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Adequately Iodized Salt and Associated Factors at Household Level in *Kolfe keraniyo* Sub-city, Addis Ababa, Ethiopia

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Abstract: Iodine deficiency is a major public health problem throughout the world. Salt iodization is the commonest type of food fortification well exercised in many countries as the method of choice to eliminate iodine deficiency disorders. This study aimed to assess adequately iodized salt and associated factors at the household level in *Kolfe Keraniyo* sub-city, Addis Ababa, Ethiopia. A community-based cross-sectional study was conducted in *Kolfe Keraniyo* sub-city, Addis Ababa, Ethiopia from July to August 2019. In this study, 541 samples were included. Rapid test kit was used to get a semi-quantitative estimation of the salt iodine level. Among all samples, 95.5% was adequately iodized (>15ppm). In multivariable analysis, educational level (AOR=3.30; 95% CI: 1.06, 10.32), storing salt in an open container (AOR=10.71; 95% CI: 3.26, 35.23), salt buying frequency (AOR= 6.69; 95% CI: 2.34-19.10), using packed salt (AOR= 4.26; 95% CI: 1.46-12.40) and household monthly income ≥200 ETB (AOR=3.10; 95% CI: 1.11-8.60) had a statistically significant association to availability of adequately iodized salt at household level. In this study, the proportion of households that use adequately iodized salt meets the WHO/UNICEF/ICCIDD recommended proportion (≥90%). However, a considerable amount of households use inadequately iodized salt. Increasing the awareness of the community on proper storage and utilization of iodized salt should be done.

Keywords: Adequately Iodized, Salt, Iodine, *Kolfe keraniyo*, Ethiopia

1. Introduction

Iodine is crucial for the body in the synthesis of thyroid hormones [1]. Taking insufficient amounts of iodine below the body requirement results in impaired thyroid hormone synthesis that leads to hypothyroidism and a series of functional and developmental abnormalities collectively called Iodine deficiency disorder (IDD) [1, 2]. Insufficient dietary supply of iodine in food is the main factor for iodine deficiency [3]. People living in areas that have a minute amount of iodine in the soil due to erosion, flooding, heavy rainfall or glaciation are prone to iodine deficiency because of lack of adequate iodine in plants, including crops, grains and vegetables that people and animals consume grown in that soil [3, 4]. Worldwide, about 1.6 billion people live in an iodine-deficient environment leading to risk of IDD. Of these, 20 million are believed to be mentally impaired due to this deficiency [5].

The best strategy for IDD control is maintaining adequacy by increasing iodine intake through supplementation or food fortification [1]. Salt iodization is the commonest type of food fortification well exercised in many countries since 1990s as the World Health Assembly adopted universal salt

iodization (USI) as the method of choice to eliminate IDD [1]. Globally, 87.8% of households use iodized salt as of survey data from 2011-2017 [1]. However, iodine deficiency disorders still constitute a public health problem in many countries where the salt iodization programs are weakly implemented. UNICEF estimates that less than one-fifth of households in the developing world were using iodized salt [3].

In Ethiopia, iodine deficiency disorder has been identified as a public health problem for many years. Severe iodine deficiency in Ethiopian women leads to 50,000 stillbirths annually and the country's goiter rate has ranged from 14% to 59%. Low dietary intake and low iodized salt consumption are among the factor that led to the deficiency [6]. According to EDHS 2016 [7], the coverage of households' iodized salt utilization was 89% that showed great progress compared to EDHS 2011 (15%). However, the survey focuses only on the household availability of iodized salt [7]. A national survey conducted in 2014 revealed that only 43% of the salt was adequately iodized (more than 15ppm of iodine) among 95% households that were using iodized salt [8]. Even if there is adequate iodized salt production, it is important to assure an optimum iodine level in consumable salt at the household level. The actual availability of iodine from iodized salt at the household level can vary over a wide range due to many reasons [3]. Thus, Supportive surveys at the district level are important to determine why adequately iodized salt is not reaching households [9]. The information is scarce in the current study setting. Thus, this study aimed to assess the availability of adequately iodized salt and associated factors that lead to inadequately iodized salt at the household level in *Kolfe keraniyo* sub-city, Addis Ababa, Ethiopia.

