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Assessment of Knowledge and Availability of Iodine in Table Salt among Households and Street Vendors in Nyamagana District, Mwanza, Tanzania

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Abstract

Background: Iodine deficiency is a major public health problem and a leading cause of preventable cognitive impairment globally. It accounts for approximately 90% of goiter cases and 5–15% of cretinism in severely endemic areas. To address iodine deficiency disorders (IDD), Tanzania implemented Universal Salt Iodization (USI) in 1994. However, previous assessments indicated that household coverage of adequately iodized salt was below the World Health Organization (WHO) recommended level of ≥90%. Regular monitoring is recommended every three years. This study assessed knowledge of iodine and availability of iodized salt among households and street vendors in Nyamagana District, Mwanza, Tanzania.

Methods: A cross-sectional mixed-methods study was conducted. A total of 417 participants were included in the quantitative component and 30 in the qualitative component. Salt samples were tested for iodine content using MBI rapid test kits. Quantitative data were analyzed using descriptive statistics (means and percentages), while qualitative data were analyzed using thematic analysis.

Results: Of the 417 salt samples tested, 399 (95.7%) contained iodine, with 355 (85.0%) having adequate iodine levels (>15 ppm). All packed salt samples (342, 100%) contained iodine, compared to 45 (97.8%) of unpacked salt and 16 (55.2%) of crude salt. In total, 18 (4.3%) samples contained no iodine, all of which were crude salt. Despite the high availability of iodized salt, knowledge levels were limited. Although 265 (63.5%) participants had heard of iodine, only 217 (51.1%) correctly identified at least one function, and less than one-third (32.6%) could identify any dietary source. Awareness of vulnerable groups requiring higher iodine intake was low (8.9%), and only 6 (1.4%) participants reported checking salt labels to confirm iodization. Additionally, improper storage practices were common, with 98 (23.5%) storing salt in open containers, which was associated with lower iodine levels. Qualitative findings revealed widespread misconceptions about iodized salt, including beliefs that it contains harmful chemicals and that crude salt is superior.

Conclusion: High availability of iodized salt indicates substantial progress in USI implementation in Tanzania. However, gaps in public knowledge persist. Strengthening community education alongside continued monitoring and enforcement of iodization standards is essential to sustain achievement

Keywords: Iodine, Iodine deficiency Disorders, universal salt iodization.

Introduction

Iodine is an essential micronutrient required for the synthesis of thyroid hormones, thyroxine (T4) and triiodothyronine (T3), which regulate metabolism, growth, and development throughout life (1). Inadequate intake results in a spectrum of disorders, including impaired thyroid function, hypothyroidism, endemic goiter, cretinism, reduced fertility, and increased infant mortality, collectively known as Iodine Deficiency

Disorders (IDD) (2). Adequate iodine intake is therefore necessary across all life stages (3, 4).

Iodine availability varies geographically due to uneven distribution in soil and water. Consequently, certain regions, including parts of the United States and areas of West and East Africa forming the "goiter belt," remain iodine-deficient (5, 6). In response to the significant burden of IDD identified in the 1960s, global strategies were introduced, including iodine supplementation and, subsequently, Universal Salt Iodization (USI), which remains the most effective and sustainable intervention (2, 7).

WHO and UNICEF recommended salt iodization as the primary strategy to eliminate IDD (8). Following the 1990 World Summit for Children, most countries enacted iodization policies by 2000. As a result, the number of countries affected by iodine deficiency declined from 110 in 1993 to 54 in 2003, based on urinary iodine assessments among schoolchildren (9, 10).

Tanzania adopted USI in 1994, following earlier interventions such as iodized oil capsule distribution (2). The Tanzania Bureau of Standards recommends iodine levels of ≥75.1 mg/kg in salt (11). Although initial compliance was low, later improvements were observed (12). However, a 2004 study showed that iodine deficiency remained a public health concern in several districts, with only 83% of salt adequately iodized below the WHO target of ≥90% (13).

