PREVALENCE OF GOITRE AMONG PRIMARY SCHOOL CHILDREN AND ASSOCIATED FACTORS IN MBEYA DISTRICT COUNCIL - MBEYA REGION

BY

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CERTIFICATION

The undersigned certifies that he has read and hereby recommends for acceptance by the Muhimbili University of Health and Allied Sciences a dissertation entitled: P*revalence of goitre among primary school children and associated factors in Mbeya district council - Mbeya region* in partial fulfillment of the requirements for the degree of Master of Public Health.



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Date.....03/11/2005

DECLARATION

I, Dr. Alfred B. Sanga hereby declare that this dissertation is my original work, and that it has not been and will not be submitted for diploma or degree in any other university.

Candidate's signature .....

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DEDICATION

This dissertation is dedicated to my wife Dr. Catherine B. Sanga our sons, Noel, Nasekile, Erick and Amon and to my parents whose believe in the importance of education has contributed much in making me the way I am.

ABSTRACT

Mbeya district council is among the districts in Tanzania where Iodine Deficiency Disorders is still a problem of public health significance. A study was conducted in Mbeya district council to determine the current iodine deficiency status by assessing the prevalence of goitre among school children and factors associated with the problem. A total of 553 school children aged 6 to 18 years were examined for goitre, using WHO classification and salt brought from their homes was tested for iodine content using MBI iodine test kit. A total of 311 households were randomly selected from the school villages for interviews on utilization and awareness on iodated salt and its relationship with level of education, urban and rural setting and type of salt used in their homes. The type and frequency of consumption of foods containing goitrogenic substances was also studied. The prevalence of total goitre was 25.7 percent being higher in females than males and in adolescent children aged 13 to 18 years than those of 6 to 12 years. There was no significant difference in goitre among children in highlands or lowlands or those from urban and rural schools. About 97 percent of the households were using iodated salt although only 45 percent of salt samples tested were adequately iodated. Awareness on iodated salt and iodine deficiency disorders was higher among interviewees who were educated than those with no formal education. The other factors associated with iodated salt included type of salt preferred, urban and rural settings, and the price of salt. The most commonly consumed foods which contain goitrogens were sweet potatoes, cabbage, sorghum and peaches. The findings in this study indicate although a large proportion of salts at household level are iodated, people are still not aware of iodated salt (29.6%) and the problem of IDD (26.7%), hence do not store salt properly resulting to loss of iodine. Education to the population to raise awareness on the importance of iodated salt is necessary in order to reduce the problem of IDD in Mbeya.

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ABREVIATIONS

ACC/SCN	Administrative Committee on Coordination/Sub-Committee on Nutrition.
DEO	District Education Officer
DMO	District Medical Officer
ICCIDD	International Council for Control of Iodine Deficiency Disorders
IOC	Iodinated Oil capsules
IDD	Iodine Deficiency Disorders
MDC	Mbeya District Council
MUHAS	Muhimbili University of Health and Allied Science
OR	Odds Ratio
PEDP	Primary Education Development Programme
PI	Principal Investigator
Ppm	Parts per million
SPSS	Statistical Package for Social Sciences
TBS	Tanzania Bureau of Standards
TDHS	Tanzania Demographic Health Survey
TFDA	Tanzania Food and Drug Authority
TFNC	Tanzania Food and Nutrition Centre
TGR	Total Goitre rate
TSH	Thyroid Stimulating Hormone
UNICEF	Unite Nations Children Fund
USA	United States of America
USI	Universal Salt Iodization
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND.

The disorders of iodine deficiency continue to be one of the most extensive problems of malnutrition in the world. Iodine Deficiency Disorders (IDD) is a descriptive term which covers the broad spectrum of disorders on human and animal populations resulting from iodine deficiency (Lamberg, 1993; Hetzel, 1983). These pathological conditions include; poor physical growth, suboptimal brain development, overt brain damage, and irreversible damage of physical stamina in infants, goitre and neurological disorders in all age groups. In women of child bearing age, iodine deficiency undermines fertility, and in pregnancy it puts the developing baby at greater risk of miscarriage, abortion or stillbirth (Hetzel, 1988).

Goitre which is the most common manifestation of iodine deficiency is an adaptative condition that develops in response to an insufficient supply of dietary iodine. This mechanism is triggered and maintained by an increased secretion of Thyroid Stimulating Hormone (TSH) from pituitary gland to stimulate the thyroid gland to work harder and hypertrophy to become goitrous.

Correlation exists between goitre prevalence and the occurrence of other iodine deficiency manifestations (Lamberg, 1993). When for instance, goitre prevalence is 30 to 40 percent few cretins are born, but the frequency of cretins born increases concomitantly reaching about 10 percent of all births when the prevalence is 70 to 80 percent. The most dreadful manifestation is endemic cretinism characterized by mental deficiency, deaf mutism and spastic diplegia (paralysis) and squint. This condition is referred as nervous or neurological cretinism as compared to the less common myxoedematous type characterized by hypothyroidism and dwarfism (Myrtle et al, 1990; Hetzel, 1989).

Iodine deficiency is the world's single cause of preventable brain damage and mental retardation (Hetzel, 1983) and is a significant threat to the health, well being, and productivity of communities worldwide. Because of its consequences, iodine deficiency is a block to the human and social development in communities living in iodine deficient environment. Apart from diminishing the toll in human misery, the prevention of IDD would mean improved educability of children, greater productivity, and better quality of life. Iodine is a major impediment to human development.

Knowledge on the impact of iodine deficiency on mental development has played an important role in mobilizing political leaders, public health officials, nutritionists, and private industry worldwide to launch effective national programmes. The correction of iodine deficiency can be achieved by diversification of diet with foods from other areas that are not iodine deficient or by iodine supplementation.

The World Health Organization (WHO) estimates that more than 1.5 billion people or nearly 30 percent of the world's population is at risk of IDD (Underwood, 1994; Mannar et al, 1995). It is further estimated that up until 1990 about 40 million children born each year were at some risk of mental impairment due to iodine deficiency in their mother's diets (Masekonyela et al, 2003). Most people in iodine deficient regions are living in subsistence agriculture systems eating foods grown in the local soil. Unlike most other nutritional deficiencies, IDD is dispersed throughout the world irrespective of level of development. The Mediterranean Regions contain the highest proportion of its population exposed to risk. Other affected regions are Southeast Asia, Africa, Western Pacific and the Americans regions in the order specified (WHO, 2005).

Globally, the prevalence of goitre which is the commonly used indicator of iodine deficiency in the general population is estimated to be 15.8 percent, ranging from 4.7 percent in the Americas to 28.3 percent in Africa. A comparison of current prevalence of goitre estimates with the 1993 estimates showed that the prevalence had increased by 31.7 percent worldwide. This masks a decrease in two regions (46.0 percent in the Americas and 32.2 percent in the Western Pacific). All other regions experienced an

increase in prevalence of goitre ranging from 18.5 percent in South-East Asia to 81.4 percent in Africa (WHO, 2005).

In Tanzania iodine deficiency is among the major nutritional problems others being Protein Energy Malnutrition (PEM) and nutritional anemia and vitamin A deficiency. It is estimated that 41 percent of its population live in iodine deficient areas in the highlands of the Northern, Southern and Western parts of the country where due to regular and heavy rainfall, iodine has been leached from the top soil (Hetzel, 1989; TFNC, 1988).

A deficiency of iodine in the soil on which food consumed by local populations is grown is the cause of iodine deficiency disorders. Iodine deficiency constitutes one of the public health problems in several districts of Tanzania. Iodine deficiency survey conducted in 2004 by TFNC among school children in Mbeya district council indicated that iodine deficiency was still a problem of public health significance in the district. The prevalence of total goitre was 24.2 percent (TFNC, 2004) while WHO recommend a level of less than 5 percent for elimination of IDD (WHO, 1994; Bimenya et al, 2002).

Goitrogens in local diets contribute to the iodine deficiency problem. The effect of goitrogens may be additive to those of iodine deficiency since consumption of goitrogen containing foods especially in iodine deficient areas has impact on utilization of iodine by the thyroid gland and so enhancing the genesis of goitre (Lamberg, 1993).

The process of iodine loss from the soil is a natural phenomenon beyond our control and so diets from such soils will be deficient in iodine. However to counteract this natural process interventions targeting populations have been in place for some years. Interventions to control iodine deficiency disorders in this district started long ago in 1986 with distribution of iodinated oil capsules (IOC) as a short term strategy (TFNC, 1993).

Like many other countries affected by iodine deficiency, Tanzania in early 1990s adopted Universal salt Iodation (USI) as a long term strategy to eliminate iodine deficiency disorders. In 1994 Salt legislation was passed requiring all salt producers to iodate all salt for human and animal use and encouraging people to use iodated salt. Despite all these measures, Mbeya district council is still having low consumption of iodated salt. The TDHS survey conducted in 2004 showed that 55.7 percent of households in Mbeya region were using adequately iodated salt (TDHS, 2004/05) which is below the level recommended by WHO of 90 percent or above if iodine deficiency disorders are to be eliminated (WHO, 1994).