2. Methods

2.1. Study Setting

The study was conducted in *Kolfe keraniyo* sub-city, Addis Ababa, Ethiopia. *Kolfe keraniyo* sub-city is the largest and the most populous sub-city in Addis Ababa. According to a projection of 2007 population census (10), the population is estimated 537,561 in 2017. The sub-city has 15 administrative areas *(Woredas')* with a total of 103,206 households.

2.2. Study Design and Period

A community-based cross-sectional study was employed during a period between July and August 2019.

2.3. Study Population

The study population was household in the selected *Woreda* at the time of data collection in *Kolfe Keraniyo* sub-city.

2.4. Variables

The dependent variable of this study was availability of adequately iodized salt. Independent variables were socio-demographic variables (age and sex of respondents, educational status of respondents, household income level, marital status, occupation, family size and religion), environmental factors (salt storage and using condition, a place they buy, duration of storage) and knowledge attitude and practice towards iodized salt (knowledge about the importance of using iodized salt, IDD, proper utilization, attitude towards packed salt and its taste)

2.5. Operational Definitions

Proper utilization of iodized salt: Adding salt to cooking at the end or right after cooking in the last 24hour.

Adequately iodized salt: Salt is said to be adequately iodized when the test result gives the determination of ≥ 15 ppm at household level by using rapid test kit (29)

Good knowledge: Respondents answer half and more than half of knowledge questions on IDD, Iodized salt considered to have good knowledge.

2.6. Sample Size and Sampling Procedure

The sample size was determined using a single population proportion formula with the following assumptions: prevalence of iodized salt utilization at household in *Dessie* and *Kombolcha* town 68.8% (11), 95% confidence level, 5% margin of error, and a design effect of 1.5. Therefore, 541 household were selected with 10% nonresponse rate. A two-stage sampling technique followed and systematic random sampling technique was employed to reach the study participants. From 15 administrative units (Woredas) of *Kolfe Keraniyo* sub-city, three were selected randomly using a lottery method. Then sample was allocated proportionally to size of the household for the selected 3 Woredas. Finally, the study subjects were selected using systematic random sampling.

2.7. Data Collection and Quality Control

The data were collected using interviewer administrated structured questionnaire which was adopted from UNICEF [9] and previous literatures [12]. A questionnaire consisting information on socio-demographic characteristics sex, age, educational status, income level, knowledge, environmental condition, availability of iodine in salt and accessibility of iodized salt was developed in English and then translated into Amharic and back translated to English to maintain consistency. Data were collected by trained four data collectors under the supervision of two supervisors. A pretest was conducted on 5% of the total sample size on the other *woreda* with similar setting. The data from each respondent was checked for its completeness, clarity, consistency, and accuracy by supervisor.

Rapid test kit was used to get a semi-quantitative estimation of salt iodine level. The interviewer took one teaspoon of salt from every sampled household for testing to determine whether the salt is adequately iodized or not. First, the small cup filled with salt and spread it, then two drops of test solution added and color change carefully observed and

compared with the standard color chart to determine the adequacy (<15ppm or >15ppm) within one minute. If the color change didn't recognize in test sample three to five drops of recheck solution was added to a fresh sample and also two drops of test solution was added and then compared to the reference chart to determine whether it was adequate (dark blue color), inadequate (light blue color) or no iodized (white color) [9].

2.8. Data processing and Analysis

The data were checked for completeness and consistency and entered into EPI-info version 7. Statistical package for social science (SPSS) version 23 was used for analysis. Descriptive statistics were used to summarize the data. Binary logistic regression was computed to all variables factors associated with adequately iodized salt. The Model fitness for logistic regression was tested using Hosmer-Lemeshow goodness of fit test at *P*-value >0.05. Variables with *P-value <0.25* level in the bi-variable analysis were used for multivariable logistic regression analysis to control confounders. For the odds ratio, 95% CI was computed and variables with a *P-value<0.05* in the multivariable analysis were considered as independently associated with adequately iodized salt.