Despite the implementation of USI in Tanzania and reported improvements in iodized salt coverage, evidence from sub-national settings remains limited and inconsistent. Previous studies have largely focused on iodine availability alone, with minimal attention to community knowledge and perceptions, particularly among both households and street vendors who play a critical role in salt distribution. Furthermore, WHO recommends regular monitoring of iodized salt coverage every three years (14). In Tanzania, such assessments remain limited, with evidence of inconsistent compliance in some regions (13, 15). Continuous monitoring is therefore essential to sustain progress (6, 16). This study aimed to assess the availability of iodine in table salt used in households and sold by vendors in Nyamagana District, Mwanza, Tanzania.

Materials and Methods

Study area

The study was conducted in Nyamagana District, located in Mwanza Region in northwestern Tanzania. Mwanza is the second-largest city in the country after Dar es Salaam, with an estimated population of 1,182,011 and an annual growth rate of approximately 5.5% (17). The region comprises seven administrative districts: Nyamagana, Ilemela, Misungwi, Magu, Sengerema, Kwimba, and Ukerewe.

Mwanza Region is predominantly inhabited by the Sukuma ethnic group, alongside other groups such as the Zinza, Haya, Kurya, Jita, and Kerewe. The main economic activities include agriculture and fishing, largely due to the region's location within the Lake Victoria zone.

Nyamagana District forms part of Mwanza City and serves as one of its central administrative areas. As of 2022, the district had an estimated

population of 363,452 and was divided into 13 wards: Buhongwa, Butimba, Igogo, Igoma, Isamilo, Mahina, Mbugani, Mirongo, Mkolani, Mkuyuni, Nyamagana, Pamba, and Kishiri (17). Geographically, Nyamagana is bordered by Ilemela District to the north, Magu District to the east, and Misungwi District to the south.

Study design and sampling

This was a community-based cross-sectional study conducted in October 2020 in Nyamagana District, Mwanza, Tanzania. The study employed a mixed-methods approach, integrating both quantitative and qualitative data collection to enable methodological triangulation and provide a comprehensive understanding of iodine availability and participants' knowledge regarding iodine and its functions.

The sample size for the quantitative component was determined based on the total population of Nyamagana District, estimated at 363,452 (17, 20). A margin of error of 5% was applied to ensure adequate precision, resulting in a minimum sample size of approximately 400 participants. To enhance the robustness of the findings and account for potential non-response, a total of 417 participants were included in the study.

A multistage sampling approach was used. First, a list of all streets within each ward was obtained from the District Executive Director's office and arranged alphabetically. Systematic random sampling was then applied to select streets. The sampling interval (k) was determined by dividing the total number of streets by the required number of streets to be selected. The first street was chosen randomly from the first sampling interval using a lottery method, and subsequently, every kth street was selected until the required number was achieved.

For the qualitative component, six focus group discussions (FGDs) were conducted in purposively selected wards (Butimba, Mirongo, Mkuyuni, Bugarika, Buhongwa, and Mbugani). Participants were selected from those who participated in the quantitative survey based on their availability and willingness to participate. The number of FGDs was guided by the principle of data saturation, whereby data collection was continued until no new themes emerged (21).

Data collection and analysis

A quantitative cross-sectional survey was conducted involving households and street vendors in Nyamagana District. Salt samples were collected from 40 households in each of the twelve selected wards by a team of twelve trained research assistants. Each sample was tested for the presence of iodine using MBI rapid test kits following the manufacturer's instructions. In addition, salt brand names and type (packed, unpacked, or crude) were recorded.

Data on knowledge and awareness of iodine were collected using a structured and pretested questionnaire adapted from previous studies. Knowledge was assessed using seven items evaluating participants' understanding of iodine functions, population requirements, and consequences of deficiency. Additional items assessed participants' knowledge of iodine

sources, methods of iodine fortification, and the effects of excessive iodine intake. Awareness was assessed by asking participants whether they had ever heard of iodine. Participants were also asked about salt storage practices (open versus closed containers), given the known impact of storage conditions on iodine stability.