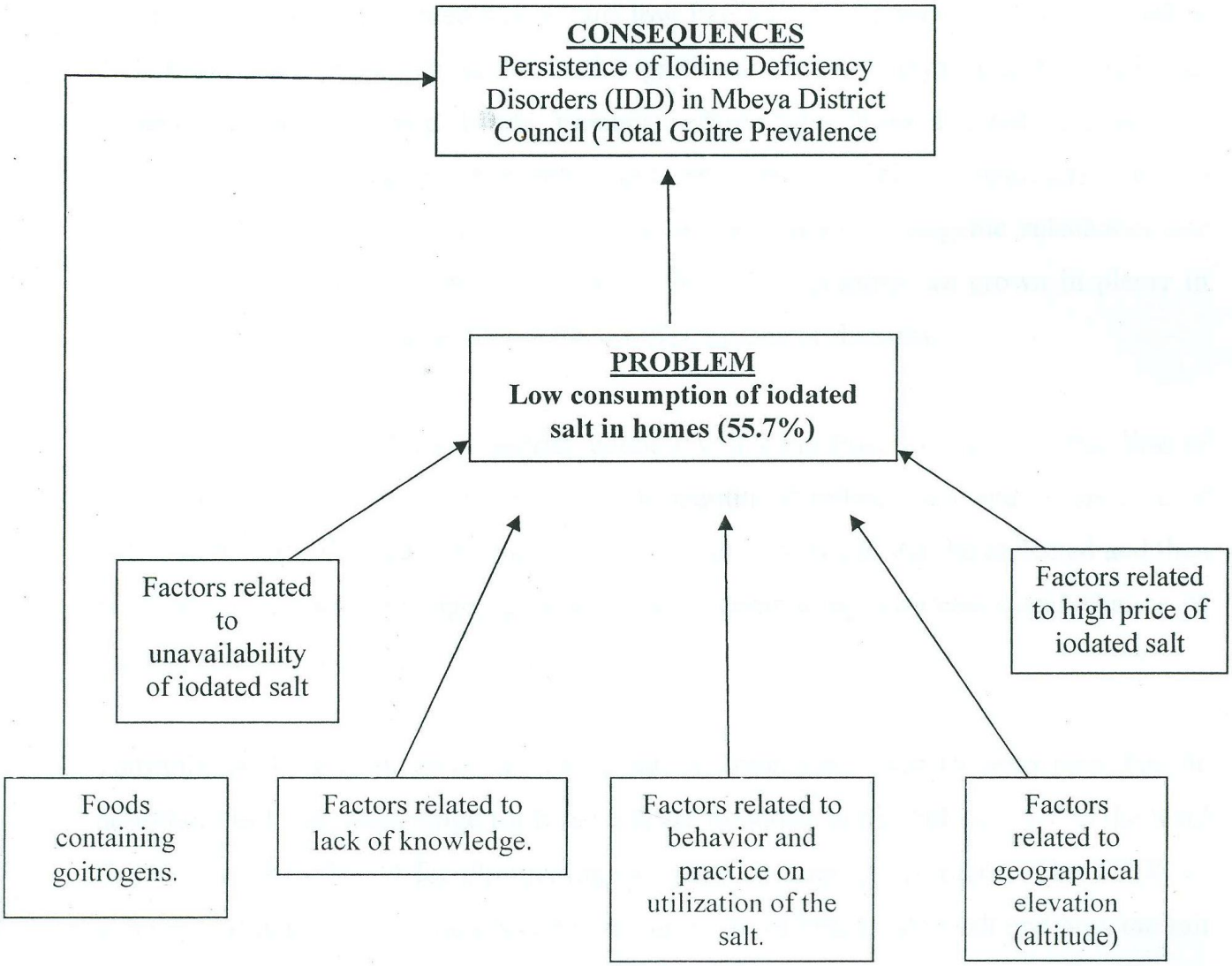
Goitre does not entirely disappear from a community when iodine prophylaxis is applied because there are other recognized categories of thyroid enlargement that are not related to iodine deficiency, but these will give only a 5 per cent or less incidence of goitre in any region where the intake exceeds 100 mg of iodine daily. Among these are chronic thyroiditis and Graves' disease (Gaitan et al, 1978).

1.2 PROBLEM STATEMENT

Iodine deficiency is still a problem of public health significance in Mbeya district council. Survey conducted by TFNC in 2004 showed that the prevalence of total goitre was 24.2 percent (TFNC, 2004) compared to less than 5 percent recommended by WHO as a level where iodine deficiency is not a problem of public health significance. Despite ongoing national efforts for over 17 years to achieve universal salt iodations and eliminate iodine deficiency disorders, iodine deficiency disorders seem to persist in Mbeya district council. Only 55.7 percent of households in Mbeya district council used iodated salt (TDHS. 2004/05). This situation indicate that, there are certain factors that hinder effective utilization of iodated salt in this district as shown in figure I below.

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Figure I: Problem analysis diagram.



Studies conducted elsewhere have been able to identify some of these factors which are mainly related to cost of the salt and education level (TDHS, 2004/05; ICCIDD, 1995). However there could be other local factors in this area contributing to the situation. Thus this study was repeated to come up with specific factors contributing to the low utilization of iodated salt in this district

1.3 RATIONALE OF THE STUDY

There are other regions and districts where iodine deficiency is known to be a problem and the utilization of iodated salt is still low like Iringa, Kigoma and Rukwa (TDHS, 2004/05; TFNC, 2004). However, in this particular study, Mbeya district council was chosen because since mid 1980s, immense efforts have been directed to Mbeya as compared to those these other areas and yet iodine deficiency disorders are still persisting. Many of the food items that are said to contain goitrogenic substances like cabbage, spinach, sweet potatoes and some fruits like peaches are grown in plenty in Mbeya district council more than in those other regions or districts.

The experience from Mbeya district council will contribute to the understanding of community factors that attribute to low utilization of iodated salt and persistence of iodine deficiency disorders. Some information and knowledge will be collected and then be used to develop messages geared towards community awareness and change of attitude and practices.

Tanzania has been implementing salt iodisation strategy for over 15 years now, but the household utilization coverage for Mbeya district council is still below (55.7%) the level recommended by WHO for elimination of iodine deficiency disorders. The TDHS of 2004/05 did not look into factors contributing to use of non iodated salt and how the salt was kept and stored at home. These factors are of paramount importance and need to be addressed in ensuring that populations get adequate iodine.

The information collected from this study will contribute to filling the existing gap on the available body of knowledge and accelerate ongoing interventions towards elimination of iodine deficiency in the district and the country as a whole.

There is a legislation which requires all salt producers and salt importers in Tanzania to iodate all salt for human and animal consumption. The existence of non iodated salt indicates that enforcement of the legislation is weak. Information gathered from this

study can influence policy and law makers on ways of ensuring all bottlenecks have been addressed in the legislation.

1.4 RESEARCH QUESTIONS

1.4.1 What is the current prevalence of goitre in Mbeya district council?

1.4.2 What are the factors associated with utilization of iodated salt at household level in Mbeya district council

1.5 OBJECTIVES OF THE STUDY

1.5.1 Broad Objective

To determine the prevalence of goitre among primary school children and factors associated with iodine deficiency in Mbeya district council in June 2008.

1.5.2 Specific Objectives

1. To determine the prevalence of goitre among school children in Mbeya district council.
2. To determine the proportion of iodated salt among urban and rural populations in Mbeya district council.
3. To determine factors associated with utilization of iodated salt in the district at household level.
4. To determine the types and frequency of consumption of goitrogen containing foods in relation to deficiency of iodine in Mbeya district council.

1.6 RESEARCH HYPOTHESES

The hypotheses set for this study were;

1. There is no relationship between age and prevalence of goitre
2. There is no relationship between sex and prevalence of goitre
3. There is no association between geographical elevation and prevalence of total goitre
4. The prevalence of goitre is not influenced by rural or urban setting
5. The use of iodated salt at household level is not influenced by urban or rural setting.

1.7 OPERATIONAL DEFINITION

Goitre

Goitre is a non cancerous enlargement of the thyroid gland visible as a swelling at the front of the neck that is often associated with iodine deficiency.

Goitrogens

These are substances that interfere with iodine uptake by the thyroid gland and thus suppress the functioning of the thyroid gland and cause an enlargement of the thyroid gland.

Highlands and lowlands

These were defined according to the land office in Mbeya where areas below 1250 meters were considered lowlands and those above as highlands.

Rural

Are areas in a district where the main activities are agriculture and keeping of herds and flocks.

Urban

Are areas where there is collection of dwellings and other buildings, and the major means of people's earnings is through employment in offices, industries, businesses and the minority through agricultural activities.

Adequately iodated salt

Salt that after adding a drop of iodine test solution from the MBI Kit will change its colour to blue/purple and if the color intensity match with that of 15 parts per million (ppm) on the colour scale then the salt will be regarded as having adequate iodine.

CHAPTER TWO

2.0 LITERATURE REVIEW

IDD continues to be a major public health problem in spite of the availability of simple and cost effective means of prevention. Growing international awareness of the problem has lead to global efforts to eliminate the problem (ACC/SCN, 1992). In 1990 a world summit attended by 90 heads of state resolved to eliminate micronutrient malnutrition of iron, vitamin A and iodine globally by the year 2000 (Bimenya et al, 2002) as part of the Primary Health Care Strategy of "Health for All by the year 2000". Many developing countries failed to achieve this due to a number of reasons including limited human and financial resources and managerial and logistical problems.

