere | 2(1.0) | 1(0.6) |
| Spaza shop | 59(29.5) | 18(11.3) |
| Informal sector: street vendor or hawker and bag of maize meal | 4(2.0) | 14(8.2) |
| Direct from salt producer | 0 | 2(1.3) |
| **Where do you get salt if the salt used at school ran out before the services provider delivers the next batch?** | | |
| Buy at nearby shop/spaza | 15(7.5) | 3(1.9) |
| Fetch salt at home | 1(0.5) | 1(0.6) |
| Do not add salt | 2(1.0) | 1(0.6) |
| Never run out of salt | 182(91.0) | 154(96.9) |
| **Do you add more salt to your food because the salt is iodated?** | | |
| Yes | 13(6.5) | 0 |
| No | 122(61.0) | 67(42.1) |
| Do not know | 6(3) | 3(1.9 |
| Do not know what iodated salt is | 59(29.5) | 89(56.0) |
| **Do you have any concerns about iodine being added to table salt?** | | |
| Yes | 17(8.5) | 3(1.9) |
| No | 107(53.5) | 50(31.4) |
| Unsure | 13(6.5) | 20(12.6) |
| Do not know what iodine is | 63(31.5) | 86(54.1) |
| **In what kind of container do you store salt in the kitchen?** | | |
| Plastic bag in which the salt was bought | 82(41.0) | 56(35.2) |
| Carton box | 7(3.5) | 25(15.7) |
| Rigid plastic container with holes at the top | 50(25.0) | 11(6.9) |
| Open porcelain, wooden, plastic or metal container with or without a lid | 61(30.5) | 67(42.1) |
| **How do you know the salt is Iodised?** | | |
| Plastic bag/container written iodised salt | 50(25.0) | 47(29.6) |
| Salt having brown colour | 4(2.0) | 3(1.9) |
| Salt with pure white colour | 34(17.0) | 27(17.0) |
| Do not know | 112(56.0) | 82(51.6) |
| **When do you add Iodised salt to food?** | | |
| While cooking | 101(50.5) | 71(44.6) |
| Start cooking with salt | 90(45.0) | 88(55.3) |
| While eating | 3(1.5) | 0 |
| Do not know | 6(3) | 0 |

### 4.5 IODINE NUTRITION KNOWLEDGE

Participants were asked questions to test their iodine nutrition knowledge. The mean scores of iodine nutrition knowledge of participants were 28.7 and 35.9 in Mopani and Vhembe districts which signifies poor and fair iodine nutrition knowledge respectively.

The results of the study suggest that almost half (47.5%) of the participants in Mopani and 34% in Vhembe had poor iodine nutrition knowledge as they could not answer the questions in the knowledge test correctly. Only 27% of the participants in Mopani and 30% in Vhembe had good iodine nutrition knowledge (table 4.6).

**Table 4.6 Iodine nutrition knowledge scores**

| Scores | Score range | Mopani n(%) | Vhembe n(%) |
|---|---|---|---|
| Poor | 0-29.9 | 95(47.5) | 54(34) |
| Fair | 30-49.9 | 45(22.5) | 45(28.3) |
| Good | 50-69.9 | 54(27) | 49(30.8) |
| Very good | 70-89.9 | 5(2.5) | 8(5) |
| Excellent | 90-100 | 1(0.5) | 3(1.90) |

Nearly one third of the participants (32.3%) in Mopani and 11.9% in Vhembe indicated that iodine is a vitamin. Participants in Mopani (29%) and Vhembe (31.5%) correctly identified iodine as a micronutrient/mineral. A total of 35.5% of the participants in Mopani and 48.4% in Vhembe did not know what iodine is (table 4.8).

Participants in Vhembe (45.9%) and Mopani (6%) correctly indicated that the main source of iodine was iodised salt. Nearly one third of the participants (30%) in Mopani and 18.2% in Vhembe indicated that the main source of iodine is fish/marine food products. In addition, 12.5% of participants in Mopani and 7.5% in Vhembe indicated the main source of iodine as vegetables. About 7% of participants Mopani and Vhembe respectively did not know what iodine is (table 4.8).

As indicated in table 4.8, 20% of participants in Mopani and 15.1% Vhembe correctly indicated that the part of the body that need iodine was the thyroid gland(gland in front of the neck). A total of 47% participants in Mopani and 36.5% in Vhembe did not know the correct answer.

When participants were asked about the most harmful effect of not getting enough iodine in the health of the child, participants in Mopani (11%) and Vhembe (13.8%) indicated that the consequences would be goitre. More than one third of the participants (37%) in Mopani and

18.2% in Vhembe indicated that they did not know the harmful effect of not consuming iodine in children (table 4.8).

Twenty eight percent of participants in Mopani and 30.2% in Vhembe read the labelling on food packages to check salt content. More than half of the participants in Mopani (54%) and Vhembe (53.5%) do not read the labelling on the food packages (table 4.8).

Half of the participants (50.5%) in Mopani and 47.2% in Vhembe correctly indicated that the daily recommendation of iodine for school attending children is 120µg/L. More than a third (39.5%) of the participants in Mopani and 42.3% in Vhembe did not know the daily recommendation of iodine for school attending children (table 4.7).

**Table 4.7 Iodine nutrition knowledge test**

| **What is iodine?** | **Mopani n(%)** | **Vhembe n(%)** |
|---|---|---|
| Vitamin | 65(32.5) | 19(11.9) |
| *Micronutrient /Mineral | 58(29.0) | 50(31.5) |
| Something in the food that we eat | 4(2.0) | 13(8.2) |
| Other (medicine, potion, etc.) | 2(1.0) | 0 |
| Do not know | 71(35.5) | 77(48.4) |
| **Main source of iodine** | | |
| ***Iodised salt/iodated salt | 12(6) | 73(45.9) |
| Fish/sea food/Marine food products | 60(30) | 29(18.2) |
| Vegetables | 25(12.5) | 12(7.5) |
| Meat or meat products | 25(12.5) | 6(3.7) |
| Dairy products | 5(2.5) | 4(2.5) |
| Drinking water | 13(6.5) | 3(1.5) |
| Other | 22(11) | 1(0.6) |
| Do not know | 14(7) | 11(6.9) |
| Do not know what iodine is | 24(12) | 20(12.5) |
| **Part of the body that needs iodine** | | |
| Liver | 42(21.0) | 47(29.6) |
| *Thyroid gland/gland in front of the neck | 40(20.0) | 24(15.1) |
| Lungs | 24(12.0) | 30(18.9) |
| Do not know | 94(47.0) | 58(36.5) |
| **Most harmful effect on health of children if they do not get enough iodine.** | | |
| *Slow growth | 59(29.5) | 59(37.1) |
| *Goiter/enlarged thyroid gland /swollen neck | 22(11.0) | 22(13.8) |
| Brain damage or under-development of the brain/low intelligence | 7(3.5) | 17(9.4) |
| Cretinism | 2(1.0) | 1(0.6) |
| Hypothyroidism | 0 | 1(0.6) |
| Death | 1(0.5) | 1(0.6) |
| Other | 7(3.5) | 4(2.5) |
| Do not know | 74(37.0) | 29(18.2) |
| Do not know what is iodine | 26(13.0) | 25(15.7) |
| All of the above | 2(1.0) | 2(1.3) |
| **Do you read labelling on the food package to check salt content?** | | |
| *Yes | 56(28.0) | 48(30.2) |
| No | 108(54.0) | 85(53.5) |
| Cannot read | 12(6.0) | 2(1.3) |
| Do not know what iodine is | 24(12.0) | 24(15.1) |

| What is the daily recommendation of iodine for school attending children? | | |
|---|---|---|
| *120µg/L | 101(50.5) | 75(47.2) |
| 150µg/L | 18(9.0) | 14(8.8) |
| 220µg/L | 2(1.0) | 2(1.3) |
| Do not know | 79(39.5) | 68(42.8) |

### 4.6 TRAINING OF THE FOOD HANDLERS

Almost three quarters (73.5%) of the participants in Mopani and 58.2% in Vhembe indicated that they were trained. One quarter of the participants in Mopani (26.5%) and a total of 42% in Vhembe reported that they were not exposed to any sort of training.

As indicated in table 4.9, 23.5% of the participants in Mopani and 43.4% in Vhembe reported that the training they received lasted a day. More than one third of participants (34.6%) in Vhembe and 46.5% in Mopani indicated that the training focused mostly on food handling and hygiene (table 4.8).

**Table 4.8 Training information of the food handlers.**

| Were you Trained? | Mopani n(%) | Vhembe n(%) |
|---|---|---|
| Yes | 147(73.5) | 93(58.2) |
| No | 53(26.5) | 66(41.8) |
| **How long was the training?** | | |
| 1 day | 47(23.5) | 69(43.4) |
| 2 days | 13(6.5) | 12(7.5) |
| 3 days | 11(5.5) | 1(0.6) |
| A week | 54(27.0) | 9(5.7) |
| Other | 24(12.0) | 3(1.9) |
| Do not know | 51(25.5) | 65(40.9) |
| **Topic covered during training** | | |
| Food handling | 93(46.5) | 55(34.6) |
| Food safety and hygiene | 5(2.5) | 37(23) |
| Nutrition | 1(0.5) | 1(0.6) |
| Other | 0 | 1(0.6) |
| Do not know | 101(50.5) | 65(40.9) |

# CHAPTER 5
# DISCUSSION

## 5.1 OVERVIEW

In this chapter, the important observations from the results regarding the demographic data, iodine content of salt, salt fortification and iodine nutrition knowledge is discussed. Where possible the results are compared with the available literature. Very few studies have explored the iodine content of salt used in the National School Nutrition Programme in South Africa.
The sample was selected from two districts namely Mopani and Vhembe respectively. The sample consisted of 318 schools and 359 food handlers.