3. Result

3.1. Socio-demographic Characteristics

A total of 515 households were included in this study with a response rate of 95.5%. Among these participants, the majority of the respondents (98.1%) were females and the mean was 35.75 (SD ±9.05). Among the respondents 292 (56.7%) were orthodox Christians, 359 (69.7%) were married, (55%) had educational level of secondary education and above, 245 (47.6%) were housewives and 393 (76.1%) had monthly income of ≥2000 ETB (Table 1).

Table 1. *Socio demographic characteristics of participants in Kolfe Keraniyo sub-city, Addis Ababa, Ethiopia, from July to August 2019. (n=515).*

Variable		Number	Proportion
Resident	Woreda 12	87	16.9
	Woreda 13	334	64.9
	Woreda 15	94	18.3
	Total	515	100
Sex	Male	10	1.9
	Female	505	98.1
	Total	515	100
Religion	Orthodox	292	56.7
	Muslim	136	26.4
	Protestant	83	16.1
	Other	4	0.8
	Total	515	100
Educational level	No formal Education	47	9.1
	Read and Write	32	6.2
	Primary (1-4)	48	9.3
	Primary (5-8)	105	20.4
	Secondary (9-12)	139	27.0
	12+	144	28.0
	Total	515	100
Marital status	Married	359	69.7
	Single	90	17.5
	Divorced	31	6.0
	Widowed	35	6.8
	Total	515	100
Occupation	Housewife	245	47.6
	Daily laborer	43	8.3
	Merchant	84	16.3
	Gov't employee	117	22.7
	Student	16	3.1
	Unemployed	10	1.9
	Total	515	100
Income	<500	5	1.0
	500-999	27	5.2
	1000-1499	36	7.0
	1500-2000	54	10.5
	>2000	393	76.3
	Total	515	100
Family size	≤5	305	59.2
	>5	210	40.8
	Total	515	100
Age group	14-24	38	7.4
	25-34	188	36.5
	35-44	196	38.1
	>=45	93	18.1
	Total	515	100

3.2. Knowledge, Awareness, and Perception of Study Subjects Towards Iodized Salt Utilization

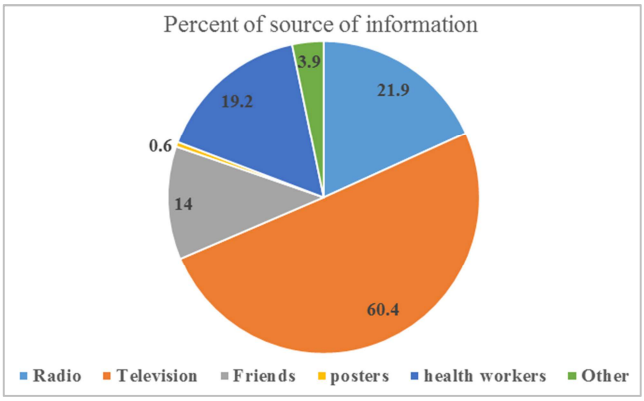

Figure 1. *Source of information about iodized salt in Kolfe keraniyo sub-city, Addis Ababa, Ethiopia, from July to August 2019 (n=515).*

Among the study participants, 485 (94.2%) heard about iodized salt. Regarding the source of information, more than half of respondents (60.4%) heard about IDS from television. Some (3.9%) heard from other information sources like from their children, school and social media (Figure 1). This study indicated that 56.3% of respondents have good knowledge on IDD and iodized salt. Among all respondents, 44.3% know iodine is important to prevent iodine deficiency disorder including goiter and 36.3% believed that iodine is important to cure goiter (Figure 2). Among study participants, 38.8% know that the salt that they currently used in their house has added iodine but 6.6% say no and 54.6% don't know whether

it is iodized or not.