Another goal was set in the year 2001 at the World summit for children held in New York. A total of 181 Heads of state passed a resolution that member states should work towards elimination of IDD by the 2006 of which many countries did not achieve the goal.

Iodine Deficiency Disorders are more pronounced in childhood and adolescence because of the rapid growth and physiological changes where iodine plays an important role. The rate of goitre development increases with age reaching a maximum with adolescence. A study conducted in Lesotho in 2003 among school children aged 8 to 12 years showed an increase in the prevalence of goitre with age; it was 3 percent in children aged 8 to 9 years and 6.3 percent in children aged 12 years ($p < 0.001$) (Masekonyela et al, 2003)

In another study of children aged 5 to 15 years in the Mohale dam catchment area of Lesotho (Jooster et al, 2003) goitre prevalence showed an increase with age in both sexes up to 12 to 14 years. Similar results were obtained in Italy (Aghini-Lombardi et al, 1997); Panchmahal district in Gujarat India (Misra et al, 2007) and West Bengal (Biswas et al, 2002). It has been suggested that mild to moderate iodine deficiencies in childhood cause subtle enlargement of the thyroid glands of juveniles, which may persist

after iodine deficiency has been corrected thus attributing to higher prevalence of goitre in older children (Masekonyela et al, 2003).

There are gender differences in the development of goitre being higher in girls than boys. Masekonyela et al in Lesotho found that goitre prevalence was higher in girls (5.4%) than in boys (4.5%) although significant differences were seen in only two districts (Masekonyela et al, 2003). These results are similar to those of West Bengal India where male and female prevalence of goitre were 10.7 and 11.9 percent respectively with no significant difference found (chi-square = 0.86, $p > 0.05$) between the two sexes (Biswas et al, 2002). Similar results were found by Nawal et al in Cairo where prevalence of goitre was 10.2 percent among males and 16.2 percent among females the difference was statistically significant. The prevalence among females was higher than that of males in all categories (Nawal et al, 1995).

This difference may be because of differences in the metabolism of iodine during growth between girls and boys (WHO, 1993). However in another study among Turkish school children the prevalence of goitre in girls was 8.6 percent and 7.3 percent in boys but the difference was not significant ($p = 0.488$), these finding agree with the results of Brahmbhatt et al (Ersoy et al, 2006).

Observation of goitre in schoolchildren provides a convenient indication of goitre prevalence in the community. The most practical method for determining iodine deficiency for a region is to assess the goitre prevalence (Ersoy et al, 2006). In addition, other parameters used include assessment of mean urinary iodine, high neonatal TSH ratio, and mean tyroglobuline levels. Due to constraints in resources, most developing countries use goitre prevalence and mean urinary iodine excretion as indicators of iodine deficiency.

Nawal, et al, (1995) conducted a study in Cairo Egypt aiming at studying iodine nutrition status and magnitude and severity of iodine deficiency among primary school children. He stratified the city of Cairo into five geographical zones (East, West, South,

North and Central) and the findings revealed that the prevalence of goitre was 13.5 percent There was also statistical difference in goitre prevalence per geographical zone; this finding is supported by the fact that, iodine deficiency is a geographical problem being more prevalent in mountainous or flood prone regions. The wide variation in goitre prevalence can also be due to other factors, dietary or non dietary or socio-economical status which some times vary with the geographical zone and not only variation in iodine deficiency (Nawal et al, 1995).

Goitre assessment using palpation method is still used to mark the public health significance of iodine deficiency in a population, but some studies have shown that the use of thyroid palpation as an isolated measure (without other supporting indicator) to assess iodine deficiency results in the mild iodine deficiency group remain undetected (McDonnell et al, 2003) since with palpation sometimes it becomes difficult to identify very small goitre which are a result of mild deficiency of iodine. Thyroid palpation is also said to be less reliable in children than in adults (Peterson et al, 2000). In the Lesotho study, both goitre and urinary iodine excretion were used as indicators in assessing iodine deficiency (Masekonyela et al, 2003).

Another study in Uganda by Bimenya et al (1998) "Monitoring the severity of iodine deficiency in Uganda" used both the two indicators. Urinary iodine excretion seems to be the most appropriate outcome indicator for determining iodine deficiency because 90 percent of ingested iodine is excreted in the urine (Hetzel et al, 1994; Orbelin et al, 2007; McDonnell et al, 2003). Urinary iodine reflects an acute deficiency (current) while goitre prevalence or TSH are consequences of chronic iodine deficiency (Orbelin et al, 2007).

In the past, thyroid palpation was the standard method for determining thyroid size. However, this procedure has been deemed inadequate for distinguishing mild thyroid enlargement from normal. Thyroid ultrasonography, provide a better and more reliable procedure for the quantitative assessment of thyroid size (Orbelin et al, 2007).

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However, palpation method is still commonly used due to several operational constraints such as cost of the instrument, training of the operator, lack of electricity, and lack of normative values for thyroid volume in iodine sufficient populations.

Iodine deficiency is likely to occur in all elevated regions subject to high rainfall and in low land plans that are prone to frequent floods. A study in Lesotho (2003) showed that statistically ($p = 0.007$) goitres were more prevalent in the mountainous areas (6.3%) and foothills (6.0%) than in the lowlands and Senqu valley (2.3%). Iodine loss is prominent in mountainous regions of the world because of the long standing leaching of iodine from the soil. In these areas there is severe deficiency of iodine, such areas include the Himalayas, the Andes, the European Alps, and the vast mountains of China. (Hetzel,1989).

Food from the iodine deficient soil cannot fulfil daily iodine requirements, and thus iodine supplementation from external sources is necessary. Salt has been assumed one of the best medium for fortification with iodine because of its widespread use, effectiveness, simple technology and low cost. All people irrespective of social or economic level consume salt in small fairly constant amounts daily making it a suitable vehicle to deliver physiological amounts of micronutrients like iodine to the population at large (Mannar, et al, 1995; Hetzel et al, 1987).

Universal salt iodization (USI), defined as iodization of all salt used for human and animal consumption, is the main strategy used to control iodine deficiency (WHO, 1999). In most countries where iodine deficiency has been identified as a public health problem, salt iodations control measures have been implemented. Potassium iodide (KI) and potassium iodate (KIO_3) are the two chemicals commonly used for salt iodations. Potassium iodate is generally recommended in our environment since it is more stable. The amount of iodate added to salt depends on the average per capita salt intake of the community and the amount of iodine lost between manufacture and consumption.

Salt iodation has been used successfully in a number of developed countries including the USA, New Zealand, the Scandinavian countries, Switzerland and other European countries. Salt iodations programmes have been initiated in several developing countries (Mutamba, 1993).

The production and importation of iodated salt in Tanzania was made mandatory in 1994 when a salt legislation was passed by the parliament that all salt produced and imported in the country for human or animal consumption should be iodated. Having salt iodations legislation is not enough to ensure that all salt in the country is iodated. Most countries have salt legislation since 1950s but have not been able to eliminate iodine deficiency disorders. For example in Brazil there has been iodation legislation since 1953 with several amendments, but it has failed to bring the expected outcome of eliminating IDD (Medeiros-Neto, 1987). The most important factor is enforcement of the legislation although it is difficult, especially where there are many salt producers as it is the case in Tanzania.

Production of iodated salt in Tanzania started in May 1991 and it is over 15 years since the salt legislation was enacted but household availability of iodated salt in the country is still low. The TDHS of 2004/05, revealed that, 43.4 percent of households tested (93%) used salt that was adequately iodated ($\geq$ 15 ppm), 29.8 percent inadequately iodated salt ($<$ 15 ppm) and 26.9 percent none iodated salt. The utilization of adequately iodated salt in urban areas was twice that in rural areas (34 percent) which indicate that accessibility to iodated salt in rural places is a problem or the rural populations are poor to afford the salt.

Many studies conducted all over India have shown high prevalence of goitre (Misra et al, 2007). In an attempt to eliminate iodine deficiency and to comply with the international goal of universal salt iodations, compulsory iodisation of table salt was introduced in 1983. Despite all these efforts, non iodated salt is still in the market. Misra et al in 2007 conducted a study among school children in Panchmahal district in Gujarat,

India and revealed that 54.3 were consuming adequately iodated salt while 21 percent consumed non iodated salt.

Another study conducted among school children in Malda district of West Bengal in 2002 showed the same pattern of results that 85.1 percent of households had adequate iodine content (≥ 15 ppm), 13.6 percent consumed salt with iodine content and less than 1.3 percent consumed salt without iodine (Misra et al, 2007; Biswas et al, 2002). Biswas et al in Birbhum district in West Bengal in 2003 showed that only 37.2 percent of the families had adequate iodine content (≥15 ppm). About 13.4 percent of the families consumed salt with iodine content of < 15 ppm and 49.4 percent consumed non iodated salt (Biswas et al, 2002).