## 5.2 LIMITATIONS OF THE STUDY

The current study had several limitations. The study was cross- sectional using the food handlers in schools receiving NSNP in Mopani and Vhembe districts. Household salt of study participants salt was not collected and analysed. And the study did not determine the nutritional status of the children or dietary intakes of iodine as this would have helped to determine the overall iodine concentration the SAC are exposed to on a daily basis.

## 5.3 SOCIO-DEMOGRAPHIC INFORMATION

In this present study majority (Mopani = 64% vs Vhembe = 82.4%) of participants in both districts had secondary education. The percentage in the current study is higher than that found by the SANHES (2012) where only 32.8% completed some grades in high school and 20.2% completed matric.
Two thirds (66%) of households in Vhembe district and 82.5% of households in Mopani district had income of between R1000.00 to R2000.00. The results of the current study are comparable to the findings of the SANHES (2012) where 53.0% of rural formal dwellers reported earning between R801 and R3 200 per month (which is only a reflection of the wide range of this income category since 36.0% of participants earned between R801 and R1 600, and 17.0% earned between R1 601 and R3 200), while 21.2% reported no formal income. Furthermore, the NFCS (1999) which reported that 58% and 49% of households' income in South Africa, and specifically in Limpopo Province, was below R1 000.00 per month respectively.

In the present study, participants depended mostly on child support grants and the stipend they get from schools as their main source of income. The results of the current study suggest that the participants were living below the poverty line since the little income is shared among three or more family members. According to Stats SA (2017) the upper-bound poverty line is R992 per person per month. Living under impoverished conditions might have a negative impact on the nutritional status of children as Edris (2007) indicated that preschool children who belonged to families with low income were at greater risk of being wasted, underweight and stunted. In general, children (aged 17 years and younger), black Africans, females, people from rural areas, those living in the Eastern Cape and Limpopo, and those with little or no education are the main victims in the ongoing struggle against poverty (Stats SA, 2017).

## 5.4 IODINE CONTENT OF SALT

In the current study, 71% of schools in Mopani and 65% in Vhembe used adequately iodised salt with an iodine concentration of 15 to 64ppm which means that school children were consuming adequately iodised salt. The results of the study also suggest that there are still continued short comings in the accuracy of salt iodisation seeing that some salt samples were not iodised (Mopani = 9% vs Vhembe = 11%) and some inadequately iodised (Mopani = 8% vs Vhembe = 16%). The findings of the current study are consistent with a study done nationally in India where it was reported that the household coverage with iodised salt was 92%, and 78% with adequately iodised salt (≥15 ppm). Only 14% of households were still consuming inadequately iodised salt (iodised at 5 to14.9 ppm), and 8% were using salt with no detectable amounts of iodine (<5 ppm). In South Africa salt producers are obliged to iodise table salt at an iodine concentration of 40 to 60 ppm (Jooste, 2003). The introduction of mandatory iodisation in 1995 at a higher level than before resulted in major improvements in both the availability and the iodine content of salt in South Africa (Jooste, 2000). In the current study, the percentage of adequately iodised salt is considerably lower than the international goal of 90% of household using adequately iodised salt (WHO/UNICEF/ICCIDD, 2001).

An assumption can be drawn that salt producers iodising salt at a concentration of more than 20 ppm contributes to the elimination of iodine deficiency (WHO/UNICEF/ICCIDD, 2001). However, a proportion of the salt examined in this study was clearly not iodised in accordance with the legal requirement. Inadequate iodine intake may result in a variety of disorders, termed iodine deficiency disorders (IDD), such as goiter, cretinism, spontaneous abortion, perinatal mortality, and heart failure (Hetzel, 1983; WHO/UNICEF/ICCIDD, 2001; Li and Eastman, 2012). The occurrence of chronic iodine deficiency (ID) during pregnancy causes hypothyroidism, which is detrimental to the neurological fetal development and, thus, mental retardation. During childhood and adolescence, ID may impair physical and cognitive function development (Li and Eastman, 2012). On the other hand, excess iodine may impair thyroid function (Lueng and Braverman, 2014). Recently a study (Mabasa *et al.,* 2018) done in Limpopo Province have reported excess UIC in SAC which is a problem. A study conducted by Roy *et al*. (2016) revealed that 54.1% of the population knew about the role of iodine in cure of goitre. In the study conducted by Zimmermann *et al.* (2005) the 25% increase in the content of Swiss iodised salt markedly improved iodine intakes in school children and pregnant women and the median urinary iodine concentration increased by 23% in schoolchildren and 80% in pregnant women. Iodine is required for the synthesis of thyroid hormones and consequently, for the regulation of metabolic activities of cells and growth especially of the brain during foetal and early postnatal life (Delange, 1998).

**5.5 GENERAL QUESTIONS ON IODINE FORTIFICATION**

The current study shows that more than two thirds (67.5%) of the participants in Mopani and more than three quarters (78%) in Vhembe obtained salt from supermarkets and pension pay points. It is not surprising, supermarkets are legally obliged to distribute iodated salt (Jooste, 2005). There is a higher chance or likelihood of consumers obtaining adequately iodised salt in supermarkets as compared to alternatives sources. The results of the current study also show that some participants obtained household salt from sources such as *spaza shops* (Mopani = 29.5% vs Vhembe = 11.3%) and directly from the salt producer (Vhembe = 1.3%). The results are comparable to a national survey conducted in South Africa where it emerged that 78% of the households obtain their table salt from typical food stores that sell iodised salt, however in the nine provinces between 8% and 37% of households used unconventional (*spaza* shops) sources to obtain their household salt, mainly non-iodised (Jooste, 2005). It is known that coarse salt is used for agricultural purposes and it is not iodised in SA (Jooste, Weight and Lombard, 2003). Furthermore, it has been observed that owners of small *spaza* shops in Limpopo Province repackage agricultural salt to be sold to local communities. The use of alternative sources of household salt such agricultural salt, salt from *spaza* shops, street vendors epitomise factors weakening the universal salt iodisation programme (Jooste, 2005).

More than half of the participants in Mopani (56%) and 51.6% Vhembe in did not know how to identify iodised salt. Lack of awareness in dual market where both iodised and non-iodized salt compete leads the population (especially the rural poor) understandably to choose non-iodized salt even if it is only marginally cheaper (Zargar *et al.,* 1996). The results of the current study are contrary to the findings of Motadi et al. (2016) where participants managed to identify the correct logo (fortification logo) from a list provided to them.

More than half (53.5%) of the participants in Mopani and 31.4% in Vhembe indicated that they did not have concerns about iodine being added to salt. The current findings are comparable to the study done in Lesotho where it was reported that despite the fact that patients did not know what iodine is, all of them indicated that they did not have any problem with iodine being added to salt (Sebotsa *et al.,* 2009). These findings are consistent with the findings of the study done by Yeatman, Player and Charlton (2010) in Australia where participants reported that mandatory fortification was an acceptable strategy, given the serious but preventable health implications related to iodine deficiency. The advantage of supplementing with iodated salt is that it is used by all sections of community irrespective of their social and economic status (Zargar *et al.,* 1996; Assey, 2009). However, this notion is contradicted by rigorous efforts made by many countries to lower salt consumption, because the primary food vehicle for iodine fortification is salt there is a concern that decreasing salt consumption will increase the risk of iodine deficiency (Campbell, Legowski and Legetic, 2011).

The results of the current study indicated that participants in Mopani and Vhembe stored salt either in the plastic that the salt was bought in or in containers with/without lid. When iodised salt is not stored in closed plastic bags, sealed waterproof materials or closed containers, iodine losses occurred leading to reduction in the iodine content of salt before it is consumed (Sebotsa *et al*., 2009). Again, when improperly packed iodated salt is transported over long distances under humid conditions, it will attract moisture and becomes wet, dissolving and carrying the iodate to the bottom of the bag, and finally it can be lost if the bag is porous to water (ICCIDD/MI/UNICEF/WHO, 1995; WHO/UNICEF/ICCIDD, 2007). Salt packed in such materials may lose as much as 75% of its iodine content over nine months. High density polyethylene bags and polyethylene laminated bags are recommended for bulk packaging purposes (Assey, 2009). Contrary to the results of the current study are the findings of a study conducted in Ethopia where it was reported that most of the salt containers had covers at household and most caterers stored salt in a cool dry area (Takele *et al.,* 2003). The iodine content of the salt remained constant and its distribution remained uniform for many months when the salt is packed and kept dry, preferably in a cool place and away from sunlight (Davidson, Finlayson and Watson, 2005). Gebremariam *et al.* (2013) also found that using packed salt at household level was significantly associated with availability of adequately iodised salt.

## 5.6 IODINE NUTRITION KNOWLEDGE

The mean scores of the iodine nutrition knowledge of the participants in Mopani and Vhembe signifies poor and fair iodine nutrition knowledge. The findings of the current study are supported by a study done by Hasler *et al.* (1997) where caretakers were found to have limited knowledge about iodine. Furthermore, it was also pointed out that low public awareness about iodine deficiency disorders and the severity of its consequences have been identified as a major constrains that African countries face. Jooste and Zimmerman (2008) asserts: "the low level of knowledge about iodine nutrition amongst South African adults suggests that the international message about brain damage resulting from iodine deficiency has not been conveyed successfully at the consumer level in the country". Jooste (2009) also indicated that the lack of knowledge increases the vulnerability of lower socio-economic sectors of the population to practice weakening salt iodisation programmes, such as the domestic use of non-iodised agricultural salt.

