

**Addis Ababa University**  
**School of Graduate Studies**  
**College of Natural Science**  
**Center for Food Science and Nutrition**

**Prevalence of Iodized salt Intake and Iodine deficiency disorders Status of Pregnant Women Visiting Bishoftu Hospital and Health Center for Antenatal Care**

**By: Zeinaba Nagesso**

**Advisors: Dr .Getachew Addis (PhD)**

**Dr.Dawd Gashu (PhD)**

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**Approved by examining board**

**Signature**

**Date**

External examiner

\_\_\_\_\_

\_\_\_\_\_

Internal examiner

\_\_\_\_\_

\_\_\_\_\_

External advisor

\_\_\_\_\_

\_\_\_\_\_

Internal advisor

\_\_\_\_\_

\_\_\_\_\_

Chairman

\_\_\_\_\_

\_\_\_\_\_

**Declaration**

I the undersigned that this thesis is my original work and all sources used in the thesis was acknowledged.

Name: Zeinaba Nagesso

Signature \_\_\_\_\_

Date \_\_\_\_\_

The thesis has been approved for submission by:

<b>Name of supervisors:</b>	<b>Signature</b>	<b>Date</b>
<b>Dr .Getachew Addis</b>	_____	_____
<b>Dr.Dawd Gashu</b>	_____	_____

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## Acronyms and Abbreviations

AOAC	Association of Official Analytical Chemistry
APDM	Ammonium per Sulphate Digestion on Microplate Method
DIT	diiodotyrosine
EDHS	Ethiopian Health and Demographic Survey
EHNRI	Ethiopian Health and Nutrition Research Institute
$H_2N_2O_8S_{24}$	Ammonium per-Sulphate molarity
ICCIDD:	International Council for Control of Iodine Deficiency Disorders
IDD	Iodine deficiency disorders
IQ	Intelligence quotient
KI	Potassium iodide
MIT	mono-iodotyrosine
ml	milliliter
N	Normality
$NH_2SO_4$	Sulphuric acid
NIS	$Na^+/I$ o Isymporter
OD	Optical density
Ppm	parts per million
RDA	Recommended Dietary Allowance
RNI	The recommended nutrient intake
SAC	School-age children

T3	Triiodo thyroxin
T4	thyroxin
TBG	Thyroxin Binding Globulin
TG	thyroglobulin
TGR	Total Goiter Rate
TPO	thyroid peroxidase
TRH	the thyrotropin-releasing hormone
TSH	Thyroid stimulating hormone,
TV	thyroid volume
UIC:	Urinary iodine concentration
UNICEF:	United Nations Children's Fund
USI:	Universal salt iodization
WHO:	World Health Organization.

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## **Abstract**

Iodine is an essential mineral for normal thyroid function, mammary gland development, and fetal and infant neurological growth. It is a trace element essential to human and animal health, and present in uneven and mostly insufficient quantities in the environment around the globe. It is a constituent of the thyroid hormone, thyroxin (T<sub>4</sub>) and Triiodothyronine (T<sub>3</sub>). Iodine deficiency disorders are among the major public health problems of the world, particularly in pregnant women of developing countries. In Ethiopia about 15.4% of households consume sufficient iodized salt. This study was designed to assess iodized salt intake and assess iodine nutrition status, to evaluate knowledge, attitudes and practice of iodine nutrition and to assess goiter rate of pregnant women attending Bishoftu clinic for antenatal care in Bishoftu town. The study participants (n=208) was randomly selected. Data over socio-demographic, and knowledge, attitude and practice about iodized salt was collected by interview. Goiter was assessed by palpation and graded according to the WHO guideline. In addition, spot urine sample was collected and the level of urinary iodine was determined following the Sandell-Kolthoff reaction. Iodine level in salt samples was determined by following iodometric titration methods. Descriptive statistics, bivariate and logistic regression were carried out. The prevalence of goiter was 8.7 % ( Grade I=7.7% and Grade II=1%). The median urinary iodine concentration was 194.3 μg/l. The consumption of adequately iodized salt was 89%. This study was indicated as there was no problem of iodine deficiency in the study area.

**Keywords:** urine, goiter, iodine deficiency disorder, Urinary iodine excretion, iodized salt, pregnant women of Bishoftu.

Iodine is present in uneven and mostly insufficient quantities in the environment around the globe. An ecological cycle starting with iodine volatilizing from the ocean and replanting the soil by rain only partially replaces lost iodine. It can be found in soil, Seaweed, Seawater and some foods such as sea fish, meat and milk [15]. Animal and plant foods produced on soil with low iodine content contain very little or no iodine. Hence there is a need for adding iodine to the food chain through fortification or Supplementation to meet the iodine needs of humans.

## **1. 2. Statement of the problem**

Estimation indicates that 54 countries have inadequate iodine nutrition [11]. About 321.1 million African people had an insufficient iodine intake [16]. In Ethiopia, around 28 million people suffer from goiter, and more than 35 million people are at risk of iodine deficiency and 50,000 prenatal deaths are related to iodine deficiency each year in Ethiopia [18]. About 34.5% to 37% of the childbearing women in the country have goiter [13]. The education potential of the nation is unattained as iodine deficiency may cause an intelligence quotient reduction of 13.5 points. The problem is both a threat to the productivity of the workforce and a cause of cretinism and mental retardation [19, 20]. Iodine deficiency in the Oromia region is high similar to other parts of Ethiopia. The Pregnant women are among groups especially affected by IDD. However, studies on iodine deficiency and IDD are scanty in Bishoftu town thus this study is designed to investigate iodine deficiency prevalence and associated disorders in Bishoftu town.

## **1.3. Objectives**

### **1.3.1 General objective**

To assess iodine nutrition status among pregnant women from Oromia region of Bishoftu town

### **1.3.2 Specific objectives**

- To evaluate knowledge, attitudes and practice of iodine nutrition by pregnant women attending Bishoftu clinic for antenatal care in Bishoftu town
- To assess goiter rate of pregnant women attending Bishoftu clinic for antenatal care in Bishoftu town
- To determine level of iodine in household salt

## **2. Literature review**

### **2.1 Distribution of iodine in the world**

The soil in large geographic areas in the world is deficient in iodine. Twenty-nine percent of the world's population is estimated to live in areas of deficiency. This occurs primarily in mountainous regions and can also occur in lowland regions far from the oceans. When this people consume only locally produced foods in these areas they face a risk for Iodine deficiency disorders [15]. Ethiopia is a mountainous country, and poor soil conservation over a long period may have contributed to leaching of the iodine-rich soil layer and the exposing of the iodine-poor layer. The iodine content of food depends on the iodine content of the soil where it is grown. The iodine present in the upper crust of earth is leached by glaciations and repeated flooding and is carried to the sea so sea water is, therefore, a rich source of iodine [21]. The seaweed located near coral reefs has an inherent biologic capacity to concentrate iodine from the sea. The reef fish which thrive on seaweed are rich in iodine. Thus, a population consuming seaweed and reef fish has a high intake of iodine [22].

Ethiopia, situated in the horn of East Africa, is mountainous where the top layer of the soil in many parts has been eroded for decades leading to leaching away of nutrient including iodine [23]. Source of foods rich in Iodine are table salt (seaweed I-enriched vitamins), dietary supplements, saltwater fish and shell fish [24].

### **2.2 Iodine deficiency in the world**

Iodine is a trace element essential for the synthesis of thyroid hormones, triiodothyronine ( $T_3$ ) and thyroxin ( $T_4$ ). These hormones regulate the metabolic pattern of most cells and play a vital role in the process of early growth and development of most organs, especially the brain. In humans, the early development of the brain occurs during fetal and early postnatal life [19]. Iodine insufficiency was defined by urine iodine levels below 100  $\mu\text{g/l}$  and assessed from single samples, the cutoff for iodine insufficiency defined by the World Health Organization (WHO) and diagnostic of mild iodine deficiency [25]. The primary cause of iodine deficiency is a low dietary supply of iodine, typically in environments where the soil lacks iodine due to past glaciations, often compounded by the leaching effects of precipitation or flooding. This removes iodine from the soil, and plants and livestock become iodine deficient. Iodine deficiency may be

aggravated by intake of natural goitrogens in staple foods such as cassava, which contains thiocyanate that inhibits thyroid iodide transport. Deficiencies of selenium, iron, and vitamin A also exacerbate the effects of iodine deficiency. Inadequate intakes of iodine lead to insufficient production of these hormones, which adversely affect the muscle, heart, liver, kidney and the developing brain. This results in the disease states collectively known as Iodine Deficiency Disorders (IDD). Mild hypothyroidism in pregnant women is associated with lower IQ and cognitive deficits in their children [17].