Despite a ban on non-iodated salt in Kangra district in Hamachal Pradesh India in 1962, non iodated salt was consumed by 0.8 percent and 11.9 percent of the households were consuming salt with iodine content less than 15 ppm while about 87 percent consumed iodated salt (Kapil et al, 2000). Consumption of iodated salt with less than 15 ppm indicates that salt was iodated but because of poor storage and due to transportation, there has been gradual loss of iodine in the salt. These results show that the situation was worse in Birbhum district where about 50 percent of families were consuming non iodated salt.

Uganda, just like many other countries in the region, is affected by the deficiency of iodine. In ensuring that all salt is iodated, in 1993 the policy requiring salt entering the country for human and livestock consumption to be iodated was introduced. After five years of its implementation the iodated salt was still filtering into the market. A study on household consumption of adequately iodated salt by Bimenya et al, (1999) in six sampled districts showed that it ranged from 33.3 percent (Apac) to 84 percent (Kabale).

The study districts were stratified into those from highlands, (three districts) and those from the low-lying areas (three districts). The same stratification was done in Mbeya district council. The study observed the effect of altitude on iodine deficiency and the

influence of urban and rural setting on prevalence of goitre and availability and utilisation of iodated salt.

According to, WHO report, only 66 percent of households globally had access to iodized salt in 2005 (WHO, 2005). A number of reasons may explain why some households still consume non iodated salt. Some of the reasons for this include; little awareness in the population about the consequences of iodine deficiency, the increased cost of iodated salt, rumours about the bad taste of iodised salt in food and the lack of promotion campaigns for iodised salt (Orbelin et al, 2007). A study by Lakhera (1995) in Garhwal Himalaya documented that the use of iodated salt was limited to educated and small families because of the cost of iodated salt was more than twice than the non iodated salt (ICCIDD, 1995).

Worldwide iodine deficiency disorders are common among poor populations in remote areas where access to external foods/diet is difficult. Because of the remoteness then the rural communities as some of the villages in Mbeya district council are likely to have limited access to iodated salt.

Beside iodine deficiency being the primary cause of goitre, there are other secondary factors responsible with development of goitre; these are naturally occurring goitrogenic and antithyroid agents in foodstuffs and drinking water. These goitrogenic agents act directly on the thyroid gland, interfering with the main steps of thyroid hormone production or altering the excretion of thyroid hormones. Several foodstuffs have been implicated in goitre endemias due to the presence of compounds with antithyroid action, e.g., thiocyanate, thiooxazolidone, and flavonoids.

Some studies have been done globally and locally to observe the impact of goitrogens from staple foods on goitre. In Democratic Republic of Congo and some other African countries, cassava is a staple food from which during the process, thiocyanate is liberated blocking the uptake of iodide by the thyroid gland. A positive correlation

between the thicyanate/iodine ratio in the urine or plasma and the goitre prevalence has been reported in Democratic Republic of Congo (Lamberg, 1993).

A report in the ICCIDD Newsletter (2007) on assessment of iodine status of school children and the frequency of consumption of selected goitrogenic foods in Arumeru district showed that, 93 percent consumed cabbage and the highest frequency of consumption was 2 to 3 times (48%) per week. Cassava was consumed by 71 percent of the children mostly once (59 percent) in a week (ICCIDD, 2007). The other foods studied were millet and sorghum. However the findings did not show the relationship between prevalence of goitre and consumption of these foods. Similarly, Mlingi et al in Kigoma confirmed that there was association between high consumption of insufficiently processed cassava (goitrogenic food) and severe iodine deficiency disorders (Mlingi et al, 1996).

All the studies mentioned above were looking on the goitrogenic effect of cassava. However cassava is not common in Mbeya district council. None of the studies has associated the non cassava goitrogenic foods and iodine deficiency. In the process of interfering with utilization of iodine by the thyroid gland, goitrogens act differently depending upon the level of interference so the effect of goitrogen for cassava may be different from that of the soy beans related foods or cruciferous vegetables which are commonly used in Mbeya.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the study area.

The study was conducted in Mbeya district council which is one of the eight districts of Mbeya region. The district lies between 1200 and 2800 meters above sea level, however with mountainous ranges rising to 3000 meters (PEDP, 2008).

The district is divided into three divisions namely Tembela, Usongwe and Isangati, with 17 wards and 126 villages. The district has an area of 2,432 sq km with a population of 254,897 (2002) people, 119,214 being males and 135,683 being females. The eligible primary school age population (7 to 13 years) was 50,114. The district annual growth rate is 2.5 and population density of 121 people per sq. km. About 85 percent of the population of the district lives in rural areas (PEDP, 2008).

Mbeya district council is fertile and agriculturally productive area with good soil and reliable rain. The regular heavy rains and the mountainous nature of the land perpetuate iodine loss from the soil and crops grown become iodine deficient. The main food and cash crops grown in the district include; maize, wheat, sorghum, rice, coffee, simsim, sunflower, irish and sweet potatoes and soy beans. Vegetables and fruits grown include cabbage, bananas, carrots, onions, cauliflowers, spinach, strawberries, peaches and avocado (MDC, 2007). Some of these products contain goitrogenic substances, which predispose those who totally depend on foods grown in such soil to become iodine deficient.

Human beings usually obtain iodine from their diet, the most potent sources being marine fish and other sea foods. For the residents of Mbeya district council, the sources of fish are Lake Rukwa in Sumbawanga district and some rivers while some traders bring fish from Mtera dam in Dodoma. However the iodine content of fresh water fish is not as much as that from sea water which are rarely available in the district.

3.2 Study design

The study was analytical cross-sectional design.

3.3 Target and study populations

The target population for goitre assessment consisted of school children aged between 6 and 18 years from the selected primary schools. It is recommended that for goitre assessment school children are the ideal population because of their combined high vulnerability to iodine deficiency, representativeness of their age group in the community and easy accessibility (Kapil et al, 2004; WHO, 1994; Hetzel, 1989).

Adult members mainly women were also included in the study to assess their awareness on iodine deficiency and iodated salt, to identify factors which determine the utilization of iodated salt in their homes and to study consumption patterns of some foods which may have effect on development of goitre. These were purposely selected as most questions were on what was happening in the kitchen and in the African culture, women spend most of their time in the kitchen. Adult population was included in this study to ensure the most appropriate responses and avoid biasness from school children.

3.4 Sample size

3.4.1 School children

Sample size varied depending on the output indicator. For school children the main indicators were prevalence of goitre, prevalence of iodated salt and awareness on iodine deficiency and iodated salt.

3.4.1.1 Prevalence of Goitre

Sample size for goitre assessment was estimated using a single proportion formula (Bland, 1995).

$$n = \frac{z^2 \, p(1-p)}{\varepsilon^2}$$

Where:

n = Minimum sample size desired.

z = The point on standard normal deviate corresponding to 95% confidence level which is 1.96

p = The prevalence of goitre among school children in the district (24.2%).

ε = Margin of error on p, set at 4%

Therefore:

$$n = 1.96^2 \frac{x\ 24.2\ (100 - 24.2)}{4^2}$$

$$n = 440$$

By adding 10 percent for the non respondents the minimum sample size for goitre assessment was 484 school children, however a total of 553 children were clinically examined for presence of goitre.

3.4.1.2 Proportion of households using iodated salt

Prior information was sent to the schools asking teachers to request school children to bring a pinch of salt from their homes for testing of iodine on day of the survey. However, for children sharing a pot only one child was requested to bring the salt. Therefore the sample size was the number of children who brought salt samples on the day of the survey.

3.4.2 Households

Sample size for households studied on utilization of iodated salt and consumption of goitrogenic foods was estimated using a single proportion formula.

$$n = z^2 \frac{p\ (1 - p)}{\varepsilon^2}$$

Where:

n = Minimum sample size desired.

z = The point on standard normal deviate corresponding to 95% confidence level which is 1.96

p = The proportion of households not using and using inadequately iodated salt (44.3%)

ε = Margin of error on p, set at 6%

Therefore:

$$n = 1.96^2 \times \frac{44.3\ (100 - 44.3)}{6^2}$$

$$n = 263.3$$

The sample size was 264. Adding 10 percent for the non respondents then the number of households for the study was 290, however a total of 311 adults were interviewed.

3.5 Sampling procedures

3.5.1 School children

Multi-stage sampling approach was used to get the study populations.

Stage 1: Selection of primary schools

Mbeya district council has a total of 156 primary schools. Considering the distance between schools/villages and the terrain nature of the district, financial resources and logistical problems, 10 percent of the schools (16 primary schools) were selected for the study. The sampling unit was primary schools where the 16 schools were selected by systematic sampling technique.

A list of all schools (156 schools) by names was prepared by the district education office. Sampling interval was calculated to the nearest whole number (156/16 = 9.75 or 10) and this number (10) was the sampling interval used to get the 16 schools.

Stage 2: Selection of school children

The study sample for goitre assessment was a minimum of 484 children from the 16 primary schools. A minimum of 31 children were selected from each school finally

making a total of 553 children all together. In each school a list of names of all school children who were at school on day of the survey was prepared from the attendance registers and systematic selection was used to get the a minimum of 31 school children from each school.

3.5.2 Households

Stage 1 Selection of hamlets

In each village visited a list of hamlets was obtained from village leaders. Half of the hamlets were selected randomly from each village and a list of households from the selected hamlets was prepared by the leaders being assisted by hamlet leaders. The number of hamlets per village ranged from 6 to 10.