Participants in Mopani (29%) and Vhembe (31.5%) correctly identified iodine as a micronutrient/mineral. A South African National Food Consumption Survey-Food Fortification Baseline results showed that 84.8% of the adult women indicated that they did not know what iodine is (Department of Health and NFCS-F, 2005). Women were clearly unaware of the role of iodine in maintaining good health, only familiar with iodine as antiseptic (Yeatman *et al.,* 2010). The results of the current study also revealed that 45.9% of the participants in Vhembe and very few (6%) in Mopani new that the main source of iodine was iodised salt. Similarly, Jooste *et al*. (2005) (15.4%) reported that the selected adult population correctly identified iodised salt as the primary source of iodine.  Contrary, Charlton *et al*. (2012) reported that there was a confusion about sources of iodine, with many women identifying vegetables and meat as good sources of iodine.

Twenty percent of the participants in Mopani and 15% in Vhembe districts correctly identified thyroid gland as part of the body that needs iodine. The current study is supported by the South African national study (Jooste *et al.,* 2005) assessing the knowledge of iodine nutrition of 2164 adults, where it was revealed that 16.2% new the thyroid gland needs iodine for its functioning. Like the results of the current study Jooste *et al.* (1999) reported that only 2% of the mothers gave the correct answer regarding the health benefits of iodine in the Northern Cape Province.  Several studies have revealed that as the salt iodisation increases, thyroid size decreases and this shows that iodised salt prophylaxis is effective in correcting iodine deficiency and in reducing goitre (Lombardi *et al.,* 1997; WHO/UNICEF/ICCIDD, 1997; Jooste *et al.,* 2000; Jooste *et al.,* 2005).

In the current study 11% of the participants in Mopani and 13.8% in Vhembe knew that school children can have goitre if they do not get enough iodine. In the study conducted by Girma *et al.* (2012) participants demonstrated a limited knowledge of the health effects of a low iodine intake when presented with a list of the following conditions: goitre (23.7%), impaired physical development (18%) blindness (14.4%) and mental retardation (12.2%). Lack of iodine knowledge and of the effects of its deficiency is of concern, since it is well documented that information, education and communication are the most important components of an IDD programme (Dunn and Van der Haar, 1990). In Turkey, the percentage of women using iodised salt increased significantly during a 3-month regional educational mass media campaign (Can, Okten and Green, 2001) indicating that a more widespread consumption of iodised salt may be led by improved IDD knowledge.

Participants in Mopani (28%) and in Vhembe (30.2%) reported to read the labelling on the salt package. Similarly, Sebotsa *et al.* (2009) arrived at the same conclusion where it was revealed that only 36.1% of patients read labelling on salt packages. Comparing the views of Webster *et al.* (2010) with that of Australian study it is clear that not all participants read nutrition labelling before purchasing. Given the current findings, government should also consider iodising agricultural salt so that those who do not read can also have access to iodised salt (Jooste, 2005).

Half of the participants (50.5%) in Mopani and 47.2% in Vhembe incorrectlyreported that the daily recommended iodine intake for school attending children (SAC) is 120µg/L. The daily iodine intake of 120µg/L is recommended for pre-scholars. According to WHO/UNICEF/ICCIDD (2007) a daily iodine intake of 150µg/L is recommended for SAC. Regular and on-going monitoring is required to ensure that population iodine intakes achieve recommended ranges without excessive intakes in some sectors of the population (Australian Institute of Health and Welfare, 2011).

The results of the study suggest that there is low iodine nutrition amongst food handlers in Mopani and Vhembe districts. Despite the remarkable progress made in South Africa to eliminate IDD, it is clear that the education and promotion aspects of the iodised salt intervention are seriously lacking. This is evident in the findings of the current study. Jooste, Upson and Charlton (2005) points out that reasons for the poor iodine nutrition knowledge might be inadequate inclusion of the topic in the school curriculum, little media reporting on the role of iodine in human health, the false notion that iodised salt will automatically solve the entire iodine deficiency problem, the fact that IDD is generally not a ‘visible’ condition, and the extensive public health focus on infectious diseases such as HIV/AIDS, tuberculosis and malaria.

# CHAPTER 6
# CONCLUSIONS AND RECOMMENDATIONS

## 6.3 CONCLUSIONS

- Majority of the salt samples (71% in Mopani and 65% in Vhembe) had adequate iodine which means the salt producers play a role in the elimination of IDD. However, there are still salt samples that are inadequately iodised or not iodised at all (9% in Mopani and 11% in Vhembe) used in the preparation of meals for NSNP in the two districts. Such instances make the programme designed to eliminate IDD fail. The addition of adequate iodine to salt helps in preventing iodine deficiencies in children and thus improve their IQ levels.

- When comparing the mean iodine content for the two districts, there was no significance difference observed. This is not surprising as most of the service providers purchase salt used in NSNP from the same supplier.

- The iodine nutrition knowledge of the two districts was poor and fair with the mean scores of 28.7 and 35.9 in Mopani and Vhembe districts respectively. It can be deduced that without public awareness on the importance of iodine in the human body, the universal iodine programme will be unsuccessful. On the other hand, the notion that the use of iodated salt will eliminate IDD should be corrected through iodine nutrition education.

## 6.2 RECOMMENDATIONS

- Salt producers and suppliers should be educated on the importance of iodine in the body and on the legislation that regulates salt fortification. This will enable salt producers to ensure that the correct amount of iodine is added at production site. The health professionals should also teach the public about the importance of iodine in the body.

- Food handlers should be given nutrition education by health professional during training. They should be taught about identifying iodated salt from the packages, how to store it. In addition, they should be taught about the importance of iodine in the body particularly at foetus level where the brain is still developing. Suppliers should also be cautioned about the use of uniodised salt and the consequences thereof.

- The Department of Education should work hand in hand with Health Inspectors and researchers to ensure that the salt supplied meet all the requirements. Constant monitoring and evaluation should be carried out by researcher to determine the iodine content of salt used to prepare meals for NSNP.

- Policy makers together with researchers should strengthen their monitoring and evaluation of salt iodization programs to ensure that salt is adequately iodised at a concentration of 15-64ppm at production level. This may result in the population consuming adequately iodised salt and at the time contributing to the elimination of IDD.

- The Department of Education should employ personnel who have adequate knowledge about nutrition. This may be achieved by allowing nutritionists and dieticians getting involved in the training of food handlers.

- Nutritionists and Dieticians should include iodine in the nutrition education talks given at clinics and hospitals. This may change wrong perceptions of the public on iodated salt.

- Department of Health (DoH) should invests in public health awareness campaigns targeting iodine fortification as an intervention in addressing IDD. These campaigns may cover a lot of areas and reduce the consumption of uniodated salt.

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# APPENICES

## APPENDIX 1

**Permission Letter**

University of Venda
School of Health Sciences
Department of Nutrition
P/Bag X 5050, Thohoyandou
0950

The Department of Education
Provincial Office
Polokwane
0700

Dear Sir/Madam

RE: **Permission to use Mopani and Vhembe schools for a MSCPNUT research**

**I Ramugondo Mpho (student number: 11571508)**, hereby request permission to use Mopani and Vhembe schools which are receiving National School Nutrition Program (NSNP). I am currently doing MSc in Public Nutrition at the University of Venda, as part of my studies I am required to do the research. The research topic is **the iodine content of salt used in the NSNP at Mopani and Vhembe districts in Limpopo province.** With this study we aim to determine the iodine content of salt used in the NSNP. This will help us to know if the children eat food with enough iodine at school. Iodine is a mineral that is very important for a child to grow and learn well.

Banking on your positive response

**Yours Faithful**

_______________________________________

Researcher: Ramugondo M

Contact: 0728450383/0606457318

Email: mpho.ramugondo@yahoo.com

_______________________________________

Supervisor: Dr Mushaphi L.F

**APPENDIX 2**

**Recruitment Letter**

Dear Participant

We would like to invite you to take part in a study. With this study we aim to determine the iodine content of salt used in the NSNP. This will help us to know if the children eat food with enough iodine at school. Iodine is a mineral that is very important for a child to grow and learn well.

If you are interested to take part in our study, one of our fieldworkers will make an appointment to meet with you at school.

What will you need to do if you take part in this study?

- We will also ask you to tell us a bit about yourself – name, the age, level of education, income and if you have been trained to cook. We will ask you who do the cooking in the house how much salt is added when food is cooked. If possible, we would like to see how the food is cooked, how much salt is added and where salt is stored when we visit your school.

You will not benefit directly from the study, but the information we get from you will help us to develop ways to improve the iodine content of salt until consumption by learners. The fieldworker will thank you for your time and participation.

**If you are interested in taking part in the study, please give us your contact details so that the fieldworker can make an appointment to interview you on the day of data collection.**

| | |
|---|---|
| Cell number( if available) | |
| Telephone number of the school were you work | |
| School address | |

**APPENDIX 2A**

**Kha vhabiki vha tshikoloni.**

Ri khou humbela uri vha dzhenelele kha thoduloso heyi. Thoduluso heyi i do lavhelesa kha muno une wa shumisiwa hu tshi bikiwa uri una pfushi ya Iodine. Iodine ndi mineral ine ya thusa kha u aluwa ha vhana na pfunzo tshikoloni.