The main changes in thyroid function associated with the pregnant state are due to increased hormone requirements, which begin in the first trimester of gestation. Increased hormone requirements can only be met by proportionally increased hormone production that, in otherwise healthy women, depends directly upon the availability of iodine in the diet [26]. Low intake of iodine during the reproductive age can cause Abortion and still birth [1]. Study done concerning these on Pregnant Women in Haramaya District to assess the relationship between pregnancy failure and presence of goiter and indicate that In Women without goiter stillbirth was 6.3% and it was 8.5% in women with goiter which indicate that stillbirth is significantly linked to the presence of goiter in women [27]. A profile analysis from different studies in different countries showed that from all babies born to iodine deficient mothers, 3% will have severe mental and physical damage, 10% show moderate mental retardation and the remaining 87% show some form of mild intellectual disability. Generally In human population, effects of iodine interventions lead to reduction in mental deficiency, deaf mutism and hypothyroidism. In animal population, iodine interventions lead to increase in live births, weight, and strength. The economic benefits resulted from such effects are: value of higher output of meat and other animal products and value of higher animal work output [28].The problem is both a threat to the productivity of the workforce and a cause of cretinism and mental retardation. These factors are estimated to lead to an enormous loss of gross domestic product. In Ethiopia, this has been estimated at nearly US\$ 1 billion over the 2000–2005 periods [19].

Iodine deficiency can cause endemic cretinism which is the extreme clinical manifestation of severe hypothyroidism during fetal, neonatal and childhood stages of development. It is characterized by severe and irreversible mental retardation, short stature and deaf-mutism. In an endemic goiter area, a large number of individuals with lesser degrees of mental retardation, speech and hearing defects, psychomotor retardation, are known as cretinism [29]. A large number of goitrous adults in an endemic region can have varying degrees of hypothyroidism leading to a variety of clinical symptomatology and complications related to hypo-metabolic states. This symptomatology can seriously decrease human energy and working capacity with resultant decrease of the economic productivity [30].

Iodine deficiency is a major public health problem in many parts of the world. More than 1.5 billion people are at risk for iodine deficiency with an estimated 655 million suffering from goiter, 11.2 million from cretinism, and 43 million suffering from different degrees of brain damage primarily due to the effects of iodine deficiency in pregnancy [31, 32].

About 54 countries of the world have inadequate iodine nutrition [11]. In 2013, 11 countries in Africa have iodine deficiency in 2013, six countries are moderately iodine-deficient with median UIC < 50 µg/L, and five countries have mild iodine deficiency with median UIC of 59–99 µg/l the largest burden of iodine deficiency was recorded in Ethiopia, Sudan, Algeria, Morocco, Ghana, and Mozambique.[16]

Ethiopia is among the top iodine deficient countries in the world. Goiter prevalence in the Southern Nations Nationalities and Peoples, Oromia, Benshangul-Gumuz, and Tigray regional states indicate the existence of severe iodine deficiency. This is a clear indication that iodine deficiency is a major public health problem in Ethiopia and the country is at an increasing risk of IDD[33]. That in many parts of Ethiopia goiter is known only when it is visible and the community seeks medication usually when goiter becomes symptomatic [34]. Study in ShebeSenbo District of Jimma zone, Ethiopia indicate that the total goiter prevalence was found to be high (59.1%), indicating that IDD is a severe public health problem [35]. Another study is that conducted in Burie and Womberma districts, West Gojjam Ethiopia in 2014 was indicate that the total goiter rate was 54.5% in school age children and 30.1% in biological mothers of the

children. More than 65% of the children have UIE less than 2µg/l [36]. Study demonstrated that goiter is one of the nutritional problems of public health significance in Ethiopia [37].The national survey in,2005 of IDD conducted by Ethiopian Health and Nutrition Research Institute (EHNRI, 2005) indicated a high prevalence goiter rate as nearly 40% in school age children and 36% in mothers. A goiter rate above 5% constitutes a public health problem. [33]. Study done on iodine deficiency indicate that goiter is prevalent more in female than male which is associated to physiological reasons such as early puberty, which starts than male which is associated to physiological reasons such as early puberty, which starts about 2 years earlier than males . As a result their iodine demand is higher than males. In addition, estrogen, which is a female hormone, has a well-known inhibitory effect on iodine uptake by thyroid follicular cells and estrogen also increases thyroid follicular proliferation; leading to thyroid gland enlargement [38].The cause of iodine deficiency is described as follows in table.1

**Table 2. 1:** Health consequences of iodine deficiency

Age group	Health consequences of iodine deficiency
All age	Goiter Hypothyroidism Increased susceptibility of the thyroid gland to Nuclear radiation
Fetus	Abortion Stillbirth Congenital anomalies Prenatal mortality
Neonate	Infant mortality Endemic cretinism

Child and adolescent

impaired mental function

Delayed physical development

Adults

Impaired mental function

Iodine-induced hyperthyroidism

Overall, iodine deficiency produces subtle but

Widespread adverse effects in a population,

including

Decreased educability, apathy, and reduced work

Productivity.

---

Source [36].

### **2.3. Metabolism of Iodine**

Iodine is reduced to iodide, and dietary iodine is absorbed from the gut. Iodide of dietary origin then mixes rapidly with iodide derived from the peripheral catabolism of Thyroid hormone and iodothyronines by deiodination, and together they constitute the extra thyroidal pool of plasma inorganic iodide. This pool exists in a dynamic equilibrium with two organs, the thyroid gland and the kidneys. When the iodine intake is restricted before the beginning of a pregnancy to 70mg/day the body increases iodide trapping through the pituitary-thyroid feedback mechanism to compensate for iodine restriction and maintain the necessary absolute iodine intake. Augmentation of iodide trapping is the fundamental mechanism through which the thyroid gland adapts to changes in the daily iodine supply [23]. In such conditions, there is a shortfall of some 10 mg of iodine a day and the thyroid gland uses stored iodine which is therefore progressively depleted to low amounts of 2–5 mg stable iodine. If the nutritional situation continues in a similar fashion the metabolic balance of iodine decline to become negative. Changes during pregnancy are increasing in renal iodide clearance by some 30–50%. Since the renal iodide clearance already increases in the first weeks of gestation and persists thereafter, this constitutes obligatory iodine ‘leakage’ which tends to lower circulating plasma inorganic iodide concentration and, in turn, induce a compensatory increase in the thyroidal clearance of iodide. Then, there is an increase in the production of thyroid hormone by 50%, which corresponds to an

increase requirement from 80 to 120 $\mu$ g of hormonal iodide/day. These two mechanisms underscore the increased physiological activity of the thyroid gland during the first half of pregnancy [39].

When the daily intake is restricted to only some 70  $\mu$ g of iodine during pregnancy and despite an increment in thyroidal uptake to 60%, the equilibrium becomes rapidly lost, with an absolute iodide entry into the gland that is insufficient to fulfill the increased requirements of thyroid hormone production. In such conditions, there is a shortfall of some 20 $\mu$ g of iodine/day in order to sustain an increased production of TH [40]. An additional mechanism of maternal iodine deprivation occurs during the second half of gestation, from the passage of part of available iodine from the maternal circulation to the fetal-placental unit. The absolute extent of iodine that is transferred from the mother to the fetus has not yet been precisely established but, at mid gestation, the fetal thyroid gland has already started to produce TH that is needed for the development of the fetus. Generally, during pregnancy when thyroidal iodine stores become more depleted within one trimester after outset; ID become more severe with the progression of gestation to its final stages and lead to excessive stimulation of the thyroid gland. The consequences of this with an increased concentration in serum thyroid stimulating hormone (TSH) and thyroglobulin (TG), and finally an increase in thyroid volume (TV) leading to goiter formation in both the mothers and newborn [41].

#### **2.4. Biological consequences of iodine deficiency during pregnancy**

The increase in TBG during gestation causes an increase in total serum TH. To estimate the free hormone concentration, a TH binding ratio, direct free T<sub>4</sub> measurement must be obtained. Because the reduction in the free fraction of T<sub>3</sub> is approximately equal to that of T<sub>4</sub>, the standard approach for these determinations using T<sub>3</sub> as a tracer can still be used. However, it is important to recognize that as the free fraction is reduced, the resin T<sub>3</sub> uptake asymptotically approaches a fixed lower limit. This is not linearly related to the increase in unoccupied TBG binding sites [42]. Thus, the decrease in the TH binding ratio usually does not match the quantitative decrease in the T<sub>4</sub>- and T<sub>3</sub>-free fractions estimated directly, and in some sera the free T<sub>4</sub> estimate will end up being slightly elevated relative to the true free T<sub>4</sub> or T<sub>3</sub> [43].

## 2.5 Assessment of iodine status

### 2.5.1 Goiter

Goiter is graded as Grade 0: None or no goiter (palpable or visible), Grade 1 or palpable: A goiter that is palpable but not visible when the neck is in the normal position, (i.e. the thyroid is not visibly enlarged). Grade 2 or visible: 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. Total Goiter Rate (TGR) is the sum of goiter grades 1 and 2 [25]. Based on total goiter rate the severity of iodine deficiency can be described as follows.

**Table.2.2:** Category of goiter based on severity

---

Total Goiter rate %	Severity of iodine deficiency
0-4.9	None
5-19.9	mild
20-29.9	moderate
≥30	severe

---

Source [44].