Stage 2 Selection of households

According to sample size calculation a minimum of 18 households selected from each village. This figure was divided between the selected hamlets and households were selected randomly and proportionate to number of households in each hamlet to get a minimum of 18 households. The final number of households selected came to 311.

3.6 Study variables

The dependent (outcome) variable of the study was goitre prevalence and the independent (explanatory) variables included age, sex, level of education, ecological location, urban and rural and consumption of iodated salt.

3.7 Data collection procedures

Data collection tools comprised of structured questionnaires (school children and household questionnaires) with open and closed ended questions, and forms for goitre grades and results of iodine salt test. The questionnaires were in kiswahili language.

3.7.1 Pretesting of research tools and training of research assistants

One day training of three research assistants was conducted by principal investigator to enlighten them on the purpose and objective of the survey, on how to interview, to filling in the questionnaires and the forms, and on standardization of the procedures to

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be used in the survey. Research assistants were also shown and briefed on how to test salt samples for presence of iodine using MBI kit and comparing and recording change of colour of salt according to standard colour chart of the MBI kit. The research assistants were from the office of the District Education Officer (DEO) and secondary school students.

Research tools were pre-tested in one school in the district and to check if the tools are understood and able to collect relevant and desired information. Any shortfalls identified were corrected before the actual field work. Village leaders and in some villages hamlet leaders led us to the selected households and took the role of introducing us and reassuring household members.

3.7.2 Goitre assessment and classification

Goitre size assessment was done by palpation method. The principal investigator, who is a medical doctor with experience on goitre assessment, inspected the anterior aspect of the neck then palpated to verify presence or absence of goitre swelling. Goitre size was then graded using simplified WHO/UNICEF/ICCIDD classification of goitre of 1994 (WHO, 1994) as shown in Table 1 below. The results were recorded in pre-designed forms. The sum of grade 1 and 2 provided the total goitre rate (TGR).

Table 1: Simple classification of goitre (WHO/UNICEF/ICCIDD)

GOITRE GRADE	INTERPRETATION
Grade 0	No palpable or visible goitre
Grade 1	A mass in the neck that is consistent with an enlarged thyroid that is palpable but not visible when the neck is in normal position. It moves upwards in the neck as the subject swallows. Nodular alterations(s) can occur even when the thyroid is not visibly enlarged.
Grade 2	A swelling in the neck that is visible when the neck is in normal position and is consistent with an enlarged thyroid when the neck is palpated.

Source: Indicators for assessing Iodine Deficiency Disorders and their control through salt iodization. WHO NUT.94.6.

3.7.3 Iodated salt

All salt brought by children from their homes was tested for iodine levels wrapped in a paper. In case all children coming from the same household brought salt from home only one sample was tested using rapid test kit manufactured by MBI Kits of Madras, India to determine whether the salt was adequately iodated or not.

One drop of iodine test solution was added to the salt sample. In the presence of iodine, the salt changed to blue-purple colouration, the intensity of which indicated the approximate iodine levels. The salt colour was then compared to the standard colour chart of the rapid test kit (MBI Kit). Results were then recorded in a pre-designed form as zero parts per million where no colour change occurred, less than 15 parts per million and more than 15 parts per million respectively depending on colour intensity. The rapid test kits were pre-tested on salt known to contain iodine to check if they were potent.

3.7.4 Utilization of iodated salt at households

In each selected household a single adult preferably a woman was interviewed regarding utilization of iodated salt. A sample of salt was requested to test if it was iodated and results recorded according to standard colour chart of the MBI kit.

3.7.5 Consumption of goitrogenic foods

A food frequency questionnaire was used to collect information on types and frequency of foods containing and those not containing goitrogenic substances from the same person in the household.

3.8 Data management

In order to ensure accuracy and completeness of each form or questionnaire, there was regular supervision of research assistants in the field done by the principal investigator. Every day in the evening, all questionnaires and forms were checked by research team being guided by the principal investigator for consistency and accuracy and to make the necessary corrections that were overlooked in the field.

3.9 Data processing and analysis

All information collected was cleaned and coded. Data entry was done using Statistical Package for Social Sciences (SPSS) software. Analysis of the data, frequency distribution and cross tabulations was performed using SPSS and EPI6 softwares. Variables collected from school children were linked to determine existence of associations. To check for statistical significance of the study findings, the Mantel Hansel chi-square test was used. Logistic regression analysis was performed to determine the relationship between goitre and other independent variables.

3.10 Ethical considerations

Ethical clearance was obtained from the Muhimbili University of Health and Allied Sciences (MUHAS) Research and Publication Committee. Before proceeding with collection of data, permission was obtained from the District Executive Director (DED) of Mbeya District Council. An introductory letter to Ward and village leaders was written by the district council authorities. These leaders were approached to obtain verbal consent to conduct the survey in their villages and schools respectively.

Individual consent was obtained before examining each child. Verbal permission was also sought from household members to interview one member in the house.

CHAPTER FOUR

4.0 RESULTS

These results are an outcome of the study carried out in 16 primary schools located in 15 villages, from 12 wards out of the 17 wards in Mbeya District council. The study comprised of two populations, primary school children and adults selected from households in the same villages where schools were located. The school children were included with the aim of assessing their goitre status and testing salt brought from their homes for iodine concentration. The adults from households were specifically included to elicit factors determining the utilization of iodated salt at households and other factors that might have role in the development of goitre.

Selected villages were from highlands and lowlands and from urban and rural areas. A total of 9 villages were from the highlands and 6 from the lowlands while 4 were from urban and 11 from rural. Schools had the same distribution pattern except in rural area where there were 5 schools since Mbalizi village had two schools (Mbalizi II and Jitegemee). According to Mbeya district land office the altitudes range for the study villages was between 1250 and 2073 meters above sea level with villages 1250 meters and below being considered as located in lowlands.

A large proportion of the two study populations came from highlands and rural areas. About 62 percent of school children were from highlands and 76.1 percent from rural settings while 57.2 percent of household respondents were from highlands and 76.8 percent were from rural areas as shown in Table 2.

Table 2: Distribution of study populations by geographical characteristics (school children N = 553, household respondents N = 311)

Geographical characteristic	School children	Household respondents
Highlands	341 (61.7%)	178 (57.2%)
Lowlands	212 (38.3%)	133 (42.8%)
Urban	132 (23.9%)	72 (23.8%)
Rural	421 (76.1%)	239 (76.7%)

Table 3: Distribution of study populations by villages, schools and geographical characteristics.

Geographical characteristics	Villages (N= 15)	Altitude (mts*)	Household respondents (N = 311)	Schools (N = 16)	Children (N = 553)
Highlands					
Urban	Igoma	1900	17	Igoma II	37
Highlands					
Rural	Izumbwe	1280	17	Izumbwe	46
	Imezu	1350	18	Imezu	33
	Isebe	1700	21	Isebe	46
	Simambwe	1450	26	Simambwe	47
	Ngangano-Ijombe	1300	19	Ijombe Juu	34
	Ruanda	2073	19	Ruanda II	32
	Isangati	1960	17	Madugu	34
	Isuto	1820	23	Isuto	33
Lowlands					
Urban	Songwe-Viwandani	1250	16	Saruji	32
	Idiga Songwe	1250	17	Songwe II	30
	Mbalizi	1250	37	Jitegemee	31
				Mbalizi II	33
Lowlands					
Rural	Mwashiwa-wala	1250	19	Mwashiwa-wala	36
	Shamwengo	1230	21	Shamwengo	34
	Mshewe	1220	19	Mshewe	34

**The district land office was contacted to get altitude of the selected study villages.*

A total of 553 children both sexes aged between 6 and 18 years with a mean age 12.1 and SD ± 2.0 years were examined for thyroid gland enlargement and salt brought from their homes was tested for iodine concentration. A large proportion of the school study population was females (59.9%). Children in the age group 6 to 12 years were 59 percent and those 13 to 18 years (adolescents) were 41 percent as shown in Table 4.

Table 4: Demographic characteristics of school children (N =553)

Demographic characteristics	Frequency	%
Age (years)		
6 - 12	326	59.0
13 - 18	227	41.0
Sex		
Male	222	40.1
Female	331	59.9

An adult preferably a female from each of the 311 selected households was interviewed on awareness, utilization, and storage of iodated salt. About 99 percent of the interviewees were females and 83.3 percent were peasants with 66.6 percent having attained a maximum of primary school education and 28.6 percent having no formal education as illustrated in Table 5.

Table 5: Socio-demographic characteristics of households respondents in Mbeya District council (N = 311)

Characteristics (n = 311)	Frequency	%
Education level		
No formal education	89	28.6
Primary education	207	66.6
Secondary education	11	3.5
College/University	4	1.3
Sex		
Male	4	1.3
Female	307	98.7
Occupation		
Peasant	259	83.3
Teacher	17	5.5
Others*	35	11.2

* *Others included Administrators, Councilors, Health workers, Agriculture extension workers, petty business women.*

Goitre assessment among primary school children was done to give an indication of how serious deficiency of iodine is a problem in Mbeya district council. The prevalence of total goitre (TG) was 25.7 percent (95% CI 25 - 25.74) with only one child (0.2%) having visible goitre (VG).Table 6 indicates that, female children had higher prevalence of goitre (69.8%) when compared to males (18.9%) and the results were statistically significant ($X^2 = 8.88$, $p = 0.003$).