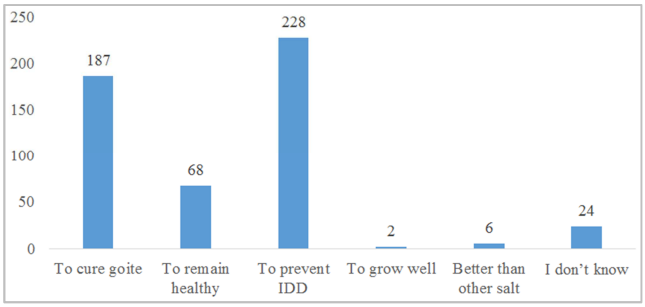

Figure 2. *Participant's awareness about the importance of iodized salt in Kolfe keraniyo sub-city, Addis Ababa, from July to August 2019 (n=515).*

Respondents have different reasons to use unpacked/coarse type of salt. These include; cheaper 46 (8.9%), good taste 42 (4.5%), good for health 57 (2.1%). Households who preferred to use packed salt had also their reasons including; good taste 17 (3.3%), good for health 238 (46.2%) and the rest 48 (9.3%) give other reasons like milled and hygienic. When they purchase the salt, 45.2% of respondents look/ask for iodized salt but 54.8% did not.

About half (51.1%) of households the salt they used had no label and no brand while in the salt of 48.9% of households had a label including the brand name but not available for the rest of the households. The different types of salt brands were used by households' in the sub-city but the predominant brands were called *Shewit, Sheger, Shewa, Yosis,* and *Asli*. According to salt storage condition, 95.3% of HHs store in a container with lid/same bag/packet in which salt is bought but the remaining 4.7% store in a container without a lid. Half of the HHs (49.5%) add salt after cooking but before serving while about 39.4% of HHs add their salt at the middle /half way of cooking. Regarding the frequency of purchasing, 62.3% HHs purchased their salt once in a month, 14.8% more than once a month and 20% of HHs purchased once in 2 to 3 months. Less than ten percent (9.3%) of the respondents had awareness about any regulations regarding salt for human consumption.

3.3. Availability of Adequately Iodized Salt

A total of 515 salt samples collected from each household were tested at the field using a rapid field test kit. Among all tested samples, 95.5% were adequately iodized (>15ppm) as shown in (Table 2).

Table 2. *Rapid test kit result of household salt in Kolfe Keraniyo sub-city, Addis Ababa, Ethiopia, from July to August 2019 (n=515).*

RTK result	Number	Proportion
<15ppm	23	4.5
≥15ppm	492	95.5
Total	515	100

3.4. Factors Associated with Adequately Iodized Salt Utilization

Factors associated with adequately iodized salt at household level were assessed using binary logistic regression analysis. In the bivariate analysis, educational level, family size, salt buying frequency, packaging, household monthly income, storage condition, and participant's perception have a significant association to availability of adequately iodized salt at the household level. However, based on multivariable analysis, only storage condition, salt buying frequency, packaging, and household income had a significant association to availability of adequately iodized salt at the household level.

The odds of availability of adequately iodized salt was higher in the household who didn't store their salt in open containers (AOR= 10.71; 95% CI: 3.26-35.23) and who use packed salt (AOR= 4.26; 95% CI: 1.46-12.40). Educated respondents were 3.3 (AOR= 3.30; 95% CI: 1.06-10.32) times the odds to use adequately iodized salt than non-educated ones. Similarly, study participants who bought their household salt in one or less a month were 6.69 (AOR= 6.69; 95% CI: 2.34-19.10) times the odds to have adequately iodized salt than those who bought once in 2 to 6 months. The odds of having adequately iodized salt was increased by 3.1 times in households whose monthly income was greater than 2000 Birr (AOR=3.10; 95% CI: 1.11-8.59) (Table 3).

Table 3. *Bi-variable and multivariable analysis show factors associated with adequately iodized salt at the household level in Kolfe Keraniyo sub-city, Addis Ababa, Ethiopia, from July to August 2019 (n=515).*