Quantitative data were entered and analyzed using IBM SPSS Statistics version 20. Descriptive statistics were used to summarize the data: categorical variables were presented as frequencies and percentages, while continuous variables were summarized using measures of central tendency (means and medians).

For the qualitative component, six focus group discussions (FGDs) involving a total of 30 participants were conducted. Participants were purposively selected from the quantitative sample to ensure diversity in sex and background. Separate FGDs were conducted for male and female participants to promote open discussion. Each session was facilitated by two trained interviewers of the same sex as the participants, with one serving as a moderator and the other as a note-taker. Discussions were audio-recorded with participants' consent, and identifying information was replaced with unique codes to ensure confidentiality.

A semi-structured FGD guide was used to explore participants' knowledge, perceptions, and practices related to iodine, including its sources, functions, and health effects. Audio recordings were transcribed verbatim and translated into English. Data were analyzed thematically using NVivo software, following Braun and Clarke's six-step approach: familiarization with the data, coding, generating themes, reviewing themes, defining and naming themes, and producing the final report (22).

Iodine salt level determination

Salt samples collected were characterized into three groups before testing for the presence of iodine. The first was packed salt, which is salt in the form of small fine crystals sealed in manufacturer packs with labels. The second group was unpacked salt, which is salt in the form of small fine crystals sold within unsealed packs and without manufacturer labels. The last group was crude salt, which is salt in very large crystals (grain) and sold without packs.

The MBI test kits were used to determine the presence of iodine. The test solutions are capable of testing salt fortified with potassium iodate. A testing reagent contains an acidic buffer capable of reducing iodine in potassium iodate into iodine molecules and starch, which forms a deep blue color with the released iodine molecule (23). A teaspoon of salt was spread on the surface of a white paper, then two drops of the test solution were spread on the salt until it was all covered. One minute later, the color changes of the salt were observed and compared to the colors indicated by the color chart contained in the test kit. The salt sample that turned dark blue signified the presence of more than 15 ppm (mg/L) of iodine. And the salt that turned faint blue contained less than 15 ppm of iodine. The salt that contained no iodine at all showed no color changes (24).

Results

Quantitative results

Socio-demographic data and general results

A total of 417 participants were recruited for the study, among them female participants were 282 (67.6%). About half of the participants, 215 (51.6%), had attained primary education, with most of the participants, 206 (49.4%), being self-employed. Demographic information is summarized in Table 1 below.

Table 1: Socio-demographic data

Variables	Frequencies (N)	Percentages (%)
Sex		
Males	135	32.4
Females	282	67.6
Education level		
No formal education	33	7.9%
Primary level	215	51.6%
Secondary level	95	22.8%
Advanced level	12	2.9%
Certificate	5	1.2%
Diploma	26	6.2%
Degree	31	7.4%
Employment		
Government Employees	93	22.3%
Farmer	18	4.3%
Housewives	62	14.9%
Retired	4	1%
Self-employed	206	49.4%
Students	13	3.1%
Unemployed	21	5'%

Availability of iodine in the table salt and salt-checking practices among study participants

Among the salt samples investigated, the majority were packed salt, 342/417 (82). The rest was either unpacked salt 46/417 (11%) or crude salt 29/417 (7%).

Most of the salt samples, 399/417 (95.7%), tested positive for iodine. All packed salt 342(100%) tested positive for iodine. However, most of the packed salt 327/342 (95.6%) contained recommended >15ppm iodine, while a few 15/342 (4%) had levels <15ppm. All but one of the unpacked salt 45/46 (97%) tested positive for

iodine. However, only 34/46(74) had recommended iodine level of >15ppm. Among the crude salts tested, only 16/29(55%) tested positive for iodine, but it's less than the recommended 15 ppm. See Table 2.