As regards to age categories, the results indicates that there was significant difference between the two age categories ($X^2 = 4.48$ and $p = 0.03$). The prevalence of goitre in children aged 6 to 12 years was 22.4 percent as compared to 30.4 percent in the age category of 13 to 18 years (adolescents) as shown in Table 6.

The prevalence of total goitre was 24.3 percent for children from the highland schools, while for children from the lowland schools it was 27.8 percent as shown in Table 6. However, when comparison is made among children with goitre, a high proportion of them were residing in the highlands (58.4%) as compared to 41.6 percent residing in the lowland although statistically these results were not significant ($X^2 = 0.83$, $p = 0.36$). There was no statistical difference in the prevalence of goitre among school children residing in urban and those in rural areas ($X^2 = 1.8$, $p = 0.18$). Children from rural schools had goitre prevalence of 27.1 percent as compared to 21.2 percent for children from urban schools as indicated in Table 6.

Table 6: Goitre status among school children by sex, age group, altitude and rural and urban setting and salt iodine levels (N = 553).

	Presence of Goitre		Total	p value
	Yes	No		
Sex				
Male	42 (18.9%)	180 (81.1%)	222 (40.1%)	0.003
Female	100 (69.8%)	231 (30.2%)	331 (59.9%)	
Age group				
6 -12 years	73 (22.4%)	253 (77.6%)	326 (59.0%)	0.03
13 – 18 years	69 (30.4%)	158 (69.6%)	227 (41.0%)	
Geographical elevation				
Highlands	83 (24.3%)	258 (75.7%)	341 (61.7%)	
Lowlands	59 (27.8%)	153 (72.2%)	212 (38.3%)	0.36
Urban/rural				
Rural	114(27.1%)	307 (72.9%)	421 (76.1%)	
Urban	28 (21.2%)	104 (78.8%)	132(23.9%)	0.18

Table 7 relates the presence or absence of goitre among school children with levels of iodine in salt samples. Out of 553 salt samples brought by school children from their homes 9.4 percent had no iodine at all (0 ppm), 54.6 percent had inadequate iodine and only 36.0 percent had adequate iodine levels. Among children with goitre 28.8 percent, had salt with no iodine at all, 28.1 percent had salt with inadequate iodine and only 21.1 percent brought salt that was adequately iodated. The results show no statistical difference (X^2 =3.4, p = 0.18) in the prevalence of goitre and levels of iodine in salt.

Table 7: Goitre status among school children compared to levels of iodine in salt consumed in their homes (N = 553)

Salt iodine levels	Presence of goitre		Total	p value
	Yes	No		
No iodine (0 ppm)	15 (28.8%)	37 (71.2%)	52 (9.4%)	
Inadequate iodine (< 15 ppm)	85 (28.1%)	217 (71.9%)	302 (54.6%)	
Adequate iodine (≥ 15 ppm)	42 (21.1%)	157 (78.9%)	199 (36.0%)	
Total	142 (25.7%)	411(74.3%)	553 (100.0%)	0.18

Table 8 shows logistic regression analysis on some factors that are associated with development of goitre, these included; sex, age, geographical elevation, urban and rural settings and iodine content in salt. Logistic regression multivariate analysis results for sex, age and iodine content in salt were statistically significant. While the other factors were held constant, female children had a risk of 2 times more likely to develop goitre (95%CI 1.3 – 3.0; p =0.001). Similarly, age and salt iodine content showed positive influence on goitre development. While the other factors were being held constant, children aged 13 to 18 (adolescents) were 1.5 more times (95% CI 1.0 – 2.3; p = 0.04) of developing goitre than the young age group.

Children using salt that had no iodine were 1.4 times more (95% CI 1.0 – 2.4; p = 0.03) likely to develop goitre as compared to those using adequately iodated salt. Meanwhile children residing in lowlands had 1.4 (95% CI 0.9 – 2.2; p = 0.1) more times likely to develop goitre and those in rural were 1.6 (95% CI 0.9 – 2.6; P = 0.09) times more likely to develop goitre although in both cases the results were not significant (p = 0.1 and 0.09 respectively).

Table 8: Risk of developing goitre among school children using regression analysis (N = 553)

Factor	N	Crude OR	Adjusted OR	95% CI	p value
Sex					
Male	222				
Female	331	1.9	2.0	1.3 – 3.0	0.001*
Age					
6 – 12	326				
13 -18	227	1.5	1.5	1.0 – 2.3	0.04*
Urban/rural setting					
Urban	132				
Rural	421	1.4	1.6	0.9 – 2.6	0.09
Iodine content					
Adequate	199				
Inadequate	354	1.5	1.6	1.0 – 2.4	0.03*
Altitude					
Highlands	341				
Lowlands	212	1.2	1.4	0.9 – 2.2	0.1

**These results are statistically significant*

The proportion of households using iodated salt was 96.5 percent irrespective of iodine levels in the salt. Meanwhile only 3.5 percent of households were using salt that was not iodated at all. Majority of the households using iodated salt were in the rural areas (76.7%) and the same is for salt with no iodine (81.8%) as shown in Table 9. However, these findings are not statistically significant (Fisher's exact test = 1.0, p = 0.7).

Table 9: Salt iodine status and levels of iodine in salt in households by urban and rural settings (N = 311)

	Geographical location			
	Rural	**Urban**	**Total**	**p value**
Salt iodine status				
Not iodine	9 (81.8%)	2 (18.2%)	11 (3.5%)	0.69
Iodated	230 (76.7%)	70 (23.3%)	300 (96.5%)	
Levels of iodine in salt				
No iodine	9 (81.8%)	2 (18.2%)	11(3.5%)	0.7
< 15 ppm	120 (75%)	40 (25%)	160 (51.5 %)	
≥ 15 ppm	110 (78.6%)	30 (21.4%)	140 (45.0%)	

Although about 97 percent of the salt was iodated, not all salt was adequately iodated to meet iodine body requirements. The proportion of salt that was adequately iodated (15ppm and above) was only 45.0 percent and 51.5 percent had less than 15 ppm indicating that the salt was not adequately iodated.

Detailed analysis of the results in table 9 shows that, out of the 11 salt samples that had no iodine at all (0 parts per million), nine salt samples (81.8%) were from rural households while only two samples were from urban areas. The chi square was = 0.69 and p = 0.7 indicating that the results are not statistically significant.

The most common type of salt that was available in homes was the granular type (74.3%) followed by fine salt (25.1%), and only two homes (0.6) had coarse salt. When the level of iodine was compared within each type of salt as shown in Table 10, 65.4 percent of the fine salt was adequately iodated while for granular and coarse salts only 38.2 percent had sufficient levels of iodine. These findings indicate significant difference in iodine levels between the types of salt (X^2 17.45, p = 0.001).

Table 10: Iodine levels in salt samples at household level by type of salt. (N = 311).

	Level of iodine in salt			
Type of salt	**Inadequate or no iodine**	**Adequately iodated**	**Total**	**P value**
Fine salt	27 (34.6%)	51(65.4%)	78 (24.9%)	
Granular and coarse	144 (61.8%)	89 (38.2%)	233 (74.9%)	0.001
Total	171(55%)	140 (45%)	311(100.0%)	

About 30 percent of the household interviewees had heard about iodated salt while 26.7 percent had heard about IDD. Results were further analyzed by urban and rural settings as shown in tables 11. Only about 27 percent of all respondents had heard about IDD and about 30 had heard about iodated salt. About 64 percent of the rural interviewees were aware of IDD ($X^2 = 10.74$, $p = 0.001$) and about 66 percent ($X^2 = 5.15$, $p = 0.02$) aware of iodated salt (68.5%). In both cases, (IDD and iodated salt) results show statistical significance.

Table 11: Household respondents ever heard about IDD and iodated salt by urban and rural setting (N = 311)

	Geographical location			
	Rural	**Urban**	**Total**	**p value**
Heard of IDD				
Yes	53 (63.9%)	30 (36.1%)	83 (26.7%)	
No	186 (81.6%)	42 (18.4%)	228 (73.3%)	0.001
Heard of iodated salt				
Yes	63 (68.5%)	29 (31.5%)	92 (29.6%)	
No	176 (80.4%)	43 (19.9%)	219 (70.4%)	0.02

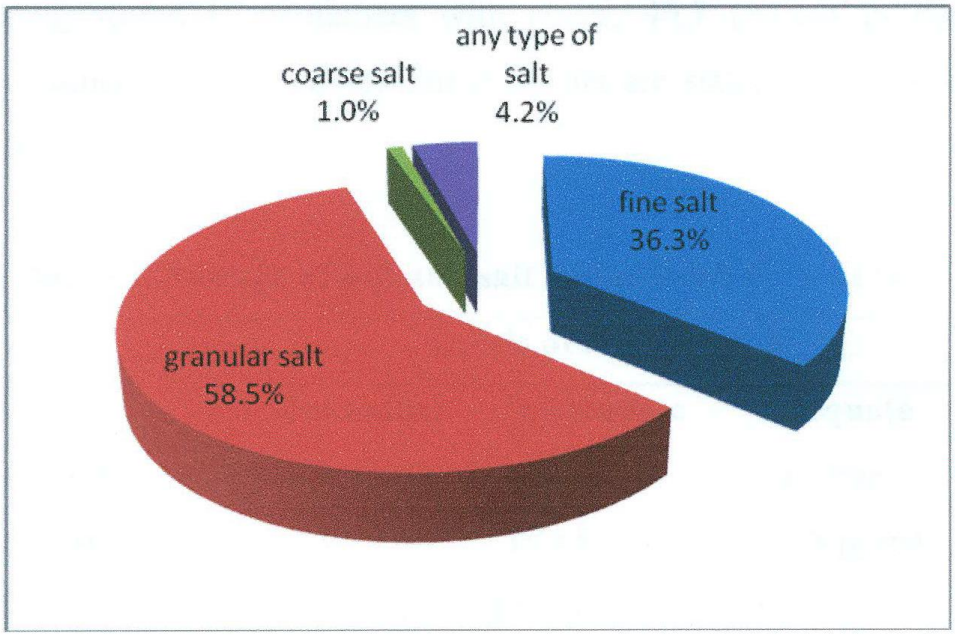
The results in Table 12 indicate statistical significance between education level and awareness on IDD (X^2 = 17.5, p = 0.001) and iodated salt (X^2 = 20.1, p = 0.001). Interviewees with primary education and above who had heard about IDD and iodated salt were 89.2 percent and 89.1 percent respectively.