### 2.5.2 Iodine level of table salt.

Worldwide out of 128 countries with house hold iodized salt data, at least 90% of households in 37 countries consume adequately iodized salt, but in 39 countries, coverage rates are below 50%. Overall, about 70% of households worldwide have access to iodized salt [45]. About 20 African countries (40%) had household coverage rates of less than 50%. Low coverage rates of less than 50% are an indication of weak salt iodization programs seriously in need of corrective actions. Universal salt iodization programmers have been successful in a number of African countries, the estimated prevalence of iodine deficiency remains as high as 42 %, with 8 % of newborns exposed to learning disabilities from iodine deficiency [46].

### 2.5.3 Urinary iodine concentration

Most of the consultation proposed that the median urinary iodine concentration is the best indicator to use in population surveys to assess the iodine nutrition of pregnant and lactating women, and of young children less than two years. Moreover this indicator should not be used for the purposes of individual diagnosis and treatment and does not provide direct information about thyroid function. However, a low median urinary iodine concentration indicates that a population is at risk of developing thyroid disorders [47]. To estimate prevalence of iodine deficiency, urinary iodine concentration (UIC) is an important biomarker to assess recent iodine intake because most iodine absorbed in the body eventually appears in the urine [15].

More than 90 % of dietary iodine is excreted in the urine. Spot random urine sampling is the standard accepted method of measuring body stores of iodine. Because random urine samples have been found to be adequate for populations screening, there is little advantage in calculating urine iodine. For individual measurements, multiple spot urine iodine measurements or 24-hour urine iodine evaluations are more precise [48].

**Table 2.3:** Epidemiologic criteria for assessing iodine nutrition based on median urinary iodine concentrations of pregnant women.

Iodine Requirement ( $\mu\text{g}/\text{day}$ )	Iodine intake
<150	Insufficient
150–249	Adequate
250–499	above requirements
$\geq 500$	Excessive

Source [49]

**Table 2.4:** Recommend daily intake of iodine in human being

Serial No.	Age Group	Iodine Requirement ( $\mu\text{g}/\text{day}$ )
1	infants (0~11 months)	29
2	Children (12-59 months)	50
3	School age children (6-12 years)	90
4	Adults (Above 12 Years)	120
5	Pregnant and lactating women	150-20

Source [50]

**Table 2.5:** Epidemiological criteria for assessing iodine nutrition based on median urinary iodine concentration.

Median urinary	Iodine intake	Iodine nutrition
< 20	Insufficient	Severe iodine deficiency
20-49	Insufficient	Moderate iodine deficiency
50-99	Insufficient	Mild iodine deficiency
100-199	Adequate	Optimal
200-299	More than adequate	Risk of iodine induced Hyperthyroidism within 5-10yr

>300 (iodine autoimmune thyroid	Excessive	Risk of adverse health consequences Induced hyperthyroidism
Diseases)		

---

Source [50]

## 2.6 Thyroid hormone

Thyroid hormones are Chemical substances made by the thyroid gland. This gland uses iodine to make thyroid hormones, which are essential for the function of every cell in the body. They help regulate growth and the rate of chemical reactions and are involved in the circadian rhythms that govern sleep, among other essential functions. The two most important thyroid hormones are thyroxin (T<sub>4</sub>) and triiodothyronine (T<sub>3</sub>). Thyroid stimulating hormone (TSH), which is produced by the pituitary gland, acts to stimulate hormone production by the thyroid gland. The pituitary gland is stimulated to make TSH by the hypothalamus gland in the brain. Disorders of the thyroid in women are common during the reproductive years. Incorrect or delayed treatment during pregnancy can adversely affect the health of mother and child. UIC reflects iodine status only at the time of measurement, not longer than a few days, whereas Thyroid size reflects iodine nutrition over months and years and represents a chronic situation of iodine deficiency [51].

## 2.7 Risk factors for iodine deficiency

The loss in iodine concentration of table salt at the household level is estimated to be 20% [44]. In addition, the iodine concentration decrease further during cooking. One way to bring sufficient iodine at the household level is to increase the concentration of iodine at the production site. This would, however, potentially expose consumers to excess intake levels. Taking into account the losses during cooking, a concentration of 119.2 mg/kg is needed at the production site to protect 50% of pregnant women. Seasonal variations and changes in climatic conditions are expected to affect the concentration of iodine in salt. Storing of salt in a dry place and a clean airtight plastic container and also avoiding excess exposure to sunlight and heat could possibly reduce the level of post-production loss of iodine at the seller and consumer levels

and creation of awareness about proper storing and handling of iodized salt may prevent possible loss of iodine at the seller and consumer levels [19].

Goitrogen is another risk factor for iodine deficiency. It is a substance that interferes with iodine utilization. Goitrogens contain a compound that is metabolized to thiocyanate and blocks thyroidal uptake of iodine. Some species of millet and cruciferous vegetables (for example, cabbage, broccoli, cauliflower, and Brussel sprouts) contain goitrogens. The soybean isoflavones, genistein and daidzein, have also been found to inhibit thyroid hormone synthesis [52]. Some plants such as cassava, which contains thiocyanate that inhibits thyroid iodide transport. In addition, deficiencies of selenium, iron, and vitamin A also exacerbate the effects of iodine deficiency. Glutathione peroxidase and the deiodinases are Selenium-dependent enzymes. In selenium deficiency, accumulated peroxides may damage the thyroid, and deiodinase deficiency impairs thyroid hormone synthesis. Iron deficiency reduces hem-dependent thyroperoxidase activity in the thyroid impairs production of thyroid hormone [11]. Iodine deficiency was higher among pregnant women consuming cabbage more than three times a week. This showed that there was significant association between normal and iodine deficient pregnant women and the frequency of cabbage intake [36]. One study conducted in Burie and Womberma in Gojjam indicate that iodine deficiency became high and concludes that it could be because of the diet shift from Teff, barley and wheat-based to millet, sorghum and other crops which are known to interfere with the metabolism of iodine and the formation of the thyroid producing hormones [36].

## **2.8. Iodine metabolism**

Iodine is actively transported together with two sodium atoms in to the cell via an intrinsic plasma membrane protein called the Na<sup>+</sup>/I symporter (NIS). Energy for this process is provided by oxidative metabolism in the gland following entrance in to the cell, iodine is translocated across the apical membrane of the cell where, after oxidation by the enzyme thyroid peroxidase (TPO), it becomes capable of binding to tyrosyl residues in the thyroglobulin (TG). After formation of the Tg-bound mono-iodotyrosine (MIT) and diiodotyrosine (DIT) a coupling reaction takes places within the Tg iodotyrosine molecule and leads to triiodothyronene (T<sub>3</sub>) and thyroxine (T<sub>4</sub>) formation. The thyroid hormone-Tg complex is stored in the colloid matter of the

epithelial cell, then is taken up by the thyrocytes, is hydrolyzed by proteases and eventually the free thyroid hormones are released in to the circulation [53]

## **2.9 Absorption**

Iodine enters the body in the form of iodate or iodide in the water we drink or food we eat. The iodate is converted to iodide in the stomach. The thyroid gland traps and concentrates iodide and uses it in the synthesis and storage of thyroid hormones. The minimum daily iodine intake needed to maintain normal thyroid function in adults is about 150µg/dl. Iodide is rapidly absorbed from the gastrointestinal tract and distributed to extracellular fluids. But the concentration of iodide in the extracellular fluid is usually low because of the rapid uptake by the thyroid gland and renal clearance. It is estimated that 75% of the iodide taken into the body each day enters the thyroid by active transport. About two-thirds of that is used in hormone synthesis, with the remaining amount released back into the extra cellular fluid. The thyroid gland contains the body's largest pool of iodide, about 8 to 10 mg. Most of this iodide is associated with thyroglobulin, a thyroid hormone precursor and a source of hormone and iodinated tyrosine[54].

The thyroid produces thyroxine (T<sub>4</sub>) and triiodothyronine (T<sub>3</sub>). Iodine is an essential component of both T<sub>3</sub> and T<sub>4</sub>. These hormones regulate the rate of metabolism and affect physical and mental growth and the rate of function of many other systems in the body. The thyroid is controlled by the hypothalamus and the pituitary gland.

The production of T<sub>4</sub> and T<sub>3</sub> is regulated by the thyroid-stimulating hormone (TSH), released by the anterior pituitary. Thyroid-stimulating hormone production is suppressed when the T<sub>4</sub> levels are high, and vice versa. The TSH production itself is modulated by the thyrotropin-releasing hormone (TRH), which is produced by the hypothalamus [54].

## **2.10. Metabolic interactions of iodine and other micronutrient**

**Selenium–Iodine Interaction:** Selenium and Iodine interactions in the body mostly concern thyroid hormones. Both Se and I are required for thyroid hormone synthesis, activation, and metabolism, and the thyroid gland has the highest Se and I concentrations of all organs. The Se-dependent iodothyronine deiodinase enzymes catalyze the production of active thyroid hormone,

tri-iodothyronine (T<sub>3</sub>) from thyroxin (T<sub>4</sub>) and also control reversion of T<sub>3</sub> to di-iodothyronine (T<sub>2</sub>) [55].