During an assessment of the practices of participants to ensure that the salt they used contained iodine, about 268/417 (64.3%) of participants had no idea about salt iodization; therefore, they made no effort to check and make sure that the salt they used contained iodine. Some of the participants, 143/417 (34.3%), knew that the salt must be iodized, but they never checked for its presence on the label. Only a handful of participants, 6/417 (1.4%), knew about the iodization of table salt and checked on the packet label if the salt they used was iodized (table 2).

Table 2: Availability of iodine in table salt and practices among study participants

Variable	Frequency(n)	Percentage (%)
Presence of iodine		
Present	399	95.7
Absent	18	4.3
Quantity present		
>15ppm	355	85
<15ppm	44	10.6
Not present at all	18	4.3
Types of salt used		
Packed salt	342	82
Unpacked salt	46	11
Crude salt	29	7
Practices for ensuring the availability of iodine in the purchased salt		
Check the label	6	1.4
Don't check at all, no idea about iodization	268	64.3
Don't check, because it must be iodized	143	34.3

Quantity of iodine present in salt samples

Salt type	>15ppm	<15ppm	No iodine	Total
Packed Salt	327	15	0	342
Unpacked Salt	34	11	1	46
Crude salt	0	16	13	29
Total	361	42	14	417

Assessment of knowledge on the functions of iodine

More than half of the participants, 265/417 (63.5%), have heard about salt iodization. Most of the participants, 80/417 (30%), heard from the radio. About half, 217/417 (51.1%) of participants knew the functions of iodine. With 98/217(45.2%) knowing about its role in the prevention of goiter and 90/217(41.5%) knowing about its role in bone strengthening. Only 37/417 (8.9%) knew that certain groups of people in the population like the elderly, children and pregnant women needed high quantities of iodine than others with 19/417 (4.6%), 14/417 (3.45), and 4/417 (1%) knowing that children, pregnant women, and elderly respectively needed iodine in large quantities than others and 380/417 (91.1%) did not know that certain groups had higher iodine requirements than others. Less than half of the participants, 136/417 (32.6%), could mention at least one source of iodine, like table salt, fish, etc. 300/417 (71.9%) of the participants were not aware of the absence or inadequacy of iodine in crude salt. About 129/417 (30.9%) knew the functions of iodine in pregnancy and the effects of its deficiency during pregnancy. Furthermore, most of the participants 411/417 (98.6%) didn't know the effects of excess iodine in the body. Additionally, a vast number of participants didn't know different ways that iodine is made available for people; this accounted for 94%; however, only 23/417 (5.5%) of the participants knew the effects of the storage method on the availability of iodine in the salt. This is tabulated in Table 3 below. More information on the functions of iodine is summarized in table5, below.

Table 3: Knowledge of the functions of iodine

Variable	Frequency(n)	Percentages (%)
Heard about salt iodization		
Yes	265	63.5
No	152	36.5
Source of information		
Radio	125	30
Television	59	14.1
School	50	12
Read	6	1.4
Health care worker	13	3.1
A friend	12	2.9
Never heard	152	36.5
Functions of iodine		
Optimize body system functions	8	1.9
Prevent mental retardation	9	2.2
Prevent miscarriage	3	0.7
Prevent goiter	98	23.5
Production of thyroid hormones	9	2.2
Strengthen bones	90	21.5
I don't know	200	47.9