Variable	Availability of adequately iodized salt		COR (95% CI)	AOR (95% CI)
	Yes	No		
Educational level				
No formal education	40 (85.1%)	7 (14.9%)	1.00	1.00
Educated	452 (96.6%)	16 (3.4%)	4.94 (1.92-12.72)	3.30 (1.06-10.32)
Family size				
≤5	296 (97%)	9 (3%)	1.00	1.00
>5	196 (93.3%)	14 (6.7%)	0.43 (0.18-1.00)	0.46 (0.16-1.28)
Every salt contains iodine				
Yes	91 (96.8%)	3 (3.2%)	1.00	1.00
No	323 (96.7%)	11 (3.3%)	0.97 (0.26-3.54)	0.87 (0.20-3.83)
I don't know	78 (89.7%)	9 (10.3%)	0.29 (0.08-1.09)	0.43 (0.09-2.05)
Taste difference				
Yes	65 (91.5%)	6 (8.5%)	1.00	1.00
No	290 (97.6%)	7 (2.4%)	3.82 (1.24-11.76)	2.43 (0.60-9.89)
Unknown	137 (93.2%)	10 (6.8)	1.27 (0.44-3.63)	2.50 (0.68-9.15)
Why you prefer				
Cheaper	38 (80.9%)	9 (19.1%)	1.00	1.00

Variable	Availability of adequately iodized salt		COR (95% CI)	AOR (95% CI)
	Yes	No		
The taste is good	54 (91.5%)	5 (8.5%)	2.56 (0.79-8.24)	3.47 (0.60-20.13)
Good for health	288 (97.6%)	7 (2.4%)	9.74 (3.43-27.68)	1.79 (0.27-11.96)
Other	57 (96.6%)	2 (3.4%)	6.75 (1.38-32.98)	2.28 (0.27-19.58)
Packed salt				
Yes	418 (97.9%)	9 (2.1%)	8.79 (3.67-21.04)	4.26 (1.46-12.40)
No	74 (84.1%)	14 (15.9%)	1.00	1.00
Container without lid				
Yes	15 (62.5%)	9 (37.5%)	1.00	1.00
No	477 (97.1%)	14 (2.9%)	20.44 (7.65-54.61)	10.71 (3.26-35.23)
Salt buying frequency				
Once/more month	390 (97.3%)	11 (2.7%)	4.17 (1.79-9.73)	6.69 (2.34-19.10)
Once in 2-6 months	102 (89.5%)	12 (10.5%)	1.00	1.00
Income level				
<2000	110 (90.2%)	12 (9.8%)	1.00	1.00
>=2000	382 (97.2%)	11 (2.8%)	3.79 (1.63-8.82)	3.09 (1.11-8.59)

COR= Crude Odds Ratio AOR= Adjusted Odds Ratio CI= Confidence interval

4. Discussion

This study was aimed to assess the level of iodized salt and its associated factors at household level. It revealed that 95.5% of households use adequately iodized salt, and educational status, type of storage container, salt buying frequency, package and household monthly income had a statistically significant association.

The proportion of households that use adequately iodized salt meets the WHO/UNICEF/ICCIDD recommended proportion (≥90%) for sustainable elimination of IDD [23] and it was higher compared to the global average (87.8%) based on a survey conducted from 2011-2017 [1, 13]. Similarly, it was better compared to the findings of studies conducted in India (78%), Pakistan (15.3%), South Africa (62.4%), and Sudan (14.4%) [14–17]. It is also higher compared to national adequately iodized salt (more than 15 ppm of iodine) coverage of 43% based on the national survey conducted in 2014 [8]. In addition, the finding of the present study was higher compared to previous studies conducted in different parts of Ethiopia [18–21]. This improved coverage might be the result of good educational status, good storage condition of salt, availability and accessibility of iodized salt, good regulatory and monitoring activities in the city.

The majority of households (95.3%) store their consumable salt on a container with a lid or the same packet salt was bought. This finding was higher compared to study finding in southwest Ethiopia, *Shebe* town (93%) and central Ethiopia, *Asela* town (87.7%). However, it was relatively lower compared to studies done in *Desssie* and *Kombolcha* town (96.4%), *Gondar* town (99.3%). Comparable results were reported from Northern Ethiopia, *Dabat* (95%) [19–21, 23]. Proper storage of salt is crucial to prevent iodine loss from iodized consumable salt since the humidity of the atmosphere, light, heat, and weather conditions generally are influential factors [24].