**Iodine interactions with Iron, Zinc, and Vitamin A:** Evidence also exists for I interactions with Zn, Fe, and vitamin A. I, Se, Zn, and Fe are essential for normal thyroid hormone metabolism. Iron deficiency inhibits thyroid hormone synthesis by reducing the activity of heme-dependent thyroid peroxidase, while Fe-deficiency anemia reduces, and Fe supplementation enhances, the effectiveness of I supplementation [54].

## **2.11 Prevention and Control of Iodine deficiency disorders**

Iodine deficiency disorders cannot be eliminated by simply changing dietary habits or by eating specific kinds of foods. The recommended strategy for IDD control is based on correcting the deficiency by increasing iodine intake through supplementation or food fortification

### **2.11.1 Iodine Supplementation**

In some regions, iodization of salt may not be practicable for the control of IDD, at least in the short term because of shortage of salt. In areas where numerous small-scale salt producers supplementation with iodized oil to correct IDD should be considered. It is prepared by etherification of the unsaturated fatty acids in seed or vegetable oils, and addition of iodine to the double bonds. It can be given orally or by intramuscular injection. A single dose of iodized vegetable oil delivers 200–480 mg of iodine that provides sufficient coverage for 6–12 months or longer. Iodized oil is recommended for populations with moderate-to-severe IDD and is usually targeted to women of child-bearing age, pregnant women, and children. one study was indicate that the goiter prevalence has decreased from 89.5% in 1994 to about 36% in 2003 which implies that iodine deficiency has been the most important cause of endemic goiter and also shows the effective role of a single intramuscular injection of iodized oil And salt iodization in treating goiter [56]. In 2007 in Ethiopia only 28% of households have access to iodized salt [57].

### **2.11.2 Salt iodization**

Universal salt iodization (USI) is the iodization of all salt for human (food industry and household) and livestock consumption. Salt iodization is the recommended strategy for control of IDD. Two techniques are used: 1) the wet method, where a solution of KIO<sub>3</sub> is dripped or

sprayed at a regular rate on to salt passing by on a conveyor belt; 2) the dry method, where KI or  $KIO_3$  powder is sprinkled over the dry salt. The dry technique is more demanding as it requires a salt made of small homogenous crystals and thorough mixing of the salt after addition of the iodine compound. Iodine stability when added to salt depends on salt moisture, acidity, and purity. To reduce losses during storage, iodized salt should be as dry as possible and properly packaged and wrinkled with a film [41].

### **2.1.3 Iodized Oil Injections and Capsules:**

A single dose of 480 mg of iodine per 1.0 ml may be injected by needle and syringe into the muscles of the buttock for small children or of the upper arm for older children and adults. Each injection protects against iodine deficiency for three to five years. It can also be given orally, an easier method than injections.

### **2.11.4 Water**

Iodine added directly to drinking water has been shown to correct iodine deficiency. A measured amount of iodine, appropriate for achieving a daily intake of at least 150  $\mu\text{g}$ , is added to the drinking water at its source or place of storage. However, unless people have regular access to a reliable source of safe drinking water, and strict measures of implementation, supervision and control are in place, iodization of water is not a viable long-term solution for controlling IDD [58].

### **2.11.5 Health education**

Creating awareness about the consequences of iodine deficiency disorder, especially for high risk groups (infants, pregnant and lactating women) advice the people to use iodized salt for household consumption Educate the public to eat iodine rich food items like sea fish, kelp and avoid goiter organic foods [43].

### **2.12 Problem with taking too much iodine**

Taking too much iodine can also cause problems in individuals that already have thyroid problems, such as hyperthyroidism and autoimmune thyroid disease. Administration of large amounts of iodine through medications, radiology procedures and dietary excess can cause hyperthyroidism and hypothyroidism. In addition, individuals who move from an iodine deficient region to a region with adequate iodine intake may also develop thyroid problems since

their thyroids have become very good at taking up and using small amounts of iodine. In particular, these may develop iodine-induced hyperthyroidism [59].

### **3. Materials and Methods**

#### **3.1. Study Design and Period**

The study was conducted in Bishoftu town of East Shewa, Oromia region in Ethiopia. Its geographical location is 45km south-East of Addis Ababa. Bishoftu town has about 200,000 populations. The present study depends on one general hospital and three health centers. The study was applied to assess urinary iodine concentration and iodized salt intake of pregnant women attending mother and child specialized clinics in Bishoftu town from January 15 to February, 15, 2016. Cross sectional studies based on MCH clinics was conducted between January 15 to February, 15, 2016. Knowledge, attitude and practice of participants about iodized salt was collected using interview method (Annexure II)

#### **3.2. Study population, sample size estimation, and sampling**

The pregnant women registered in one hospital and all three health centers from January 15 to 30, 2016, was included in the study. Calculation based on previous study from Bishoftu health office (Bishoftu health office, 2015) and using an expected IDD prevalence of 10%, precision of 5%, confidence level of 95% and 10% non-response, and design effect of 1.5 yielded as shown below. The pregnant women was interviewed using questionnaire about their menstrual history, previous miscarriage if it was present, food they consume and monthly income by principal investigator of the project.

The sample size has been estimated as under:

Desired precision (%): 5%

Expected prevalence: 10%

Confidence level (C.L): 95%

Non-response rate: 10%

Design effect (1.5)

Formula: 
$$\frac{(C.L. \%)^2 \times \text{Prevalence \%}(100-\text{Prevalence \%})(\text{design effect})}{(\text{Precision \%})^2}$$

N: 
$$\frac{(1.96)^2 \times 10(100-10)}{(0.05)^2} (1.5) = 207$$

N=207

### **3.3 Eligibility criteria**

Inclusion criteria: all pregnant women willing to participate were included.

Exclusion criteria: non pregnancy

### **3.4 Variables of the study**

#### **3.4.1 Independent variables**

Socio demographic characteristics or information on their knowledge, attitudes practice towards ways of using iodized salt, dietary, reproductive history, occupation and income are independent variables.

#### **3.4.2 Dependent variables**

Grade of goiter, urinary iodine concentration and iodine content of salt consumed by pregnant women is dependent variables.

### **3.5 Data quality**

All the data were collected by the principal investigator and experienced person and Laboratory analysis of all samples was conducted in duplicate.

### **3.6 Knowledge, Attitude and Practice (KAP)**

Pregnant women were interviewed by using semi structured comprehensive questionnaire, which was based on knowledge attitude, and practices about salt use pattern and awareness about IDD, dietary, reproductive history were interviewed and their response was recorded on the questionnaire .

### **3.7 Assessment of goiter**

All pregnant women were physically examined by a trained person. The goiter was graded according to classification by WHO/UNICEF/ICCIDD 2007,) [25],as Grade 0: None or no goiter (palpable or visible), Grade 1 or palpable: A goiter that is palpable, but not visible when the neck is in the normal position, (i.e. the thyroid is not visibly enlarged). Grade 2 or visible: 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. The prevalence of goiter was expressed by Total Goiter Rate (TGR) which is the Sum of goiter grades 1 and 2. ). Based on severity, goiter was categorized as mild if  $TGR = 5.0-19.9\%$ , moderate if  $TGR = 20-29.9\%$  severe if  $TGR \geq 30\%$  [44].

### **3.8 Collection and analysis of urinary iodine**

Urine sample was collected by the principal investigator of the project and laboratory experiment on the level of iodine in urine was conducted by laboratory technologist. About 10 ml spot urine samples was collected from every pregnant women in a properly labeled and sterile screw-caped plastic vials and was immediately transferred to the cool box containing ice bags and was transported to the Ethiopian public health institute laboratory. The samples were kept at  $-40^{\circ}\text{C}$  in refrigerator until analysis. Analysis of urinary iodine was done using spectrophotometric procedure. Each sample was analyzed duplicate. It was based on ammonium persulfate method [60].

Determination of urinary iodine involves the spectrophotometric analysis (measuring the absorbance) of a reaction medium, which utilizes iodine as a catalyst. During this reaction, ceric ammonium sulfate (yellow in color), one of the reactants was reduced to cerrous (colorless) form, which uses iodine as a catalyst. The absorbance value/ optical density (OD) at 405 nm gives information about the iodine content of urine sample. It indicates that the more the absorbance value is the lesser the iodine content. The absorbance value can be used for the determination of the actual iodine concentration using a standard graph prepared by using a range of standard  $\text{KIO}_3$  solutions [61].