Differences in iodine requirements		
children	19	4.6
elderly	4	1
pregnant women	14	3.4
I don't know	380	91.1
Sources of iodine		
Fish	1	0.2
Salt	135	32.45
I don't know	281	67.4
Awareness about the inadequacy of iodine in crude salt		
Yes	117	28.1
No	300	71.9
Effects of iodine shortage during pregnancy		
Birth defects	5	1.2
Miscarriage	11	2.6
I don't know	401	96.2
Effects of excess iodine		
Over sweating	4	1
Thyroid cancer and inflammation	1	0.2
Weight loss	1	0.2
I don't know	411	98.6
Methods of making iodine available universally		
Salt iodization	25	6
Cereal fortification	0	0
I don't know	392	94
Awareness of the effects of salt storage methods on iodine content		
Yes	23	5.5
No	3	0.7
I don't know	391	93.8

Effects of storage methods on the quantity of iodine

The study went further to assess the storage methods of the quantity of iodine, and it was found that a total of 98/417(23.5%) was stored in an open container, with 30/98 (30.6%) and 11/98(11.2%) of the samples with an iodine quantity of less than 15ppm and not present at all, respectively. On the other hand, a total of 298/319 (93.4%) samples were stored in a closed container, with about 14/319 (4.7%) and 7/319 (2.3%) samples having less than 15ppm of iodine and not present at all. See Table 6 below.

Qualitative results

A total of six focus group discussions were conducted with five participants in each of the groups, making a total of thirty participants. Both male participants were 15/30 (50%), more than three-quarters of the participants, 26/30(86.7%), had attained primary education. About half of 16/30 (52%) were self-employed, and 7/30 (23%) were employed. Participants discussed various key parts of the iodine topic. See summarized information in Table 4. They discussed the functions of iodine, sources, the effects of excess iodine, and the notions that society or themselves have about the crude and packed salt. Their responses are as presented below.

Table 4: Focused Group Discussion Summary

FGD	Average age(years)	Sex	Number of participants	Duration (min)	Location
1	36	Males	5	25	Butimba
2	25	Males	5	30	Mirongo
3	45	Males	5	23	Mukuyuni
4	30	Females	5	15	Bugarika
5	20	Females	5	22	Buhongwa
6	37	Females	5	33	Mbugani

Thematic content analysis of the interview data revealed (how many) themes and (how many sub-themes) as presented in the table below.

Table 5: Main themes and findings

Main Theme	Subtheme	Finding
Knowledge on Iodine function, sources	Iodine Function	1. Participants have heard about iodine 2. Vague responses on iodine functions
	Sources of Iodine	fill
Iodine Deficiency	Iodine Deficiency	fill
Notions on iodized salt and crude salt in the community	Harmful Chemicals during fortification	fill
	Salt Superiority and Preference	fill

Theme 1: Knowledge of Iodine

Subtheme 1:1 Iodine function

Almost all the participants in the focus group discussions had heard of iodine. They heard about iodine from different sources. However, they did not have enough knowledge about its functions, sources, and deficiency consequences. One FDG 1 adult male participant provided his testimony as follows: *"I have heard about it, but I hardly know what it is, or what its functions are".*

A lot of vague responses were given concerning the functions of iodine in the body. One FDG 4 adult female participant mentioned, *"iodine is important to increase body temperature"*. Another thought of the important function of iodine mentioned was to prevent diseases. One male FDG participant said, *"Iodine helps to prevent common diseases like regular fevers and increasing body temperature on cold days".* Hence, though participants had the idea of iodine, their knowledge of it was still vague.

The commonest source of information on iodine was the mass media (radio and television). One of the male participants from Mukuyuni said, *"I have heard of Madini joto (a Swahili word for iodine) from various sources, especially television, where King Majuto (one actor in Tanzania) emphasizes the importance of using iodized salt for proper growth of children's brains, but I don't have enough knowledge about it. I hope you will clarify it more."*

Other participants heard from friends and others, especially female participants from health care workers. As witnessed by a 25-year-old female in FGD 5 who said: *" When we go for antenatal clinic visits and immunizations for our children in various health centres, nurses usually tell us that it's important to use iodized salt for it helps in the physical and mental development of our children".*

Subtheme 1.2 Sources of iodine

Another area of interest was the knowledge of the participants on the sources of iodine.