Table 12: Awareness on IDD and iodated salt among household respondents in relation to their level of education (N = 311).

	Education level			
	None	Primary to University	Total	p value
Heard of IDD				
Yes	9 (10.8%)	74 (89.2%)	83 (26.7%)	
No	80 (35.1%)	148 (64.9)	228 (73.3%)	0.001
Heard of iodated salt				
Yes	10 (10.9%)	82 (89.1%)	92 (29.6%)	
No	79 (36.1%)	140 (63.9%)	219 (70.4%)	0.001

Personal preference determines on what to eat irrespective of its nutritional value. The most preferred type of salt in most households was the granular type (58.5%) followed by fine salt (36.2%) as illustrated in figure 4. The granular type of salt was the salt commonly available in households (74.3%).

Figure 2: Preference of salt by type of the salt in households (N =311)



A number of reasons were given for salt preferences and the most frequent reasons given included; the salt provides instant taste to the food, it is the only salt available in their areas and the salt dissolve instantly. The least reason for salt preference was because the salt was iodated.

The way salt is stored and kept in our households contributes to retention or loss of iodine in the salt. Over 60 percent of households stored their salt in containers such as tins, bottles and bowls with or without cover or lid as shown in Table 13. About 53 percent stored their salt in containers with cover or lid while only 7.4 percent stored salt in containers without cover or lid and about 39 percent stored salt in polyethylene packets.

About 4 percent of salt samples that had no iodine (0 ppm), were stored in containers with cover/lid while 13 percent in containers with no cover. About 51 percent of salt stored in containers with cover or lid had inadequate iodine levels (< 15 ppm) while 47.8 percent was stored in containers without cover. Salt that was stored in packets seemed to be much better in retaining iodine, because only about 1 percent had no iodine, 52.5 percent had inadequate iodine levels (<15 ppm) and 46.7 had adequate iodine (≥15ppm).

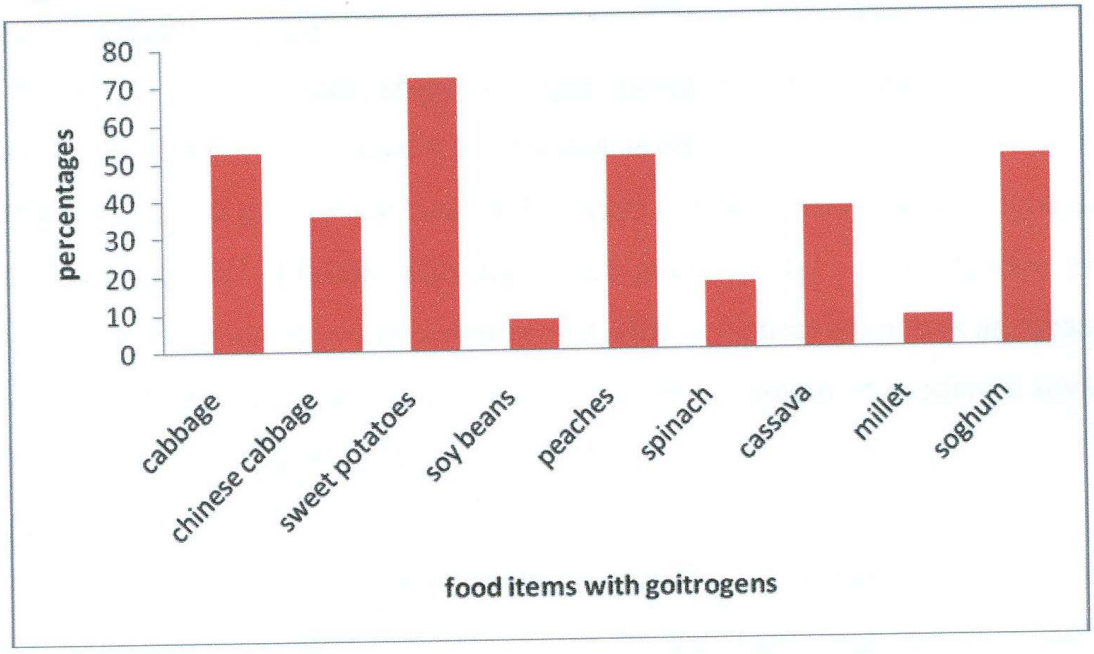
Further analysis revealed that, 52.9 percent of salt with inadequate iodine content was being stored in containers with cover, 40.7 percent in packet and 6.4 percent in containers without cover. These results are statistically not significant (Fisher's exact test = 7.8, p = 0.08).

Table: 13: Storage of salt and salt iodine levels (N = 311).

	Levels of iodine in salt				
Storage container	**No iodine (0 ppm)**	**Inadequate iodine (< 15ppm)**	**Adequate iodine (≥ 15 ppm)**	**Total**	**p value**
With cover/lid	7 (4.2%)	85 (51.2%)	74 (44.6%)	166 (53.4%)	
No cover/lid	3 (13.0%)	11 (47.8%)	9 (6.4%)	23 (7.4%)	
Packet	1 (0.8%)	64 (52.5%)	57 (40.7%)	122 (39.2%)	0.08
Total	11 (3.5%)	160 (51.4%)	140 (45.1%)	311 (100.0%)	

Foods that contain goitrogenic substances are commonly consumed in Mbeya district council. The cumulative consumption frequency for each food item is shown in figure 3 below. The most frequently consumed food items in a week were sweet potatoes (72.3%), cabbage (52.1%), peaches (50.8%) and sorghum (50.5%). However the least consumed foods included soy beans (8.4%) and millet (8.4%

Figure 3: Consumption of foods containing goitrogens on weekly basis.



Food items that were consumed daily by a large proportion of households include peaches (38.6%), sorghum (29.6%) and sweet potatoes (10.3%).

CHAPTER FIVE

5.0 DISCUSSION

The results of this study shows a slight increase in the prevalence of total goitre in school children (25.7%) aged 6 to 18 years as compared to the past study carried in 2004 where the goitre prevalence was 24.2 percent (TFNC. 2004). When segregated by goitre grades almost all children with goitre had goitre grade1. TGR (goitre grade 1 and 2 together) of 5 percent or more signify that Mbeya district council is an area still endemic to iodine deficiency and that it is a public health problem of moderate severity. (WHO, 1994; Biswas et al, 2001; Kapil et al, 2000).

When comparison is made between two sexes, female children had higher prevalence of goitre than male children and these results are statistically significant. Similarly, findings were reported in another study carried out in the same district council in 1999, where females had higher prevalence of TG (49.3%) than males (43.1%) (TFNC, 2000). Other studies in West Bengal India, and Egypt (Nawal et al, 1995; Biswas et al, 2001) have reported similar findings.

According to literature there may be differences in metabolism of iodine during growth between girls and boys (WHO, 1993). Iodine is the precursor of thyroid hormones produced by the thyroid gland and these hormones have a role in the production of other hormones such as sex hormones. The difference in metabolism could be the contributory factor in making the clinical signs of the deficiency more vivid in females than males in areas deficient in iodine.

Iodine has a major role in growth and development and its deficiency becomes vivid in the period of adolescence because of rapid growth and other physiological changes occurring within the body. This could explain why adolescent children 13 to 18 years had higher prevalence of goitre than those 6 to 12 years of age ($p = 0.01$). Similar findings were observed in a study conducted in Lesotho in children aged 5 to 15 years (Masekonyela et al, 2003).

The highest prevalence of goitre in both sexes was at 12 years being higher in females than males. A study conducted in West Bengal India among school children 8 to 10 years of age observed highest prevalence at the age of 10 years in both sexes being 11.7 percent in males and 12.0 percent in females ($p > 0.05$) (Biswas et al, 2001). Improvement in diets especially in urban areas where people have almost shifted from traditional diets and food preparation methods has probably attributed to early physiological and anatomical changes occurring during the period of childhood and adolescence. This could be the explanation for the high goitre prevalence at around 12 years in both sexes.