As recommended by WHO/UNICEF/ICCIDD(,2001) urinary iodine concentrations of  $<150 \mu\text{g/l}$  is insufficient,  $150\text{--}249 \mu\text{g/l}$  is adequate,  $250\text{--}499 \mu\text{g/l}$ , more than adequate and  $\geq 500 \mu\text{g/l}$  was used as excessive levels of iodine intake in population of pregnant women [47]. In this study, UIC  $<150 \mu\text{g/l}$  defined subclinical iodine deficiency and value  $\geq 150 \mu\text{g/l}$  absence of iodine deficiency. Median UIC and iodine deficiency were dependent variables. The group with  $<150 \mu\text{g/l}$  was again categorized into  $<20 \mu\text{g/l}$  as severe iodine deficiency,  $20\text{--}49 \mu\text{g/l}$  as moderate iodine deficiency, and  $50\text{--}149 \mu\text{g/l}$  as mild iodine deficiency [62].

### **3.9 Collection and analysis of Household salt**

The 20-25 grams of salt from each respondent household was collected and stored in airtight polythene pouch. The salt was transported to the laboratory of Ethiopia public health institute for analysis. The laboratory experiment on the level of iodine in salt was conducted by laboratory technologist in Ethiopian Public Health Institute laboratory. The samples were kept in desiccators at room temperature until iodine content was analyzed. The salt samples were analyzed quantitatively for iodine level by idometric titration method [63].

The method of determining iodine in the salt involves the titration of a solution of salt against standard Sodium thiosulphate ( $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ) solution to find out the end point. The volume of  $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$  used up is a direct measure of the content of iodine present in the salt. The Amount of thiosulphate used is proportional to the amount of free iodine liberated from the salt. Starch is added as an external indicator of this reaction and reacts with free iodine to produce blue color and the loss of this color indicates that all remaining free iodine was consumed by thiosulphate. Iodine level  $< 15\text{ppm}$  was good quality and iodine level  $>15 \text{ppm}$  was inadequate in their iodine content. The concentration of iodine in salt is calculated based on the titrated volume (burette reading) of sodium thiosulphate as

Iodine (ppm) =  $\frac{\text{titration volume in ml} \times 21.15 \times \text{normality of sodium thiosulphate} \times 1000}{\text{Salt sample weight in gram}}$

Salt sample weight in gram

### **3.10 Ethics**

This study was conducted following the ethics guideline of the Helsinki declaration and ethical approval was obtained from College of Natural Science of Addis Ababa University ethical Review Committee (annexure III). All the study participants were asked their consent to participate in the study. In addition, they were providing written informed consent. The purposes, the data collection procedures, and the benefits of the research will be explained to the eligible respondents before obtaining their consent.

### **3.11 Statistical analysis**

Descriptive statistics was used for frequency distribution and Chi-square statistical tests were used to test the association between factors and iodine deficiency and associated disorders. Correlation between quantitative variables was calculated by Pearson correlation coefficient. Data analysis was done using SPSS version 20 Software. Mean iodine content of sample of salt and urine was calculated using Microsoft Excel 2010. Association between dependent & independent variables was examined by using logistic regression and P-value  $\leq 0.05$  was considered as significant.

## 4. Results

### 4.1. Socio-demographic characteristics of the study population

A total of 208 pregnant women participated in the study of which 38% ( $n=79$ ) were between the age of 23-27, followed by those with age range of 18-22 years (34.6). 96.7% were literate among the study population (59%) were housewife and only 13% were government employee. Forty-three percent of the participants were at the third trimester of gestation.

**Table 4.1:** Socio-demographic characteristics of pregnant women ( $n=208$ ) in Bishoftu town, 2016

Socia demographic Variables	Frequency	%
Age of the participant		
<b>18-22</b>	<b>72</b>	<b>34.6</b>
23-27	79	38.0
28-32	40	19.2
33-37	17	8.2
Educational qualification		
Grade 9 and above	63	30.3
Grade 5-8	95	45.7
Grade 1-4	29	13.4
Can read and write	14	6.7
Unable to read and write	7	3.4
Occupation		
Government employee	27	13.0
Self business	58	27.8
House wife	123	59.0
Trimester		
First	51	24.5
Second	67	32.2
Third	90	43.3
Any abortion/stillbirth in the past		
Yes	198	95.2
No	10	4.8
No of family		
<5	179	86.1
>5	29	13.9
When you had last child birth		
Before 5years	32	27.4
After 5 years	85	72.6

Where you have delivered your child		
Home	11	9.4
Hospital	106	90.6
What was the mode of delivery?		
Cesareans	5	4.3
Normal	112	95.7
Total income		
<1000	34	16.3
1000-1500	94	45.2
>1500	80	34.5

#### 4.2 Knowledge and practice towards iodized salt of pregnant women in Bishoftu town.

Eighty-nine percent of the participants used powder salt and only 21.6% used both type of salts. More than two third (77.4%) of the respondents have knowledge towards the use of iodized salts and 77% responded as iodine is important to prevent goiter and for better health. However; none of them know as it is important for better intelligence. Most of the participants (76.6%) identify iodized salt by its labeling.

**Table 4.2:** Knowledge and practice towards iodized salt of pregnant women ( $n=208$ ) attending MHC clinics in Bishoftu Town, 2016.

Variables	frequency	(%)
Heard of message on iodine deficiency diseases		
/Iodized Salt		
No=2	32	15.4
Yes=1	176	84.6
Source of information		
Radio	35	19.9
Television	68	38.6
Friend	21	11.9
Other	52	29.5
Type of salt used		
Packed	82	39.4
Non packed	81	38.9
Both	45	21.6
Method of identifying IS		
Cleaner	32	15.4
By labeling	160	76.9
Don't know	16	7.7
Storage practices		
In the container with cover	199	95.7
In the container without cover	3	1.4

Don't know	6	2.9
Do you think we should take I		
Yes	161	77.4
No	47	22.6
If yes why		
Prevent goiter	78	48.4
Prevent cretinism	3	1.9
Good health	80	49.7
Better Intelligence	0	0
If not why		
Not available	7	14.9
Cost	36	76.6
Don't know	6	12.8
Food rich in I		
Sea food	13	6.25
Iodized salt and oil	98	47.1
Milk and milk product	53	25.5
Meat and meat product	44	21.15

#### 4.3. Urinary iodine excretion level

A total of 208 urine samples were analyzed to determine urinary iodine excretion level. The median urinary iodine excretion was 194.3 µg/l. Majority of the study population 145(69.7%) had UIE >150 µg/l.

**Table 4.3:** Distribution of urinary iodine status pregnant women ( $n=208$ ) attending Bishoftu MCH clinics, 2016.

UIE	frequency	(%)
<20	1	0.48
20-49	8	3.8
50-99	21	10.10
100-199	77	37.0
200-299	48	23.1
>300	53	25.5

UIE-urinary iodine excretion

As described in table 4.4 all health centers have median UIE greater than 100 µg/l and median UIE of Bishoftu hospital was somewhat less than other health centers.

**Table.4.4:** UIE level of pregnant women (*n*=208) attending Bishoftu MHC clinics, 2016.

UIE	Bishoftu Hospital ( <i>n</i> =54)	Cheleleka Health center ( <i>n</i> =50)	Keta Health center ( <i>n</i> =51)	Bishoftu Health center ( <i>n</i> =53)	Total ( <i>n</i> =208)
<20	0(0%)	0(0%)	1(2%)	0(0%)	1(0.48%)
20-49	5(9.3%)	3(6%)	0(0%)	0(0%)	8(3.8%)
50-99	7(13%)	6(12%)	8(15.7%)	1(1.9%)	22(10.6%)
>100	42(77.8%)	41(82%)	42(82.3%)	52(98.1%)	177(85.1)
MUI C	151.9	188.2	159.45	285.05	194.3

MUIC: median urinary iodine concentration

#### 4.4 Iodine content of salt

Eighty nine percent (*n*=186) of the household consumed adequately iodized salt and only 10.6% of the house hold consumed inadequately iodized salt (<15ppm) as shown in the following table.

**Table 4.5:** Iodine level of salt in household of pregnant women, ( $n=208$ ) attending MHC clinics in Bishoftu town, 2016.

Salt iodine content	Frequency	%
<15 ppm	22	10.6
15-30 ppm	69	33.2%
>30 ppm	117	56.2%

#### 4.5 Goiter status of the study population

The total goiter rate status of the study population was 8.7% of which only 1% was grade 2 goiters.

**Table 4.6:** Goiter status of the pregnant women ( $n=208$ ) attending MHC clinics in Bishoftu, 2016

Goiter grade	frequency	percent%
Grade 0	190	91.3
Grade1	16	7.7
Grade2	2	1.0
TGR	18	8.7

TGR: Total goiter rate

#### 4.6 Health center based distribution prevalence of goiter.

As shown in the following table 4.7 iodine deficiencies is mild in all HC except Cheleleka health center; the rest of them indicate the presence of mild iodine deficiency. Cheleleka health center had no iodine deficiency and had a goiter prevalence <5%.