Arali vha tshi takalela u dzhenela kha heyi thoduluso, munwe wavha shumisani na rine u do tangana na vho thsikoloni tshine vha shuma khatsho.

Ndi mini tshine tsha todiwa kha vhone kha heyi thaduluso?

- Ri do vha vhudzisa nga vhudala nga - minwaho yavho na hune vha shuma hone. Ri do vhudzisa muthu ano anzela u bika uri u shela muno mungafhani kha zwiliwa. Arari zwinga konadzea, vha nga ritendela ra vhona musi vha khou bika zwiliwa tshikoloni na urit tendela ravhona hune muno uyu wa dzula hone.

Vhone avha nga badeliwi, ndivho ine ra do i wana kha vhone I do ri thusa uri muno une vha shela zwiliwani u vhe una iodine. Ri do livhuwa tshifhinga tshavho tshi ne vha do rifha tshone kha heyi thoduluso.

**Arali vhakho takalela uri vhone vhavhe tshipida tsha thoduluso heyi,ri khou humbela dzi nomboro dza vho uri ri kone u vha dalela tshikoloni tshine vah shuma khatsho.**

| | |
|---|---|
| Nomboro dza vho dza cell (arali vha nayo) | |
| Nomboro dza vho dza tshikoloni (arali vha nayo) | |
| Address ya tshikoloni | |

**APPENDIX 2B**

**Ka vasweki va le xikolweni**.

Mi rhambiwa ku va xiphemu xa ndzavisiso wa mimunyu leyi I tirhisiwa ka ku sweka a xikolweni. Ndzavisiso leyi i languta le swaku mimunyo leyi I na xiakamirhi xa iodine xana. Iodine I xiakamirhi xi i pfunaka ku vana va kula kahle na ku va va dyondza kahle xikolweni.

Loko mi switsakela ku va xiphemu xa ndzavisiso leyi,u nwani wa va tirhisani nahina uni vakela xikolweni xa nwina.

Ka ndzavisiso leyi xana ku ta laviwa yini ka nwina?

- Hi ta mi vutisa malembe a nwina, ku sweka manhi, milunga ri ni munyu lokomi sweka? Hi ta tsakela na ku vona la mivekaka kona munyu.

Mi nge hakerhiwi, dondzo leyi minga ta hi nyika yona I ta hi pfuna ku endla le swaku swakudya swa hina swi va swi rhi na munyu minkarhi hi hinkwayo. Mi ta khensiwa nkarhi wa nwina wa ku va xiphemu xa ndzavisiso leyi.

Loko mi swi tsakela hita kombela ti nomborho ta nwina ta rhitingo le swaku hita kota ku mivakela xikolweni xa nwina.

| | |
|---|---|
| Ti nomborho ta cell (loko ti rhi kona). | |
| Ti nomborho (loko ti rhi kona). | |
| Address ya le swikolweni. | |

**APPENDIX 3**

**INFORMED CONSENT FORM: Participants**

**RESEARCH PROJECT**: **THE IODINE CONTENT OF SALT USED IN THE NATIONAL SCHOOL NUTRITION PROGRAM (NSNP) AT MOPANI AND VHEMBE DISTRICTS IN LIMPOPO PROVINCE, SOUTH AFRICA.**

**Researchers**

Ms Ramugondo M MSCPNUT student at the University of Venda.

Dr Mushaphi LF(SA) Division of Human Nutrition, Faculty of Health Sciences, University of Venda

Mr Mabapa S(SA) Division of Human Nutrition, Faculty of Health Sciences, University of Venda

Dear Sir/ Madam

We would like to invite you to take part in our study. With this study we aim to determine the iodine content of salt used in the NSNP. This will help us to know if the children eat food with enough iodine at school. Iodine is a mineral that is very important for a child to grow and learn well.

What will you need to do if you take part in this study?

- We will also ask you to tell us a bit about yourself – name, the age, level of education, income and if you have been trained to cook. We will ask you who does the cooking in the house how much salt is added when food is cooked. If possible, we would like to see how the food is cooked, how much salt is added and where salt is stored when we visit your school.

You will not benefit directly from the study, but the information we get from you will help us to develop ways to improve the iodine content of salt until consumption by learners. The fieldworker will thank you for your time and participation.

There are a few other important things that we would like you to know:

- This study was approved by the ethics committee of the University of Venda. This committee makes sure that it is safe for you to take part in the study.

- We give participant who takes part in the study a code number so that nobody knows the answers you gave.

- You are free to withdraw from the study at any time, it does not matter what the reason is. This will not count against you in any way.

If you have any questions about the study you can phone Ms Ramugondo M on 0728450383/0606457318. You may also phone the chairperson of the Department of Nutrtion, Dr Mushaphi LF at 021 4066338, *ethics committee UNIVEN Prof GE Ekosse kha 015 962 8000,* if you are worried about the way the study is done or the way you are treated.

**If you agree that you will take part in the study, please fill in the following:**

I …………………………………..………… …………………….. (name an surname)

The information in this document has been explained to me and I understand it. I agree to participate in the study. This decision was made of my own free will; nobody forced me to take this decision.

Signature ………………………………

I declare that I did not force the subject to participate in the research study. I have fully informed the above person of the aims, procedures and risks of the study.

......................................................... ..........................................................................

Signature of the fieldworker Name

**APPENDIX 3A**

**FOMO YA THENDELANO: Mubiki wa tshilkoloni.**

| |
|---|
| **RESEARCH PROJECT**: **THE IODINE CONTENT OF SALT USED IN THE NATIONAL SCHOOL NUTRITION PROGRAM (NSNP) AT MOPANI AND VHEMBE DISTRICTS IN LIMPOPO PROVINCE, SOUTH AFRICA.** |

| |
|---|
| **Researchers**<br>Ms Ramugondo M MSCPNUT student at the University of Venda.<br>Dr Mushaphi LF(SA) Division of Human Nutrition, Faculty of Health Sciences, University of Venda<br>Mr Mabapa S(SA) Division of Human Nutrition, Faculty of Health Sciences, University of Venda |

Kha mubiki wa tshikoloni

Ri khou humbela uri vha dzhenelele kha thoduloso heyi. Thoduluso heyi i do lavhelesa kha muno une wa shumisiwa hu tshi bikiwa uri una pfushi ya Iodine. Iodine ndi mineral ine ya thusa kha u aluwa ha vhana na pfunzo tshikoloni.

Arali vha tshi takalela u dzhenela kha heyi thoduluso, munwe wavha shumisani na rine u do tangana na vho thsikoloni tshine vha shuma khatsho.

Ndi mini tshine tsha todiwa kha vhone kha heyi thaduluso?

- Ri do vha vhudzisa nga vhudala nga - minwaho yavho na hune vha shuma hone. Ri do vhudzisa muthu ano anzela u bika uri u shela muno mungafhani kha zwiliwa. Arari zwinga konadzea, vha nga ritendela ra vhona musi vha khou bika zwiliwa tshikoloni na urit tendela ravhona hune muno uyu wa dzula hone.

Vhone avha nga badeliwi, ndivho ine ra do i wana kha vhone I do ri thusa uri muno une vha shela zwiliwani u vhe una iodine. Ri do livhuwa tshifhinga tshavho tshi ne vha do rifha tshone kha heyi thoduluso.

*Huna zwitho zwa ndeme zwine ra toda uri vha zwi divhe:*

- Thoduluso heyi yo tendeliwa nga vha ethics committee of the University of Venda. Komiti heyi ita zwauri vha vhe vho tsireledzea musi vha tshikhou dzhenelela kha heyi thoduluso.

- Ri fha vha dzhenelei vha thoduluso heyi nomboro ya tshidzume, ari shumisi madzina uri husi vhe na muthu ano divha phindilo dzavho.

- Vho tendelwa u dibvisa kha tsedzuluso heyi tshifhinga tshinwe na tshinwe tshine vha toda.

Arali vha na mbudziso nga heyi thoduluso vha nga kwama Ms Ramugondo M on 0728450383/0606457318. Kana vha kwama thoho ya Department ya Nutrtion ya UNIVEN, Dr Mushaphi L.F at 021 4066338, *ethics committee UNIVEN Prof GE Ekosse kha 015 962 8000.*

***Arali vho tenda u dzhenelela khathoduluso heyi, kha vha nwale zwidodombedzwa zwi tevelaho:***

Nne ……………………………….…………. ……………………..(dzina na tshifani) *ndo thalutshedzwa mafhungo othe nga vhudalo ari kha heli bambiri. Ndi a tenda udi dzhenisa u vha tshipida tsha heyi thoduluso.*

Tsaino nga mubiki…………………..

Datumu………………………… Fhethu……………………………………………

**U ana ha muthu wa u thusa kha thoduluso**

*Ndi khou ana uri a thingo kombetshedzha mubiki uri vhavhe tshipida tsha heyi thuduluso. Ndo talutshedza nga vhudalo vhuleme, na khombo ya heyi thoduluso.*

........................................................ ..........................................................................

Tsaino nga muthusi wa thoduluso Dzina

**APPENDIX 3B**

**FOMO YA MPFUMELELANO: Mubiki wa tshilkoloni.**

**RESEARCH PROJECT: THE IODINE CONTENT OF SALT USED IN THE NATIONAL SCHOOL NUTRITION PROGRAM (NSNP) AT MOPANI AND VHEMBE DISTRICTS IN LIMPOPO PROVINCE, SOUTH AFRICA.**

**Researchers**

Ms Ramugondo M MSCPNUT student at the University of Venda.