Most of the participants in the FGD had heard of iodine sources. Sources like table salt, sardines, and fish were mentioned by most of the participants. Others mentioned surprising sources for iodine, for example, one male participant in FDG 3 said: "Chili pepper is a good source of iodine because during cold days when I chew chili pepper, I usually sweat; therefore, it could be a good source of iodine." This is because iodine is called "Madini Joto"; actually, this participant made a direct English-Swahili translation of "iodine". Therefore, many participants knew that anything that increases the body temperature is a source of iodine.

Also, a male participant in FGD 1 mentioned sugarcane as a good source of iodine as he explained: "When I use sugar cane after a long starvation period, energy gain is usually drastic; it must be superior to other sources of iodine". He concluded that when hungry, energy gain is drastic.

Theme 2: Effects of iodine deficiency

Some participants were able to discuss the effects of low iodine contents in FDGs. However,

most of the correct responses came as a guess or after brain jogging the participants on some common diseases due to iodine deficiency. One middle-aged male participant in FGD3 mentioned goiter as the disease due to iodine deficiency, another one in FGD 2 had an idea of goiter but couldn't mention it, he demonstrated it as "neck enlargement", and another 30 years old female participant in FGD 4 from Buhongwa mentioned cerebral palsy and bone weakness and most of the participants in FGDs 1, 2, 4 and 6 mentioned generalized body weakness and bone weakness. Other participants gave ambiguous answers like skin exfoliation, poor vision, and failure of blood vessels to work efficiently. Three of the participants from FGD 2,3 and 6 could not mention anything about the functions of iodine as they claimed to have not heard of it at all.

Theme 3: Notions on iodized salt and crude salt in the community

Subtheme 3.1 Harmful Chemicals during Fortification

The participants were allowed to say what they thought about iodized salt and crude salt, as well as whatever they had heard from society about the two types of salt. About half, 17/30 (56.7%), of the participants said the crude salt was better than the packed salt because they thought that during the process of iodizing it, many harmful chemicals are added to it. This is as evidenced by the words of a 37-year-old male in FGD 1 who insisted, *"The government must watch the process of iodization closely because in recent years diseases have become a major problem, unlike in the past years where people lived to old age >90 years healthy. These chemicals are sources of diseases and cancers we see today. I therefore kindly ask the manufacturers to decrease the amounts of chemicals they add in iodized salt"*. Moreover One 20 years old male in FGD1 said, *"packed salt causes red lips a sign that harmful chemicals are added to it"*. This statement was mentioned by almost all the participants in all FGDs except two participants in FGD 3 and two females in FGD 6 who preferred packed salt over crude salt. As one said, "*I prefer packed salt as it is easy to dissolve in water during cooking. Also, from the knowledge I got from the nurse, I would rather use packed salt, which is iodized".* Sub-theme 3.2 Salt Superiority and Preference

During the interviews, a comparison of which crude non processed salt versus fortified salt emerged. The comparison was based on taste and personal preference among participants. A participant in FGD 5 added that *"crude salt is superior as, in addition to relishing food, it has medicinal functions such as treatment of bone pain, skin cleansing, and other traditional purposes; it is, therefore, better than the packed salt"*.

One old male participant in the focused group discussion 2 said the crude salt worked better than the packed salt, especially with brain development. As he claimed, *"People in the past were intelligent compared to the young children we see now. Also, the rates of mental retardation are high these days compared to the past"*.

Also, most of the participants in FGDs 1,3,5, 6 said crude salt is used especially by the people in the village because they love its taste, and its concentration is higher than that of packed salt; therefore, a little amount of it is needed to season the food. Another reason for use was that it's cheaper compared to the packed salt.

A few participants in FDG 3, 5, and 6 knew the importance of iodine added to the salt and gave testimonies that there is a reduction in the number of goiter patients as compared to the past years when many people could be seen with swollen neck masses. "*I don't see these people nowadays,"* said a male participant in FGD 3.