**Table 4.7:** Goiter rate prevalence of pregnant women by health center.

<b>Goiter</b>	<b>Bishoftu</b>	<b>Cheleleka</b>	<b>Keta</b>	<b>Bishoftu</b>
	<b>Hospital</b>			
<b>grade</b>	<b>(n=54)</b>	<b>(n=50)</b>	<b>(n=51)</b>	<b>(n=53)</b>
Grade 0	47(87%)	49(98%)	46(90.2%)	48(90.6%)
Grade1	6(11.1%)	1(2%)	4(7.8%)	5(9.4%)
Grade2	1(1.9%)	0(0%)	1(2%)	0(0%)

## 5. Discussion

### 5.1 Coverage of iodized household salt

Household iodized salt is one means of measuring the community iodine level. The present study household's iodized salt consumption was 89.4% and it was greater when compared to similar study in rural kebele of Ada district that was 39% of households' iodized salt consumption [64]. It was also the highest among the study conducted in our country such as study in Akaki kality on school aged children, Assosa town, in Burie and Womberma district of west Gojjam, Gondar town, Bale goba town, Shebe-Senbo district of Jimma which were 20%, 26.1%, 1.1%, 33%, 29.7%, 26.2% respectively [65,66,36,67,68 and 35]. In Ethiopia the proportion of households utilizing iodized salt was 15.40%. [69] Community based cross sectional studies conducted in 2014 indicates that the prevalence of adequately iodized salt is 53% and iodized salt coverage is 89% in Ethiopia. [70].

In Africa Countries with successful iodized salt programs achieving a household coverage of more than 90% are: Burundi, Kenya, Nigeria, Uganda, Tunisia, Namibia, Zimbabwe, and Libya. Countries with promising household coverage rates of between 80 and 90% are: Rwanda, Sao Tome & Principe, Cote d'Ivoire, Lesotho, Comoros, the Congo Brazzaville, and Tanzania [16]. Whereas in Burundi, Kenya, Nigeria, Tunisia, Uganda and Zimbabwe it is more than 90%. [16]

The current household iodized salt coverage was better than that of Sudan, Mauritania, Guinea-Bissau and Gambia, which were less than 10%and, [16]. In South Sudan in a 2005 survey, households consuming iodized salt had increased from 40 to 73% [71]. (ICCID) indicates that South Sudan, Sudan and Ethiopia have only 35% or fewer households with access to iodized salt, [16]. Another study in Senegal indicates that an average iodine concentration in salt was 22 ppm. [72]. Finally in one country to implement high coverage of iodized household salt the following activities must undergo: awareness, availability, accessibility, and affordability [73].

## 5.2. Urinary Iodine status of pregnant women

To study the UIE collection of 24 hours urine is so difficult instead collection of spot or morning urine can be easy way the average was expressed by median UIE instead of mean. School-aged children have traditionally been used as a proxy of the iodine status in the general population. In recent years, however, several studies have demonstrated that pregnant women in most populations are another extremely vulnerable group exposed to iodine deficiency and that the iodine status of children does not necessarily reflect the iodine status of pregnant women. As example in Tanzania's 2010 Demographic Survey report on women of reproductive age, where the overall median UIC was 160 µg/l but pregnant, lactating and non-pregnant women indicated median of UIC 136, 113 and 194 µg/l respectively. It therefore appears critically important that the iodine status of pregnant women should be assessed, in addition to that of children [17].

In the current study the median UIE was 194.3 µg/l which indicate adequate iodine nutrition or as none of iodine deficiency in the study area. It was greater when it is compared to previous study in the same district of rural area of Ada'a that was 85.7 µg/l [65].

Another study in parts of our country it was greater than that of study on pregnant women visiting Jimma University Specialized Hospital for Antenatal Care Median UIC was 37.2 µg/L, in rural women from sidama zone southern Ethiopia MUIC of pregnant women was 48µg/L and Only 3.5% of the women had UIC  $\geq$  100 µg/L.52 in Burie and Womberma district of West Gojjam was 50 µg/l it was better [26, 20 and 36].

Ethiopia is among the top iodine deficient countries in the world [74].this is may be because of geographical area is different from current study and especially when we take gojjam it among the highest prevalence of goiter in our country. Another reason why current study MUIC was high is may be because of government policy of salt iodization.

When this study is compared to another study conducted outside of Ethiopia such as Senegal Median urinary iodine concentration was 92.20µg/l, in Indian Orissa indicate that Median Urinary Iodine Excretion for the study population was 125 µg /l and in rural of South Sudan, median urinary iodine secretion of participants with goiter was 152 µg/ml [70,75,and 71].So the present study was better of all those study this is because of awareness given to the community

towards IDD and iodized salt, policy implementation of the government on salt iodization and the geographical location of the study area.

### **5.3 Goiter prevalence**

Goiter prevalence is one of the indications of iodine deficiency in the community. In the current study prevalence of goiter was 8.7% so there was mild iodine deficiency in the area. It was low goiter prevalence when it is compared to study in the same area of rural kebele that was 20%. [64]. another study in parts of the country such as study in high land of Tigray district indicate goiter prevalence of 71.4%, in Burie and Womberma district of Gojjam was 30.1%.and in rural women from Sidama Zone Southern Ethiopia the total goiter rate was 15.9%, [75,36 and 20]. Another study among women in Ethiopia indicate Total goiter prevalence of 35.8% this demonstrates that more than 6 million women were affected by goiter and Goiter prevalence in four regional states (Southern Nation Nationalities and People, Oromia, Benshangul-Gumuz and Tigray) was greater than 30%. In the rest of the regions except Gambella, the IDD situation was mild to moderate. [9].the current study was better than all of these study may be because of several reason such as the geographical location of study area that was at low land area and consumption of iodine rich food such as milk and its products.When the current study is compared to criteria for tracking progress towards eliminating IDD it indicate that TGR was 8.7% which indicate prevalence of mild iodine deficiency and status of iodine nutrition was with MUI excretion of 194.3  $\mu\text{g} /\text{l}$ . This indicates none of iodine deficiency in the study area. The house hold consumption of iodized salt was 89% indicate almost met the criteria of elimination of IDD. Generally the study area had not too much iodine deficiency problem and a little improvement is required to meet the criteria for tracking progress towards eliminating iodine deficiency disorders.

## **6. Conclusion and recommendation**

### **6.1. Conclusion**

The iodine deficiency in the study area is only with goiter prevalence of 8.7% and 89% of household's iodized salt consumption. Median UIE was 194.3 µg /l. this indicate low prevalence of iodine deficiency in the study area.. High rate of goiter was recorded in participants at lower age category (18-22) and those in their first trimester of pregnancy.

The current study indicates high median urinary iodine excretion this may be because of high consumption of dietary source of iodine. The geographical location of the study area is in the rift valley land and can be rich in iodine. The iodine content of food depends on the iodine content of the soil where it is grown. The iodine present in the upper crust of earth is leached by glaciations and repeated flooding and is carried to, the lowland therefore, plants grow on this land may be a rich source of iodine.

The study community had also a high coverage of iodized salt. This maybe because of presence of iodized salt widely in the market and most of the study population nearest to the media and can have information about iodine deficiency and iodized salt.

### **6.2. Recommendation**

Iodine deficiency is not as such a problem in the study area but to increase their knowledge towards iodine deficiency and iodized salt giving awareness to the community at the household's level by health extension will be important. Adjusting the program of learning and teaching in the health center about iodine deficiency, how to use iodized salt, different diets as source of iodine and cause of iodine deficiency such as cretinism, reduce intelligence, abortion and other cause of iodine deficiency for pregnant women during their check up for improvement of their iodine nutrition consistently .

Further study has to be conducted in the whole community on goiter status, urinary iodine excretion, household using iodized salt and their knowledge and practice towards iodized salt and IDD as well as the consequence of iodine deficiency on human health at different age groups.

### **6.3 limitation of the study**

The study was only depend on the pregnant women attending health center and do not concern those whom do not attend health center and other community such as school age children.

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## **Appendixes**

### **Annexure, I: Information sheet**

#### **A. Introduction**

My name is Zeinaba I was conducted my study on assessment of iodine concentration on pregnant women in our population. Iodine is an essential mineral for normal thyroid function, mammary gland development, and fetal and infant neurological growth. The deficiency of this iodine can affect all of these.

#### **B. Purpose of the study**

Iodine deficiency is great problem of our country especially during pregnancy. It is not affect only mothers it can also affect the fetus. So it is so important especially for future pregnancy to improve your iodine status by correcting your diet or using iodized salt.

#### **C. procedure to be followed**

If you agree to participate in the study, you will give as sample of urine and the sample of the salt you use and we will ask you some questions. Their result was told for those want to know result.

#### **D. Voluntary participation**

During the study you have the right to answer or not the question. Giving the urine sample and salt sample was also based on their interest. A decision not to participate or with draw from the participation have no any effect on their attending hospital and clinic to get the service you want.

You can call by **0912836659**.

#### **E. Risk**

It has no anticipated risk

#### **F. Benefits**

There is no benefits you get in salary forms for your participation but if you want to know your result we will tell you and these is so important to know iodine status of our town.

#### **G. Cost**

There is no cost or salary you paid for your participation

**H. Compensation**

You have no any compensation for your participation.