Dr Mushaphi LF(SA) Division of Human Nutrition, Faculty of Health Sciences, University of Venda

Mr Mabapa S(SA) Division of Human Nutrition, Faculty of Health Sciences, University of Venda

Ka vasweki va le xikolweni

Mi rhambiwa ku va xiphemu xa ndzavisiso wa mimunyu leyi I tirhisiwa ka ku sweka a xikolweni. Ndzavisiso leyi i languta le swaku mimunyo leyi I na xiakamirhi xa iodine xana. Iodine I xiakamirhi xi i pfunaka ku vana va kula kahle na ku va va dyondza kahle xikolweni.

Ka ndzavisiso leyi xana ku ta laviwa yini ka nwina?

- Hi ta mi vutisa malembe a nwina, ku sweka manhi, milunga ri ni munyu lokomi sweka. Hi ta tsakela na ku vona la mivekaka kona munyu.

Mi nge hakerhiwi, dondzo leyi minga ta hi nyika yona I ta hi pfuna ku endla le swaku swakudya swa hina swi va swi rhi na munyu minkarhi hi hinkwayo. Mi ta khensiwa nkarhi wa nwina wa ku va xiphemu xa ndzavisiso leyi.

*Mahungo a nkoka :*

- Ndzavisio leyi I amukeriwile hi va ethics komiti ya University ya Venda. Komiti leyi I endla swa ku mi hlayiseka loko miri xiphemu xa ndzavisiso.

- Hi nyika vangenelili ti nambara, a ku tirhisiwi mavito, leswi hiswi endlela ku mahungo a nwina a hlayiseka.

- Ma pfhumeleriwa ku ti humesa ka ndzavisiso ley nkarhi unwani na unwani loko mi swi lava.

Loko mi rhi na swi vutiso minga vutisa Ms Ramugondo M ke 0728450383/0606457318,kumbe mi vutisa hloko ya Department ya Nutrtion ya UNIVEN, Dr Mushaphi L.F ka 021 4066338, kumbe *ethics committee UNIVEN Prof GE Ekosse ka 015 962 8000.*

**Loko mipfumela hi komela mi tsala leswi swi landzelako***:*

Minha …………………………………..…………. ……………………..(vito na xivongo) *ndzi hlamuseriwile nkoka wa ndzhaavisiso leyi, ndzhapfumela ku va xiphemu xa yona.*

Nsayino ………………………………

**Ku pfumela ka mu pfuni wa ndzavisiso**

*Ndza pfumela ku ani hlohlotelani mungeneleli ku a va xiphemu xa ndzavisiso leyi, ndzi hlamuserini nkoka wa ndzavisiso.*

........................................................ ...........................................................................

nsayino hi mupfuni wa ndzavisiso vito na xivongo

**APPENDIX 4**

**TRAINING MANUAL FOR FIELDWORKERS**

**1. SAMPLE SELECTION**

- ✓ Identify schools to be included on the study.
- ✓ Visit the selected schools.
- ✓ Introduce yourself.
- ✓ Explain the purpose of the study.
- ✓ Determine if the school is eligible for inclusion.
- ✓ Obtain consent.
- ✓ Fill in the socio-demographic and iodine knowledge questionnaire with the food handlers.
- ✓ Obtain anthropometric measurements.
- ✓ Collect salt samples.

**2. CONSENT**

- ✓ Complete the consent form for each household you visit. The consent form assures us that the food handler participated in the study voluntarily.

**2.1. Ethics and informed consent**

- ✓ The intervention of the participant in the study is minimal, with time and inconvenience in the asking of questions.

**2.2. Procedure for consent by the fieldworker**

- ✓ After the schools have been identified, enter the school and request to speak to the school principal. Introduce yourself and request the permission to conduct the study. Explain the procedure for conducting the study.
- ✓ If permission is granted, identify if the food handlers who meet the inclusion criteria. Discuss the study verbally with them, stating clearly the objectives of the study, what is expected of them and voluntary and confidential nature of their participation.
- ✓ Allow them to read the informed consent. Allow the caregiver to ask any questions regarding the study and answer them to the satisfaction of the client.
- ✓ Once everything has been agreed upon, ask them to complete and sign the informed consent.

**3. CONDUCTING THE INTERVIEW**

**3.1. Interview schedule**

- ✓ During each interview that you conduct, you have to complete the following:
- ✓ Socio-demographic data and Iodine knowledge questionnaire.

**3.2. Interview skills**

- ✓ Apply the following guidelines when conducting interviews.
- ✓ Introduce yourself
- ✓ Explain briefly that you are collecting data for the study that is focusing on Iodine content of salt used in the NSNP.
- ✓ Explain that you are going to ask questions on socio-demographic data and iodine Knowledge questionnaire. Explain that you need as take a small sample of salt that they use while cooking.
- ✓ Request the food handler to sign the consent form.
- ✓ Assure the food handler of the confidentiality of the information she gives you and the importance of answering truthfully.
- ✓ Ask the questions in the order that they appear on the interview schedule.
- ✓ Ask the questions as they are written on the questionnaire.
- ✓ Do not try to influence the way the interviewee answers. Do not lead her or put words in her mouth.
- ✓ Keep control of the interview. Do not hurry the interviewee. Allow her to think.
- ✓ Make sure that you have completed all the questions on the interview schedule.

**4. TECHNIQUES**

- ✓ Collect two tablespoon of salt and pour into the zip lock seal plastic bag and always keep it dry
- ✓ Label the plastic bag (always writing the name and code of the school).

**APPENDIX 5**

**QUESTIONNAIRE FOR FOOD HANDLERS**

**Instruction:** Please do not give the answers to the respondents! Ask the questions in the set sequence and make a cross on the appropriate box.

**CODE**

| | | | |
|---|---|---|---|
| | | | |

District name ______________________

Circuit name ______________________

Name of the school ______________________

**SECTION A**

**Demographic information**

1. Date of the interview

| | | |
|---|---|---|
| | | |

2. Date of birth

| | | |
|---|---|---|
| | | |

3. Age of participant

| | |
|---|---|
| 18-25 | 1 |
| 26-35 | 2 |
| 36-45 | 3 |
| 46 and above | 4 |

4. Gender

| | |
|---|---|
| Male | 1 |
| Female | 2 |

5. Level of education

| | |
|---|---|
| Never attended | 1 |
| Grade 1-7 | 2 |
| Grade 8-12 | 3 |
| College/ tertiary | 4 |

6. Marital status

| | |
|---|---|
| Single | 1 |
| Married | 2 |
| Divorced | 3 |
| Living with partner | 4 |

7. Household Income

| | |
|---|---|
| Less than R1000 | 1 |
| R1001-R2000 | 2 |
| R2001-R3000 | 3 |
| 3001- R4000 | 4 |
| R4001-R5000 | 5 |

8. Where you trained on food handling?

| | |
|---|---|
| Yes | 1 |
| No | 2 |

9. If yes, how long was the training?

| | |
|---|---|
| 1 day | 1 |
| 2 days | 2 |
| 3 days | 3 |
| A week | 4 |
| Other | 5 |

10. What where you trained on?

| | |
|---|---|
| Food handling | 1 |
| Food safety | 2 |
| Nutrition | 3 |
| Other | 4 |

11. Number of children

| | |
|---|---|
| None | 1 |
| 1-2 | 2 |
| 3-4 | 3 |
| 5 or more | 4 |

12. Do you have a child at this school?

| | |
|---|---|
| Yes | 1 |
| No | 2 |

**SECTION B**

**General questions on Iodine Fortification.**

13. Where do you usually buy or obtain the salt that is used for food in your house?

(Please probe to elicit an accurate response).

| | |
|---|---|
| Purchase in a shop like Pick ‘n Pay, Shoprite, Spar, General Store, Pension pay point etc. | 1 |
| Agricultural coarse salt obtained from farmer, employer, cooperation or elsewhere | 2 |
| Spaza shop | 3 |
| Informal sector: street vendor or hawker | 4 |
| In bag of maize meal | 5 |
| Direct from salt producer | 6 |
| No salt is used in my household | 7 |
| Other, please specify: ________________________________ | 9 |
| Do not know | 10 |

14. Where do you get salt if the salt used at school ran out before the services provider delivers the next batch?

| | |
|---|---|
| Buy at nearby shop/spaza | 1 |
| Fetch salt at home | 2 |
| Do not add salt | 3 |
| Never run out of salt | 4 |

15. Do you add more salt to your food because the salt is iodated?

| | |
|---|---|
| Yes | 1 |
| No | 2 |
| Do not know | 3 |
| Do not know what iodated salt is | 4 |

16. Do you have any concerns about iodine being added to table salt?

| | |
|---|---|
| Yes | 1 |

| | |
|---|---|
| No | 2 |
| Unsure | 3 |
| Do not know what iodine is | 4 |

17. In what kind of container do you store salt in the kitchen?

| | |
|---|---|
| Plastic bag in which the salt was bought | 1 |
| Carton box | 2 |
| Rigid plastic container with holes at the top | 3 |
| Open porcelain, wooden, plastic or metal container with or without a lid | 4 |

18. How do you know the salt is Iodised?

| | |
|---|---|
| Plastic bag/container written iodised salt | 1 |
| Salt having brown colour | 2 |
| Salt with pure white colour | 3 |
| Do not know | 4 |

19. When do you add Iodised salt?

| | |
|---|---|
| While cooking | 1 |
| Start cooking with salt | 2 |
| While eating | 3 |
| Do not know | 4 |