The findings in this study indicate that children from lowland schools had higher prevalence of goitre than those in the highlands which is contrary to what is said in the literature. The arbitrary classification of highlands and lowlands could have affected the results when goitre prevalence is correlated with altitude. An altitude of 1250 meters above sea level is generally high enough to be considered as highland but in this study villages and schools at an attitude of 1250 meters and below were considered as located in the lowlands, thus no wonder that these results were not statistically significant ($p = 0.36$) However, among those with goitre, over 50 percent were from the highlands ($p=0.36$). These findings are different with those found in Lesotho where the prevalence of goitre was higher the mountains than in the lowlands and Senqu river valley ($p=0.007$) (Masekonyela et al, 2003).

Generally, poor communities in the rural highland areas tend to be at high risk of developing goitre or other iodine deficiency disorders, because the majority totally dependent on foods grown locally. They have limited or no access to external foods because of their remoteness and poor roads for external commodities to reach them regularly and sometimes they are too poor to afford purchasing food coming out of their areas.

Among those who had goitre, the prevalence was higher in rural than urban schools

(p = 0.18). The study did not assess the socio-economic status of its study population, which might play a role in goitre development. Living in rural areas most of the time is associated with low socio- economic status. This is because there are limited activities to generate sufficient money and there is poor circulation of money. A study in Turkey among school children in a city showed that goitre rate was high in children with very low socio-economic status (Ersoy et al, 2006). It cannot be denied that malnutrition is more rampant in rural than urban areas (TDHS, 2005) which signify that the rural population is of low economic status since malnutrition is a proxy indicator of poverty.

The study showed no association between having goitre and using adequately iodated salt (p=0.18). These findings need to be interpreted with caution. Although some measures were taken, including excluding salt samples from the same household and those sharing a pot, still there was no assurance that the salt tested was from that child's home and that there was no sharing of salt among the children resulting in testing the salt more than once. Salt tested on the day of the survey was not necessarily the salt used routinely at home. Looking for association between the results of iodine in salt with prevalence of goitre can sometimes be tricky because goitre is an indication of past iodine deficiency (Orbelin et al, 2007).

Consumers buy salt because it is the salt that is available and not because it is iodated thus they use iodated salt unknowingly. About 97 percent of households use iodated salt regardless of the concentration of iodine in salt. However, these results indicate an increase in the use of iodated salt in the district compared to 74 percent observed in 2004 (TDHS, 2005). Although there is increase in the use of iodated salt, the proportion of adequately iodated salt was only 45 percent which was slightly lower compared to 55.7 percent observed in the demographic health survey in 2004 (TDHS, 2005).

The proportion of households using adequately iodated salt was higher in rural than urban communities although the results are statistically not significant (p = 0.69). These findings differ with those documented in TDHS, 2005 where national figure for utilization of adequately iodated salt in urban areas was twice that in rural. However, in

this study, some awareness on IDD and iodated salt among rural communities than urban has contributed to the change ($p = 0.001$). The changes going on globally have influenced communities both in rural and urban populations to understand what commodity is of good quality and what is convenient to have or to use. With globalization, a large proportion of commodities in urban places including salt are also found in rural areas. The market of commodities has become more open reaching even the rural areas in plenty.

The retention of iodine depends very much on the quality of salt. Granular type of salt was the most commonly used salt in households (74.3%) although it was the most inadequately iodated salt (57.6 %). This type of salt is not always 100 percent dry; it retains some moisture which perpetuates iodine loss from the salt especially when the salt is not properly stored.

Coarse type of salt was not commonly used (about 2%) because communities have realized the inconveniences of such salt in the process of food preparation. The proportion of households using granular and coarse salt together was 74.9 percent and about 62 percent of this was inadequately iodated which imply that a large section of the population consume less iodine than what the body needs.

Fine type of salt is supposed to be dry and flow freely when being used. However, the salt claimed to be of fine type had no qualities mentioned above, that is why about 35 percent of it had no iodine or was inadequately iodated.

The level of awareness on both iodated salt and IDD was low. The term iodine deficiency disorders seem to be new to most respondents but on further clarification it was observed that they were familiar with the word goitre where they even have a local word for it "*kimilo*" in Kisafwa language. It was a surprise to note that a very minute portion of the interviewees knew that iodated salt was available in the market. The poor rate of awareness for iodated salt might contribute to most respondents not be able to identify iodated salt and to improper storage and keeping of salt.

Despite urban communities being exposed to more communication channels, a large proportion of the rural population was aware of iodated salt (68.5%) and IDD (64.9%) compared to urban population. Because of availability of various communication channels, urban population might be spending their time on leisure rather than educative programmes. Secondly, urban population is busy on social activities and income generating activities thus having minimal time for educative programmes. Contrary to this, rural communities have limited choice of communication channels (television and newspapers) thus spending most of their time after shamba work listening to educative programmes in radios.

Storing salt in covered containers and away from heat is the most effective way of minimizing iodine loss which is volatile. In this study, a substantial proportion of households kept salt in the kitchen. This is a place where there is always heat especially when cooking using fire woods which is common practice with most households especially in rural areas. Frencesconi in Iringa Rural district had similar findings where he observed that, salt was mostly stored in containers with cover followed by polyethylene packets (Francesconi et al, 1996).

In populations where its people consume adequately iodated salt, the prevalence of goitre should not exceed 5 percent of its school age children (WHO, 1994). The 5 percent is due to secondary factors which are not related to iodine deficiency such as foods containing goitrogenic substance, familial defects or auto-immune disorders.

Many foods items that are said to have goitrogenic substances are locally grown in Mbeya district council. These include: sweet potatoes, cabbage, chinese cabbage, cassava and some fruits like peaches. These foods contain cyanogenic glucosides capable of liberating cyanide of which its metabolite thiocyanate is goitrogenic.

In areas where foods containing some goitrogens are consumed in plenty, even with sufficient iodine supplementation a certain proportion of the community will still have

goitre. These goitrogenic substances are thought to be contributory factors for the persistence of goitre in such communities. In this study, iodated salt was widely available although not all was adequately iodated. Less than half of the households were using adequately iodated salt which imply that only 45 percent of the population was getting sufficient iodine.

The clear demarcation of the impact of the goitrogenic foods on goitre development could not be established because a large proportion of the households still consume none iodated salt or salt that is inadequately iodated. A similar study was conducted in Arumeru district in Arusha district but the author did not come up with conclusive remarks (ICCIDD, 2007).

The association between consumption of these goitrogenic foods with persistence of goitre in this study is difficult to establish because less than half of the households use salt that is not adequately iodated. Consumption of these food items was not quantified and so not possible to establish association with prevalence of goitre among school children, but the information gathered can still be useful in future researches in this area.

Study limitations

1. School children were requested to bring salt from their homes for iodine testing. There is likelihood that some children shared salt samples with their friends in case they forget to bring the samples or they had no salt at home.

2. Lack of research assistants with experience in palpation of goitre, forced the principal investigator to palpate all children so as to reduce inter-observer bias. This was a limitation as sometimes misclassification might have occurred because of the large number of children examined in a day.

3. The list of households obtained from hamlet leaders might not be the most updated list.

4. The socioeconomic status of families could also be a factor contributing to IDD, however in this study this aspect was not studied. The outcome results could have given a much broader picture of the situation.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

This study revealed that the prevalence of goitre in Mbeya district council was still high which imply that iodine deficiency disorders are problems of public health importance of moderate severity.

The proportion of households using iodated salt in Mbeya district council was substantially high. This is a very high coverage but it is unfortunate that not all salt had adequate iodine. Less than half of the salt in households was adequately iodated which could be a factor contributing to persistence of goitre in the district.

Awareness on iodated salt and manifestations resulting from iodine deficiency was low. Although a high proportion of households were using iodated salt; they were not aware that the salt was iodated.

Retention of iodine in salt depends on the quality of salt and the way salt is stored. Granular type of salt was the salt mostly preferred and available in most households. However, a large proportion of this type of salt had no adequate iodine to provide the body with recommended iodine levels.

Persistence of IDD in Mbeya could be a result of a large section of the population having low level of awareness and knowledge on the need and importance of iodated salt and on proper storage of the salt. The high frequency of consumption of foods which are known to have goitrogenic substances might have played a role in having high goitre prevalence although it could not be substantiated in this study.

6.2 RECOMMENDATIONS

1. Based on study findings, it is recommended that there should be deliberate efforts to ensure that information and education on IDD and iodated salt reach all the people. Motivational campaigns, print media and other communication channels should be used to convey information to communities. Efforts to eliminate iodine deficiency disorders are deterred by communities being unaware of iodated salt, not able to identify the salt and not able to store the salt properly.

2. The frequency of consumption of goitrogenic foods in Mbeya could have a significant impact on persistence of high prevalence of goitre. More quantitative and qualitative researches are necessary to have proper answers to the problem.

3. Since most food items grown in Mbeya are said to have goitrogenic effect, communities should be educated on the use of salt that has adequate iodine to counteract the goitrogenic effect of such foods like cabbage, sorghum, cassava and the others. The most appropriate strategy that will ensure salt has adequate iodine content is to improve on salt storage and keeping in shops, markets and homes.

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