**I. Confidentiality**

The records concerning your participation are to be used only for the purpose of this study. Your name was not used on any study forms and does not label on laboratory specimen or any result report of this study. Study identification number was used on the forms and laboratory specimen. Any information obtained on study was kept secret and only team members now your name linking to your study number.

**J. Participant statement**

I have been informed about this study and understand what is involved .I understand I can withdraw at any time without effecting my care I get already from clinic .I agree to participate on this study as a volunteer subject and will be given a copy of this.

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Date	name of volunteer	signature of volunteer
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**K. investigator statement**

All the things I mentioned above are explained to the volunteer in language she can understand and the volunteer is agrees to participate.

Zeinaba Nagesso

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Date	Name of investigator	signature of investigator
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## **Shiittii Odeeffanno**

### **A.seensa**

Maqaan koo zeeynabaa jedhama.qorannoo koo waa'ee hamma ayoodiinii dubartoota ulfaa naannoo keenyaa keessatti argamanii madaaluu irrattin hojjadha. Ayoodiiniiin albuuda bu'uura adeemsa dalagaa ayoodiiniiifi ,guddina xannacha harmaatiif akkasumas guddinna sammuu miciree fidaa'imaatiif tajaajila.kanaafuu hir'inni albuuda kanaa adeemsa kana hunda gufachiisa.

### **B.kaayyoo qorannicha**

Hir'inni ayoodiinii biyyattii teenya keessatti rakkoo cimaadha.rakkoon kun keessattu yeroo ulfaa ni hammata.kunis kan haadha qofa miidhu osoo hin ta'in rimaa garaa irrattis rakko kan fiduudha. Kanaafuu kana qorachuun of beeknee rakkoo fulduraa furuuf nu tajaajila.

### **C.Ulaagaaleehordofamuuqabu**

yoo qorannicha irratti hirmaachuu barbaaddan fincaani fi ashaboo itti fayyadamtan nuuf kennitan akkasumas gaafii tokko tokko isin gafanna.bu'aa keessan yoo barbaaddanisi beeksisna.

### **D.Hirmannaa fedhii irratti hundaaye**

Yeroo qorannicha adeemsifamu gaafii deebisuufii deebisuu dhiisuu mirga qabdan naamunaa fincaanii fi ashaboo kennuu fi kennuu dhiisuus mirga qabdu. Qorannoo keenyarratti hirmaachuu dhabuun faayidaa kilinika irraa argattan irratti dhiibbaa homaatuu hin qabu. Lakkoofsa bilbilaa [0912836659](tel:0912836659) n bilbiluu ni dandeessu.

### **E.miidhaa**

Miidhaa tokkoillee hin qabu

### **F.faayidaa**



**የመረጃ ሺት**

**ሀ. መግቢያ**

ስሜ ዘይነባ ይባላል ጥንቱን የማደርገው በነፍሰጡር ሴቶች ላይ የአዮዲን ንጥረነገር ይዘትን በተመለከተ ነው። አዮዲን በጣም አስፈላጊ ሲሆን በተለይም ለፅንሰ አይምሮዊ እድገት አስተዋጾ አለው። የአዮዲን እጥረት ከላይ የተጠቀሱትን ጥቅሞችን የሚያሳጣ ነው።

**ለ. የጥናቱ አላማ**

በአገራችን የአዮዲን እጥረት ከፍተኛ ችግር ነው ፤ በተለይም በእርግዝናጊዜ። ይህ ችግር በናቶች ላይ ብቻ ሳይሆን በፅንሰም ላይ ከፍተኛ ችግር ነው የሚያስከትለው። ስለሆነም እናቶች ለወደፍት እርግዝናናከዚህ ችግር ነፃለመሆን የአመጋገብ እናበአዮዲን የበለፀገን ጨው በመጠቀም የአዮዲን ደረጃቸውን ከፍ እዲያደርጉ መደገፍ ነው።

**ሐ. የምንከተለው ሂደቶች**

በጥናቱ ተስማምተው የሚሳተፉ ከሆነ ፤ከእርሶ የሚጠበቀው የሽንትና የሚጠቀሙበትን የጨው ናሙና እንዲሁም ለምንጠይቃችሁ አጠር ያሉ ጥያቄዎች መልስ መስጠት ነው። ለሰጡት ናሙናዎች ውጤት ማወቅ ከፈለጉ የሚነገራችሁ መሆኑን እንገልጻለን ።

**መ. በፍቃደኝነት ላይ የተመሰረተ ተሳትፎ**

በጥናቱ ወቅት ለሚነቀርብሎት ጥያቄ መልስ የመስጠትም ሆነ ያለመስጠት መብቶ የተጠበቀ ነው። የሽንትና የሚጠቀሙበትን የጨው ናሙናየሚወሰደው በእርሶፍላጎት ላይ የተመሰረተ ነው። የእርሶ ውሳኔ ላለመስጠት ሆነም መሳተፍ ጀምረውበሚያቆርጥበት ጊዜበሚከታተሉበት የጤና ተቋም ውስጥ የሚያገኙት አገልግሎት ላይ ምንም አይነት ተፅኖ አያሳድርም። ውሉን ማቆረጥ ስፈልጉ በ 0912836659 ደደውሉ።

**ሠ. ስጋት**

ምንምአይነት ስጋት አለው ተብሎ አይታሰብም

**ረ. ጥቅም**

በጥናቱ ላይ በመሳተፍ ውጤቶን ከማዎቅናጥናቱን ከመደገፍ ባሻገር ሌላ ምንምአይነት በክፍያ መልኩ የሚሰጥ ገንዘብ የለም።

**ሰ. ወጪ**

በመሳተፍ ምንምአይነት ክፍያ አይጠበቅበትም

**ሺ. ካሳ**

በመሳተፎ ምንም አይነት ካሳ አይደረግም

**ቀ. ምስጥር ጠባቂነት**

ከእርሶ የምናገኛውን መረጃዎች ባጠቃላይ ለዚህ ጥናት ግብአትነት ብቻ የሚውል ነው። በጥናቱ ውስጥ ምንም አይነት በስሞምሆነ በላብራቶሪ ውጤቶች ላይ እርሶን ሊገልፅ የሚችል ነገር የማንጠቀም መሆኑን እንገልጻለን። ውጤቱን የሚለየው ለተሳታፊው በሚሰጠው የኮድ ቁጥርሲሆን፤ በተጨማሪነት ለሚሰጡን መረጃ ሚስጥሩ የተጠበቀ ነው።

**ሸ. የተሳታፊው ቃል**

ስለጥናቱና በጥናቱ ውስጥ የተካተቱ ጉዳዮች ተረድተናል። በማንኛውም ሰዓት ጥናቱናማቻረጥ እንደምንችል ተረድተናል። እዲሁም በምናደርገው ውሳኔ ምንም አይነት በጤና ተቋም ውስጥ በምናገኛው አገልግሎት ላይ ተፅኖ የለውም። በዚህ ጥናት ውስጥበፍቃደኝነት ለመሳተፍና የዚህ ግልባጭ እንደሚሰጠኝም ተስማምቻለሁ።

ቀን----- የበጎ ፍቃደኛዬ ስም----- ፊርማ -----

**ጥናቱ ባለቤት ቃል**

ከዚህ በላይ የተጠቀሱት በሙሉ በሚያውቁት ቋንቋተገልጾላቸው ለመሳተፍምተስማምቷል።

ዘይነባ ነጌሶ

ቀን

ፊርማ

## Annexure II: Questionnaires

### Socio-demographic characteristics

No	Variables	Multiple choice	Answer code
1	Age of the participant	18-22	0
		23-27	1
		28-32	2
		33-37	3
2	Educational qualification	1.unable to read and write	0
		2. can read and Write	1
		3.grade 1-4	2
		4.grade 5-8	3
		5.grade 9 and above	4
3	Occupation	1. Government employee	0
		2. Self business	1
		3. House wife	2
4	trimester	1. First	0
		2.second	1
		3.third	2

5	Any abortion in the past.	1.yes	0
		2.no	1
6	No of family	<5	0
		>5	1
7	When you had last child birth	1. before 5years	0
		2. After 5 years	1
8	Where you have delivered your child	1. Home	0
		2. Hospital	1
9	What was the mode of delivery?	1. Cessations	0
		2. Normal	1
10	Total incomes	<1000	0
		1000-1500	1
		>1500	2

---

### B. Household salt survey sample

11	Have you ever heard message on iodine deficiency and iodized salt?	1. Yes	0
		2. no	1
12	If yes, what was the source of information?	1. Radio	0
		2. Television	1
		3. Friends/Neighbor	2
		4 .others(specify)	3
13.	What type of salt are you using right now?	1. Crystal	0
		2. Powdered	1
		3. both	2

14.	How do you store the salt?		
15	How do you store the salt?	1.container with cover	0
		2.container without cover	1
		3.don't know	2
16.	When do you add salt while cooking?	1.In the beginning	0
		2.Halfway through cooking	1
		3.After cooking	2
		4.Towards the end	3
17.	Do you think we should take iodized salt?	1.Yes	0
		2.No (If no Go to 18)	1

<b>18.</b>	If yes, why do you think that we should take iodized salt?	1. Prevent goiter	<b>0</b>
		2.Prevent cretinism	<b>1</b>
		3.Good health	<b>2</b>
		4Better Intelligence	<b>3</b>
<b>19.</b>	If no, why?	1.Not available	<b>0</b>
		2.Costly	<b>1</b>
		3.Any other (specify)	<b>2</b>
<b>20.</b>	Which of iodine rich foods you know?	1. Sea foods	<b>0</b>
		2.Iodized salt	<b>1</b>
		3.Milk and its product	<b>2</b>
		4.Meats and its product	<b>3</b>

We have finished our interview thank you.