20. Is it important to fortify salt?

| | |
|---|---|
| Yes | 1 |
| No | 2 |

**SECTION C**

**QUESTIONNAIRE ON IODINE KNOWLEDGE OF FOOD HANDLERS**

**The following questions are related to iodine.**

[Field worker, please do not give the answers to the respondents! Ask the questions in the set sequence from Question 22 to 27 and do not go back to a question. Please read the field worker's guide on the iodine questions thoroughly before asking the questions. Remember that iodated salt and iodised salt have the same meaning]

21**.** Can you please tell me what iodine is**?**

| | |
|---|---|
| Vitamin | 1 |
| Mineral | 2 |
| Micronutrient | 3 |
| Something in the food that we eat | 4 |
| Other (Specify) | 5 |
| Do not know | 6 |

22**.** Do you know the <u>most important or main source</u> of iodine in the food of the people in South Africa?

| | |
|---|---|
| Iodised salt/Iodated salt/iodine in salt/salt | 1 |
| Fish/Sea food/Marine food products | 2 |
| Vegetables | 3 |
| Meat or meat products | 4 |
| Dairy products, e.g. milk, cheese, butter | 5 |
| Drinking water | 6 |
| Other | 7 |
| Do not know | 8 |
| Do not know what iodine is | 9 |

23. Can you tell me which part of the body needs iodine for its functioning?

| | |
|---|---|
| Liver | 1 |
| Thyroid gland/Gland in front of the neck | 2 |
| Lungs | 3 |

| | |
|---|---|
| Do not know | 4 |

24. What do you think is the most harmful effect on the health of children if they do not get enough iodine from the food that they eat?

| | |
|---|---|
| Slow growth | 1 |
| Goiter/Enlarged thyroid gland/Swollen neck | 2 |
| Brain damage or under-development of the brain/Low intelligence | 3 |
| Cretinism | 4 |
| Hypothyroidism (low concentration of thyroid hormones in the blood) | 5 |
| Death | 6 |
| Other | 7 |
| Do not know | 8 |
| Do not know what iodine is | 9 |
| All of the above | 10 |

25. Do you read the labelling on the salt package when you buy salt, to make sure the salt is iodated?

| | |
|---|---|
| Yes | 1 |
| No | 2 |
| Cannot read | 3 |
| Do not know what iodated salt is | 4 |

26. What is the daily recommendation for iodine for school attending children?

| | |
|---|---|
| 120 µg/L | 1 |
| 150 µg/L | 2 |
| 220 µg/L | 3 |
| Do not know | 4 |

**APPENDIX 5A**

**DZIMBUDZISO**

**KHOUDU**

| | | |
|---|---|---|
| | | |

Dzina la District ______________________

Dzina la circuit ______________________

Dzina la tshikolo ______________________

**KHETHEKANYO YA A**

**Ngudo ya muvhalelano wa matshilele a vhathu na hune vha dzula hone.**

1. Datumu ya duvha la dzimbudziso

| | | |
|---|---|---|
| | | |

2. Duvha la mabebo

| | | |
|---|---|---|
| | | |

3. Minwaha

| | |
|---|---|
| 18-25 | 1 |
| 26-35 | 2 |
| 36-45 | 3 |
| 47  Na u fhira | 4 |

3. Mbeu

| | |
|---|---|
| Munna | 1 |
| Mufumakadzi | 2 |

4. Maimo a ngudo

| | |
|---|---|
| Thi ngo dzhena tshikolo | 1 |
| Grade 1-7 | 2 |
| Grade 8-12 | 3 |
| Gudedzini | 4 |

5. Lumalo

| | |
|---|---|
| Thi ngo maliwa | 1 |
| Ndo maliwa | 2 |
| Ndo taliwa | 3 |
| Ndi dzula na mungana | 4 |

6. Muholo

| | |
|---|---|
| Fhasi ha R1000 | 1 |
| R1001-R2000 | 2 |
| R2001-R3000 | 3 |
| 3001- R4000 | 4 |
| R4001-R5000 | 5 |

7. Vho gudisiwa u bika naa?

| | |
|---|---|
| Ee, kha vha taluse. | 1 |
| Hai, kha vha taluse. | 2 |

**KHETHEKANYO YA B**

**DZIMBUDZISO NGA HA IODINE**

8. Ndi khou humbela u vhudziwa uri iodine ndi mini?**.**

| | |
|---|---|
| Ndi tshifhatamuvhili | 1 |
| Ndi minerala | 2 |
| Ndi tshifhatamuvhili tshi no todiwa zwituku | 3 |
| I wanala kha zwiliwa zwine ra la | 4 |
| Zwinwe vho (talusa) | 5 |
| A thi divhi. | 6 |

9. Vha ya divha uri iodine I wanalesa kha zwifhio zwiliwa zwine vha la South Africa?

| | |
|---|---|
| Muno une wo sheliwa iodine | 1 |
| Khovhe/zwiliwa zwine zwa wanala lwanzheni | 2 |
| Miroho | 3 |
| Nama kana zwibveledzwa zwa nama | 4 |
| Zwiliwa zwa dairy e.g. mafhi,cheese kana margarine | 5 |
| Madi a unwa | 6 |
| Zwinwevho: | 7 |
| A thi divhi | 8 |
| A thi divhi uri iodine ndi mini | 9 |

10. Ndi tshi fhio tshipida tsha muvhili tshine tsha toda iodine uri tshi kone u shuma?

| | |
|---|---|
| Gulokulo | 1 |

| | |
|---|---|
| Incorrect | 2 |
| A thi divhi | 3 |

11. Ndi a fhio masia ndo itwa a musi nwana sa wani iodine kha zwiliwa zwine ala?

| | |
|---|---|
| U lenga u aluwa | 1 |
| U kukumuwa ha gulokulo | 2 |
| U vhavhisea ha maluvhi, u si kone tshikoloni | 3 |
| Cretinism | 4 |
| Hypothyroidism (u si vhe na thyroid hormone nnzhi muvhlini) | 5 |
| Lufu | 6 |
| Zwinwevho: | 7 |
| A thi divhi | 8 |
| Athi divhi uri iodine ndi mini | 9 |

12. Muno une vha u shumisa vha wana kana vha u renga gai?

| | |
|---|---|
| Mavhengeleni a no nga Pick ‘n Pay, Shoprite, Superette, Spar, General Store etc. | 1 |
| Muno uno wanala kha vhalimisi | 2 |
| Tshiphazani | 3 |
| Kha vha rengisi ha nefha nnda | 4 |
| Kha saga la mugayo | 5 |
| Kha mu bveledzi wa muno | 6 |
| A huna muno | 7 |
| Ndi a funa u renga muno wa iodated mar a uho | 8 |

| | |
|---|---|
| Zinwe kha vha taluse : ......................................................... | 9 |
| A thi divhi | 1<br>0 |

13. Vha ya vhala zwo nwaliwaho naa kha phakethe ya muno?

| | |
|---|---|
| Ee | 1 |
| Hai | 2 |
| A thi koni u vhala | 3 |
| A thi divhi uri muno wa iodated ndi mini | 4 |

14. Vha ashela muno munzhi zwiliwani naa ngauri muno una iodine?

| | |
|---|---|
| Ee | 1 |
| Hai | 2 |
| A thi divhi | 3 |
| A thi divhi uri muno wa iodated ndi mini | 4 |

15. Vha na mbilahelo naa musi iodine itshi sheliwa kha muno wa hayani?

| | |
|---|---|
| Ee | 1 |
| Hai | 2 |
| Thi na vhutanzi | 3 |
| A thi divhi uri iodine ndi mini | 4 |

16. Muno u vheiwa kha tshikhonthina tsha hani khishini ya vho?

| | |
|---|---|
| Ka bambiri line la renga lo fara muno | 1 |
| Carton box | 2 |
| Kha khothaina ine ya vha na mabuli nga ntha | 3 |
| Kha khothaina ine ya vha I sina tshivalo | 4 |

17. Vha zwidivhisa hani uri muno una iodini?

| | |
|---|---|
| Khotheina ya u nwalwa uri muno una iodine | 1 |
| Muno wa muvhala wa braweni | 2 |
| Muno wa muvhala mutshena | 3 |
| A thi divhi | 4 |

18. Ndi lini hune ha sheliwa muno kha zwiliwa?

| | |
|---|---|
| Musi u tshi khou bika | 1 |
| U thoma u bika na muno | 2 |
| Musi muthu a tshi khou la | 3 |
| Athi divhi | 4 |

19. Ndi zwa vhuthogwa u engedza micronutrient kha muno?

| | |
|---|---|
| Ee | 1 |
| Hai | 2 |

**SECTION C**

20**.** Iodine ndi mini**?**

| | |
|---|---|
| Vitamini | 1 |
| Minerala | 2 |
| Micronutrient | 3 |
| Zwinwe kha zwiliwa zwine rala | 4 |
| Zwinwe (Talusa) | 5 |
| A thi divhi | 6 |

21**.** Iodine I wanala kha zwiliwa zwihio South Africa?

| | |
|---|---|
| Iodised salt/Iodated salt/iodine in salt/salt | 1 |

| | |
|---|---|
| Khovhe | 2 |
| Miroho | 3 |
| Nama | 4 |
| Dairy products, e.g. mafhi, cheese, butter | 5 |
| Madi a u nwa | 6 |
| Zwinew vho | 7 |
| A thi divhi | 8 |
| A thi divhi uri iodine ndi mini | 9 |

23. Ndi tshipida tshi fhio tsha muvhili tshi no toda iodine?

| | |
|---|---|
| Tshivhindi | 1 |
| Gulokulo | 2 |
| Mafhafhu | 3 |
| A thi divhi | 4 |