This study indicates that only half of HHs (49.5%) added salt properly, such that after cooking but before serving where comparative findings were also reported from similar studies conducted in Shebe town (49.5%) and Dabat (49.6%). However better findings were reported *Desssie* and *Kombolcha* town (80.6%) and *Asela* town (76.8%) [19, 20, 21, 23]. A previous study revealed that excessive heat could cause up to 24% iodine loss [24]. The amount of iodine loss in cooked food varies from 18.7%-63.4% due reasons like cooking time, cooking temperature, amount of water added, and the nature of foods [25]. WHO/UNICEF/ICCIDD have recommended monitoring of consumable salt to minimize losses of iodine by excessive heat since there is 20% loss during cooking before consumption for sustainable elimination of IDD [2, 22].

According to this study storing salt in an open container has a significant association with availability of adequately iodized salt at the household level. Study done in 8 countries (Bolivia, Ghana, India, Indonesia, Philippines, Senegal, Tanzania, and Canada) revealed that open containers allow free contact between the air and the salt and any absorbed or condensed moisture would remain in the salt as a liquid and contribute to the loss of iodine [26]. WHO states there are considerable losses of iodine resulting from high humidity, deterioration of salt due to excessive long term exposure to moisture, heat, and contaminants [2].

This study revealed that the odd of getting adequately iodized salt at household level was higher in families who used packed salt than those who use unpacked salt. This finding is consistent with studies done in *Dabat* district, *Gondar* town, *Dessie* and *Kombolcha* town of Ethiopia [19–20]. Studies indicate that inadequate packaging, for example in jute rather than high-density polyethylene, aggravates iodine losses during transport, handling, and storage [22]. Since packaging affected by moisture which leads to iodine loss solid low-density polyethylene bags are excellent materials to maintain iodine stable in salt [26].

Similarly, this finding indicates that households who bought their salt in longer periods were less likely to use adequately iodized salt. This might be due to longer duration which can cause liable to moisture, heat, and contaminants. Study findings say iodine losses over six months of storage ranged up to 98.5%, indicating that all of the iodine added to the salt disappeared within six months [26].

Regarding household's monthly income those families

whose monthly income greater than 2000 Birr had a higher probability of using adequately iodized salt. This is supported by studies conducted in *Dessie* and *Kombolcha* town (21) and *Asela* town [22]. This might be due to the reasons that families with high income have the probability to buy packed salts have better information about iodized salt.

Finally, the current study has the following limitation: the salt iodine level was determined by a semi-quantitative measure of rapid test kit so difficult to know the exact level of iodine. The study didn't consider salt iodine level at different stage like production site and retail shops.

5. Conclusion

In this study, household use of adequately iodized salt meets the WHO/UNICEF/ICCIDD recommended proportion of ≥ 90% of households' iodized salt consumption. However, considerable amount of families are still using inadequately iodized salt. Storing salt in an open container, using packed salt, salt buying period, educational level of respondents and household monthly income were significantly associated with adequately iodized salt at the household level.

Ethical Consideration and Consent

Ethical clearance was obtained from St. Paul's Hospital Millennium Medical College/SPHMMC/ institutional review board/IRB and Addis Ababa Health bureau IRB before the actual data collection. Letter of permission was obtained from the *Kolfe Keraniyo* sub-city health office and submitted to each selected *Woreda* administration office. Informed verbal consent was obtained from each respondent after explaining the purpose of the study and the assurance of confidentiality. The study used unique survey identification number in the entire process.

Acronyms and or Abbreviations

AOR=Adjusted Odds Ratio; CI = Confidence Interval; COR= Crude Odds Ratio; EDHS = Ethiopian Demographic Health Survey; EPHI = Ethiopian Public Health Institute; ETB = Ethiopian Birr; ICCIDD= International Council for Control of Iodine Deficiency Disorder; IDD = Iodine Deficiency Disorder; MOH= Ministry of Health; PPM = Parts Per Million; RTK = Rapid Test Kit; SPMMC= St. Paul's Millennium Medical College; SPSS = Statistical Package for Social Science; UNICEF= United Nations Children's Fund; USI = Universal Salt Iodization; WHO = World Health Organization

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Author Contribution

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Competing Interests

The authors have declared that they do not have any competing interests.

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