Lakk.	Jijjiiramaa	filannoo	Koodii deebii
1	Umrii hirmaataa	1.11-22	0
		2.23-27	1
		3.28-32	2
		4.33-37	3
2	Sadarkaa baruumsaa	1.Kan hin baratin	0
		2.kan dubbisuu fi barressuu danda'u	1
		3.1-4 kan barate	2
		4.5-8 kan barate	3
		5.9 fi Sanaa ol	4
3	Hojii	1.kan mootummaa	0
		2.biiznassii dhuunfaa	1
		3.giiftii manaa	2
4	Sadarkaa ulfaa	1.ji'a 1-3	0
		2.ji'a 4-6	1
		3.ji'a 7-dhumaa	2
5	Kanaan dura ulfiisinirra bahee beekaa?	1.eeyyee	0
		2.miti	1
6	Lakkofsa maatii	1.5 ol	0
		2.5 gadi	1
7	Yeero dhumaatiif daa'ima kandeesse yoomi?	1.waggaa 5 dura	0
		2.waggaa 5 booda	1
		3.hin deenye	2
8	Daa'ima dhumaa eessaati deesse	1.Mana	0
		2.mana yaalaa	1
9	Akkamitti deesse	1.cininsuudhaan	0
		2.opiraasi'ooni	1

10	Galiwaliigalaa	1.<1000	0
		2.1000-1500	1
		3.>1500	2

**Sadarkaa maatii fi Oddeffanno waa'ee**

**Ashaboo**

11	wa'ee Ashaboo ayoodinii fi hir'ina ayoodiinii dhageesse beektaa ?	1. Eeyyen	0
		2. Hin dhagenyee	1
12	Yoo deebin Keessaan eeyyee ta'ee maddi odeeffanno Keessaani eessa?	1. Raadiyoo	0
		2. Televisionii	1
		3. Hiriyyaa	2
13	Yeroo ammaa Ashaboo gosaKamii fayyadamtu	1.Jajjaboo	0
		2.Kan daakkame	1
		3. lacheenuu	2
14	Ashaboo ayoodiinii akkamitti addaan baastu?	1.qulqulluudha	0
		2.barreffamaan	1
		3. kanbiraa	2
15	Ashaboo akkamitti Keessan ?	1.Qabee qadaada qabu	0
		2.Qabee qadaada hin qabne	1
		3.hin beeku	2
16	Yoo nyaata bilcheessitan ashaboo yeroo kam itti naqxu?	1.jelqabarra	0
		2.Gidduu keessa	1
		3.Gara dhumaarra	2
		4.dhumarra	3
17	Ashaboo ayoodiinii fudhachu qabna jettanii yaadduu?	1.Eeyyee	0
		2.Miti	1
		3.Hin beekuu	2
18		1. Huccuba ittisa	0

	Gaafi duraattif yoo deebin kee eeyyee yoo ta'ee maalif ?	2. Kireetizimii ittisaa	<b>1</b>
		3. Faayya aofitiif	<b>2</b>
		4. Cimina Sammu fi guuddinaa tajaajila	<b>3</b>
<b>19</b>	Gaafii duraattif yoo deebin kee miti ta'ee maalif ?	1. Hin Argamu	<b>0</b>
		2. qaalidhaa	<b>1</b>
		3. Kana biro(ibsii)	<b>2</b>
<b>20</b>	Sooratawwan madda ayoodiinii ta'an kannen keessaa isa kam beektan?	1.Nyaata haraa	<b>0</b>
		2.Ashaboo fi zayita ayoodiinii	<b>1</b>
		3.Aannanii fi bu'aawwan aannanii	<b>2</b>
		4.Fooniifi bu'aawwan foonii	<b>3</b>

Gaafii Keenya Xumurrerraa Galatoomaa.

ከዚህ በታች ለተዘረዘሩት ጥያቄዎች መልስዎን ከአማራጭ መልሶች በመምረጥ ያክብቡ

1	የተሳታፊ እድሜ	1. ከ 18-22	0
		2. ከ 23-27	1
		3. ከ 28-32	2
		4. ከ 33-37	3
2	የትምርት ደረጃ	1. ማንበብ የማየችል	0
		2. ማንበብ የምችል	1
		3. ከ 1-4 3	2
		4. ከ 5-8 4	3
		5. 9ኛ ከዝያባይ	4
3	የስራ ሁኔታ	የመንግስት ስራተኛ	0
		የ ስራ	1
		የቤ ስራተኛ	2
4	ተቅላላ ገቢ	1. <1000	0
		2. 1000-1500	1
		3. >1500	2
5	ለመጨረሻ ጊዜ የወር አበባቸው የታየበት ጊዜ	ከ 3 ወዲ	0
		ከ 3-6 ወር	1
		ከ 6 ወር በፊት	2
6	ከዚህ ቀደም የፅንሰ ማሰረድ አጋጥሞት ያውቃል	አዎ	0
		አልሰማውም	1
7	ስንት ቤተሰብ አሎት	ከ5 በላይ	0
		ከ5 በታች	1
8	መቼ ነበር የመጨረሻ ፅንሰን የወለዱት	ከ5 አመት በፊት	0
		ከ5 አመት በላይ	1
9	የትነበር የመጨረሻ ወሊዶችን የፈፀሙት	ቤት ውስጥ	0
		የጤና ተቋም	1
10	የወሊዶች ሁኔታ እንዴት ነበር	በቀዶ ጥገና	0
		በምጥ	1

ስለ አዮዳይዚድ ጨው እውቀት ነ አጠቃቀም			
11	ከዚህ ቀደም ስለ አዮዳን ስለሚያስከትለው ጉዳት እንዲሁም ስለ አዮዳይዚድ ጨው ስምተው ያውቃል	አዎ	0
		አልሰማውም	1
12	.መልሶ አዎ ከሆነ የመረጃ ምንጫቸውምንነበረ	1.ሬዲዮ	0
		2.ቴሌቪዥን	1
		3.ከጋደኛ/ ጎረቤት	2
		4.ከሌላ(የግለፁ)	3
13	ለእለታዊ ፍጆታ ምን አይነት ጨው ይገዛሉ	1.ኮረት	0
		2.ደቃቅ	1
		3.ሁለቱንም	2
14	አዮዳይዚድ የሆነውን ጨው እንዴት ይለያሉ	1.ንፁህ	0
		2.በ ፁሁፍ	1
		3.ሌሎች ካሉ(ይዘርዘሩ)	2
15	ጨዎን እንዴት ነው የሚያስቀምጡት	ክዳን ባለው ማስቀመጫ ውስጥ	0
		ክዳን በሌለው ማስቀመጫ ውስጥ	1
		በሌላ መንገድ(ይዘርዘሩት)	2
16	ምግብ ሲያበሰሉ መቼነው ጨው የሚጨምሩት	1.መጀመሪያው ላይ	0
		2.መሃልላይ	1
		3.ወደ መጨረሻው አካባቢ	2
		4.ምግቡን ካበሰልን ቦሀ	3
		5.ቦሀ 4አካባቢ 3	4
17	.አዮዳይዘድ ጨው እየተጠቀምን ነውብሎው ያስባሉ	አዎ	0
		አይደለም 2 (አይደለም ከሆነ ወደ 19ጥያቄ ይመልከቱ	1

18	.አዎ ከሆነ ለምን አዮዳይዝድ ጨውን ለመውሰድ ወሰኑ	1. እንቅርትን ስለሚከላከል	0
		2. ለተሻለጤንነት	1
		3. ለተሻለ አይምሮ ጥንካሬ	2
		4. ለትምርት ቤት ውጤት	3
19	1ኛ አይደለም ከሆነ	1. ስለማይገኝ	0
		2. የዋጋ ንረት	1
		3. ሌላ ምክንያት ከሆነ(የግለፁ)	2
20	በአዮዳይዝ ከበለፀጉ ምግቦች የትኛውን ያውቃሉ?	1. በአዮዳይዝ ከበለፀገ ጨው	0
		2. ወይም ዘይት	1
		3. ስጋና የስጋ ውጤቶች	2
		4. ከሀይቅ ውስጥ የሚገኙ ምግቦች	3
		5. ወተትና የወተት ተዋጋዎች	4

**ጨርሰናል ስለተሳተፍዎ እናመሰግናለን**

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