24. Hunga itea mini kha nwana arali a sa wani zwiliwa zwa uvha na iodine?

| | |
|---|---|
| U si hule zwavhudi | 1 |
| Gulokulo | 2 |
| U si talifhe | 3 |
| Cretinism | 4 |
| Hypothyroidism (low concentration of thyroid hormones in the blood) | 5 |
| Lufu | 6 |
| Zwinew vho | 7 |
| A thi divhi | 8 |
| A thi divhi uri iodine ndi mini | 9 |

| | |
|---|---|
| Zwothe zwa nwaliwaho a fho nntha | 10 |

25. Vha ya vhala zwo nwaliwaho kha phakhethe ya muno naa, u ri vha u vhone uri u na iodine?

| | |
|---|---|
| Ee | 1 |
| Hai | 2 |
| A thi koni u vhla | 3 |
| Athi divhi uri iodine ndi mini | 4 |

26. Ho tendeliwa mupimo wa duvha wa iodine kha vhana vha tshikolo?

| | |
|---|---|
| 120 µg/L | 1 |
| 150 µg/L | 2 |
| 220 µg/L | 3 |
| A thi divhi | 4 |

**APPENDIX 5B**

**SWIVUTISO**

**CODE**

| | | |
|---|---|---|
| | | |

Vito ra dsitrict ______________________

Vito ra circuit ______________________

Vito ra xikolo ______________________

**SECTION A**

**Demographic information**

1. Siku ra vuxokoxoko

| | | |
|---|---|---|
| | | |

2. Siku ra kuvelekiwa

| | | |
|---|---|---|
| | | |

3. Malembe

| | |
|---|---|
| 18-25 | 1 |
| 26-35 | 2 |
| 36-45 | 3 |
| 48 ku ya hehla | 4 |

4. Rimbeu

| | |
|---|---|
| Nuna | 1 |
| Nsati | 2 |

5. Xiimo xa tidyondzo

| | |
|---|---|
| A ni yanga xikolweni | 1 |
| Grade 1-7 | 2 |
| Grade 8-12 | 3 |
| Dyondzo ta le hehla | 4 |

6. Ku teka kumbe ku tekiwa

| | |
|---|---|
| A ni tekiwwanga | 1 |
| Ndzi tekini | 2 |
| Ndzi tsikiwini | 3 |
| Ndzi tsama na mungana | 4 |

7. Muholo

| | |
|---|---|
| Hansi ka R1000 | 1 |
| R1001-R2000 | 2 |
| R2001-R3000 | 3 |
| 3001- R4000 | 4 |
| R4001-R5000 | 5 |

8. Mi dondzisiwine ku sweka naa?

| | |
|---|---|
| Ee, hlamusela | 1 |
| Hai, hlamusela. | 2 |

**SECTION B**

**SWIVUTISO**

9. Hi kombela mi hi byela ku iodine I yini?

| | |
|---|---|
| Vitamini ( xiakamiri) | 1 |
| Minerala( xiakamiri) | 2 |
| Xiakamiri lexi xi laviwaka hi mpimo lo wu tsongo e mirini wa hina | 3 |
| xikumeka ka swa ku dya | 4 |
| swinwani (hu mesa mongo wa maka leyi) | 5 |
| A ni swi ti vi | 6 |

10. Iodine yi kumeka kwini ka swa kudya la South Africa?

| | |
|---|---|
| Iodised salt/Iodated salt/iodine in salt/salt | 1 |
| hlampfi/swakudya swa le lwandle | 2 |
| Matsavu | 3 |
| Nyama | 4 |
| Swa kudya swa meleka, e.g. meleka, cheese, butter | 5 |
| Mati ya kunwa | 6 |
| Swinwanyana | 7 |
| Ani swi tivi | 8 |
| A ni swi tivi ku iodine i yini? | 9 |

11. Iyini xiro xa mirhi xi lavaka xiakamirhi xa iodini?

| | |
|---|---|
| Thyroid gland/Gland in front of the neck | 1 |
| Incorrect | 2 |
| A ni swi tivi | 3 |

12. Ku ta humelela yini loko vana va nga kumi iodine ka swa kudya?

| | |
|---|---|
| Unga kuli kahle | 1 |
| Bundukulu | 2 |
| Ku vaviseka ka byongo | 3 |
| Cretinism | 4 |
| Hypothyroidism (low concentration of thyroid hormones in the blood) | 5 |
| Rifu | 6 |
| Swinwanyana | 7 |
| A ni swi tivi | 8 |
| A ni switivi ku iodine iyini? | 9 |

13. Mi xava kwini munyu lowu mi wu tirisaka e kaya?

(Please probe to elicit an accurate response).

| | |
|---|---|
| Ni xava ka Pick ‘n Pay, Shoprite, Spar, General Store etc. | 1 |
| Ni xava munyu mapurasini | 2 |
| Xiphazeni | 3 |
| Mudendeni | 4 |
| Ka saka ra mugayo | 5 |

| | |
|---|---|
| La munyu wu endliwaka kona | 6 |
| Ku hava munyu kaya | 7 |
| Na swi lava ku xava, munyu wa iodated a u kumeki | 8 |
| Swinwanyani , please specify: ........................................................... | 9 |
| A ni switivi | 1<br>0 |

14. Wa hlaya leswi swi nga tsariwa ka phakiti ra munyu xana ?

| | |
|---|---|
| Ina | 1 |
| Ee | 2 |
| A ni swikoti ku hlaya | 3 |
| A ni switivi ku iodine I yini? | 4 |

15. Mi chela munyu wo tala ka swa kudya hi ku munyu wu na iodine xana?

| | |
|---|---|
| Ina | 1 |
| Ee | 2 |
| A ni switivi | 3 |
| A ni switivi ku iodine iyini? | 4 |

16. Mi na xivillelo lo ko ku engeteriwa iodine ka munyu xana?

| | |
|---|---|
| Ina | 1 |
| Ee | 2 |
| A ni tsembi | 3 |
| A ni switivi ku iodine iyini? | 4 |

17. I xibye xa njani le xi mi cheleka munyu ka xona ?

| | |
|---|---|
| Phepha le ri mi xavaka munyu ka rona | 1 |
| E ka bokisi ra kathoni | 2 |
| E ka khotehina ya kuva na ti mbhovo | 3 |
| E ka khotheina yak u kala xipfalo | 4 |

18. Vha zwidivhisa hani uri muno una iodini?

| | |
|---|---|
| Khotheina I tsariwe ku munyu una iodine | 1 |
| Munyu wa muvala wa braweni | 2 |
| Munyu wa muvla wo basa | 3 |
| A ni switivi | 4 |

19. Xana munyu y tsheriwa rini e swakudyeni?

| | |
|---|---|
| Loko u sweka | 1 |
| Uu sungula ku sweka na munyu | 2 |
| Loko munu a dya | 3 |
| A ni switivi | 4 |

20. I swa nkoka xana ku engetela micronutrient e ka munyu?

| | |
|---|---|
| Ee | 1 |
| Hai | 2 |

**SECTION C**

**QUESTIONNAIRE ON IODINE KNOWLEDGE OF FOOD HANDLERS**

**The following questions are related to iodine.**

[Field worker, please do not give the answers to the respondents! Ask the questions in the set sequence from Question 22 to 27 and do not go back to a question. Please read the field worker's guide on the iodine questions thoroughly before asking the questions. Remember that iodated salt and iodised salt have the same meaning]

21. I yini Iodine?

| | |
|---|---|
| Vitamini | 1 |
| Minerala | 2 |

| | |
|---|---|
| Micronutrient | 3 |
| Zwinwe kha zwiliwa zwine rala | 4 |
| Zwinwe (hlamusela) | 5 |
| A ni switivi | 6 |

22**.** Iodine I kumeka ka swa kudya swi South Africa?

| | |
|---|---|
| Iodised salt/Iodated salt/iodine in salt/salt | 1 |
| hlampfi | 2 |
| Miroho | 3 |
| Nyama | 4 |
| Swa kudya leswi swi nga endlwa hi meleka e.g. meleka, cheese, botoro | 5 |
| Mati a ku nwa | 6 |
| Zwinew vho | 7 |
| A ni switivi | 8 |
| A ni switivi ku iodine I yini | 9 |

23. I xiro xi xi lavaka iodine?

| | |
|---|---|
| Xivindzi | 1 |
| Gulokulo | 2 |
| Mahahu | 3 |
| A ni switivi | 4 |

24. ku nga humelela yini loko nwana a nga kumi iodine?

| | |
|---|---|
| U nga kuli ka hle | 1 |
| Gulokulo | 2 |

| | |
|---|---|
| U nga thlarihi | 3 |
| Cretinism | 4 |
| Hypothyroidism (low concentration of thyroid hormones in the blood) | 5 |
| Rifu | 6 |
| | 7 |
| A ni switivi | 8 |
| A ni tivi ku iodine iyini | 9 |
| Hinkwaswo | 10 |

25. Wa hlaya leswi nga tsariwa e ka pakethe ya munu naa, ku kota ku tiva ku kuna iodine?

| | |
|---|---|
| Ee | 1 |
| Hai | 2 |
| A ni swikoti ku hlaya | 3 |
| A ni switivi ku iodine I yini | 4 |

26. Ku pfumeleriwe mpimo wi wa siku wa iodine e ka vana va xikolo?

| | |
|---|---|
| 120 µg/L | 1 |
| 150 µg/L | 2 |
| 220 µg/L | 3 |
| A ni switivi | 4 |

APPENDIX 6

**FIELD WORKERS' GUIDE ON IODINE QUESTIONS**

The following guidelines for completing the questions on iodine nutrition is important in order to generate accurate and useful information.

**Background information for field workers**

Iodine, like vitamin A and iron, is an extremely important micronutrient in the daily food intake of all South Africans. An insufficient iodine intake can lead to abnormalities such as brain damage, slow mental development and a low IQ (resulting in poor school performance), goitre etc. Babies may die during pregnancy or after birth, or, in extreme cases, they may be born with permanent neurological abnormalities.

Seafood is a rich source of iodine, but iodised salt is the most important source of iodine in the diet of South Africans.

**How to complete the questionnaire**

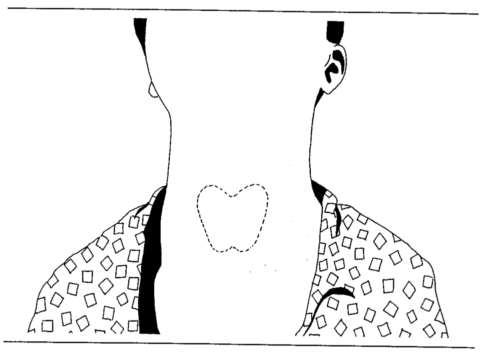
The first 3 questions deal with aspects of knowledge on iodine nutrition, the 4th question with the sources of household salt, the next 4 questions with practices related to the use of iodated salt.

Read the very first sentence on the Questionnaire to orientate the respondent and to introduce the core issue of these iodine related questions. **Please do not give more information**, as additional information at this stage may influence the respondents' response to some of the questions. Mark only one answer option at each question.

Question 1: In this question we would like to determine whether or not the respondent knows that iodine is a mineral, or micronutrient, that is found in the food that we eat.

Question 2: This questions aims to establish the percentage of people that correctly knows the most important source of iodine in food that people eat. Only one response is allowed and should be marked by the field worker. If the respondent does not know what iodine is, mark option 9.

Question 3: By means of this question we would like to establish the percentage of people who knows that the thyroid gland needs iodine for its normal functioning. We would like to see if the respondent could link dietary iodine to the thyroid gland, or to the functioning of the thyroid gland. If the respondent answers that the gland in front of the neck produces the hormones, please probe by asking the respondent to show where the thyroid is located in the neck. The thyroid gland consists of two lobes, one on each side of the windpipe. The position of the thyroid is shown in the drawing below.



*The position of the thyroid gland in the neck.*

If the respondent answers incorrectly, please tick the second option, and if he/she does not know at all (explicitly said they do not know) then tick the third option.

Question 4: There is a range of abnormalities that may occur as a result of inadequate iodine in the food that people eat. We are interested to find out how many people know the most important harmful effect on the health of a child that may develop or occur due to iodine deficiency. Therefore please tick only one option without reading or giving the answer options to the respondent.

For the information of the field workers a description of cretinism, or of cretins, is given as follow: Cretinism refers to the very severe consequences of iodine deficiency during fetal or neonatal life. Cretins have severe irreversible mental retardation. In addition, they may have several other signs, including deaf mutism, short stature, and retarded development of the muscles and skeletal system. (Cretinism is not necessarily the correct answer).

Question 5: In this question we would like to establish the sources where the salt used in the household for food is usually obtained, irrespective of whether or not the salt was paid for. If salt is usually obtained from more than one source, mark the predominant source, in other words, the source where salt used in the household is obtained from most of the time.

Options:

1: If salt was purchased from any food store, packaged in the usual plastic bag or container (or sometimes in a cardboard box), and usually labeled that it contains iodated (iodised) salt, then tick the first option. If someone else purchased the salt on the respondent's behalf in any of these shops, this option still applies.

2: The second option applies in cases where salt was originally produced for agricultural use, but because the salt is cheap and easy to obtain, the agricultural salt is used in the house in the preparation of food. This is usually coarse salt.

3: We would like to find out how many people obtain their salt from spaza shops. A spaza shop is a small shop in rural areas, peri-urban areas or townships.

4: Salt is sometimes bought in large bags from producers or salt traders and then repacked in small bags to be sold in the informal sector by street vendors or hawkers.

5: We found that some millers put a small bag of salt in large maize meal bags that they sell to make it attractive to clients to purchase their maize meal. We would like to know how many of the respondents obtained their salt in this way. This practice may have ceased or changed, but then we would like to establish what the current situation is.

6: People with access to salt producers often obtain their salt directly from the salt producer, or obtain the salt from somebody else who has obtained the salt directly from the salt producer.

7: If there is no salt in the household, then option 7 applies.

8: If none of the answer options correctly identify the source of the salt, then tick this “Other” option, and please specify the source accurately.

9: Finally, if the respondent, after thorough probing do not know where the salt is usually obtained or purchased, and cannot find out where the household salt was obtained, then tick option 9.

Question 6: The purpose of this question is to establish which percentage of women, when buying salt, actually read the label of the salt package to see if it is indeed iodated. It would also indicate how many women intentionally buy iodated salt.

Question 7: This is a particularly important question. We would like to know if people use more salt in or on their food because it is iodated. Please be careful that the respondent do not give the kind of answer that she perceives the investigator/fieldworker expects, but try to elicit an honest response. Obviously we do not expect women who do not know what iodated salt is to respond sensibly to this question.

Question 8: This question will show how many people have a concern about iodine that is added to the salt.

Question 9: Finally, we would like to investigate in which containers salt is stored in the kitchen. If more than one container is used, ask which container is predominantly used from which the salt is taken for the preparation of the food. It would be desirable to check the salt container in the kitchen, if practically possible.

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Appendix 7

Approval letter form provincial office

national treasury

Department:
National Treasury
REPUBLIC OF SOUTH AFRICA

Private Bag X115, Pretoria, 0001

**Transversal Contracting :OCPO**
Enquiries: Carlo Raffanti
Tel: (012) 3155364
Fax: 0123155400
E mail: carlo.raffanti@treasury.gov.za
Ref: 43/4/RT57-2016

The Senior Manager :Demand and Acquisition Management
Directorate :Demand and Acquisition
56-58 Paul Kruger Street
Polokwane
0700
**Attention Mr Zitha**

**CONTRACT RT57-2016: SUPPLY AND DELIVERY OF MOTOR VEHICLES, LIGHT AND HEAVY COMMERCIAL VEHICLES, BUSSES AND MOTOR CYCLES TO THE STATE**

**PERIOD: 1 APRIL 2016 TO 31 MARCH 2018**

Your e-mailed participation documents from various end user Departments dated 22 August 2016 and latest e-mail of today,refer.

The individual participation requests to participate in the RT 57 -2016 vehicle contract as submitted by the Limpopo Provincial Treasury on behalf of its user Departments were approved on 23 August 2016 and 25 August 2016.

Approval for the following Departments to participate were effected on the Special Conditions of Contract.

- Agriculture
- Transport
- Health
- Office of the Premier
- Social Development

Kindly inform the end users hereof as well. .

Yours faithfully

(Signed on behalf of Lebogang Mosuwe)

**CARLO RAFFANTI**
**For CHIEF DIRECTOR: TRANSVERSAL CONTRACTING: OCPO**
**Date: 25 August 2016**

CMD 8: Letter of Acceptance — Page 1

Appendix 8

Ethics certificate

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:
**Ms M Ramugondo**

**Student No:**
**11571508**

PROJECT TITLE: **Iodine content of salt used in the National School Nutrition program (NSNP) in the Mopani and Vhembe District, Limpopo Province, South Africa.**

PROJECT NO: SHS/16/NUT/01/1011

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

| NAME | INSTITUTION & DEPARTMENT | ROLE |
|---|---|---|
| Dr LF Mushaphi | University of Venda | Supervisor |
| Mr NS Mabapa | University of Venda | Co-Supervisor |
| Ms M Ramugondo | University of Venda | Investigator - Student |

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE

Date Considered: November 2016
Decision by Ethical Clearance Committee Granted
Signature of Chairperson of the Committee: ..................................
Name of the Chairperson of the Committee: Prof. G.E. Ekosse

University of Venda
PRIVATE BAG X5050, THOHOYANDOU, 0950), LIMPOPO PROVINCE), SOUTH AFRICA
TELEPHONE (015) 962 8504/8313 FAX (015) 962 9060
"A quality driven financially sustainable, rural-based Comprehensive University"

APPENICES 9

Editing certifcate

# Balote Projects (Pty) Ltd

**Cell no:** 084 255 2164 **Email:** matlou.moloto@email.com
P O Box 1106, Faunapark, 0787
Reg No: 2017/113184/07
Tax Ref: 9299915224

**EDITING CERTIFICATE- DISSERTATION**

10 January 2020

**TO WHOM IT MAY CONCERN**

This serves as confirmation that I Matlou Moloto have edited the dissertation document of Ms Mpho Ramugondo, entitled **"Iodine Content of Salt Used in The National School Nutrition Programme at Mopani and Vhembe Districts in Limpopo Province, South Africa**." to be submitted for the degree Master of Science in Public Nutrition at the University of Venda .

I therefore, declare that the document is to my knowledge devoid of language errors which may deprive the said persons' work from being accepted for the degree and publication.

I am contactable at the above contact details should you have queries.

Matlou Moloto (Miss)

*DTech Candidate (Tshwane University of Technology) MPhil Second Language Studies (Stellenbosch) BEd Language Methodology (University of Limpopo) BA Languages (University of Limpopo) Higher Education Diploma (University of Limpopo) member of the Professional Editors Group (PEG)*