Others said they observed no difference between the two salt types. *"They are all extracted from the ground; one type is processed and packed, and the other is brought for use in its natural form, but the ground is the same",* said one male participant in FGD2 as he insisted on the sameness of the two types of salt.

In general, none of the participants in the FGD had complete knowledge of the importance of iodine in the human body and all other related themes. These people are just a portion representing the whole society; this means that the society should be encouraged to understand the importance of the basic elements in the body, like iodine. Also, ways of assuring them should be sought out to make sure that they understand the importance of the health interventions introduced by the Ministry of Health. This will help society to accept and use the fortified products, for instance, salt, to obtain the intended nutrients.

Discussion

The study findings showed that all packed salts from various salt brands contained adequate amounts of iodine. This shows that since the activation of compulsory salt iodization in the 1990s by the Tanzania Food and Nutrition Centre (TFNC), most of the salt producers have managed to abide by the set guidelines (25). These study findings are almost similar to the study in the year 2009 by Vincent et al which was carried out in all 21 regions of Tanzania by then, with one district representing the region that showed 83.6% of salt samples tested to contain iodine (2). However, it is quite different from the findings of the Tanzania Nation Survey of 2009 in the southern highlands, showing that <50% of the assessed salt contained iodine. This is because the salt used in the southern highlands by then was mostly crude salt, and the iodization machines were found to be poorly calibrated in areas with low iodine contents in the salt (7). This means that in some areas of the country, iodine coverage is higher than in other areas. This difference necessitates the need for continuous surveys in all parts of the country to make sure that the coverage is high in all areas. Also in the same study, the TGP (Total Goitre Prevalence) has shown a decrease from 61% in the 1980s to 12.3% in 2004 (2). This shows how Tanzania has achieved milestones in the process of eliminating IDD.

A good number of people have heard about iodine from different sources, with the radio ranking high. Like in many other health interventions, the radio remains the common

source of health information. Tailored programs should be made to build on the success that Tanzania has on table salt iodization. Therefore, more advertisements should be added to various radio stations in addition to the already available methods to keep emphasizing the importance and functions of iodine. However, these findings are different from the study conducted in New Delhi in India, which showed that most of the participants heard about iodine from television (31.1%) (26). This difference could be explained by the difference in television ownership between the households of Tanzania and India. While 66% of Indian households owned a television in 2018, only 24% of Tanzanian households owned a television in the same year (27, 28). Therefore, it is expected that the Indians obtain more information from television because most of them own a television. Moreover, the study in Northwest Ethiopia published in 2019 showed that participants who had heard of iodine approximately 17% got the information from mass media (29). This shows that mass media is the principal source of information about iodine in many regions of the World. Most of the participants had never heard of the universal salt iodization (USI) program. Therefore, we're not aware of various methods of iodine supply. The finding is almost similar to the findings in the study conducted among Croatian women of reproductive age, where none of them knew about compulsory salt iodization as a method of iodine supply (30). There is a need to educate the public about the importance of various health interventions, as this shows that many interventions might be ongoing, but the public is not well informed about them.

Furthermore, only 1.4% of participants checked their salt to know whether it was iodized before using it. This shows a lack of understanding of the importance of using iodized salt, and it shows that they only use salt for relishing their food and not to get the nutrients contained in it. The practice of checking salt for iodization before use seems to be a problem among people not only in Tanzania but also in other regions of Africa. For instance, the findings from a study conducted in Mecha District, Northwest of Ethiopia, in 2019 showed that only 30% of the participants were sure about the iodization status of their table salt (29). This is quite a good number compared to this study, but also almost similar to the findings of Sebotsa et al that found that about 36.1% of the participants checked on the label to see whether their salt was iodized or not (31).

Despite the fact that more than half, 265(63.5%), of the participants had heard of iodine, about 213 (51.1%) had some knowledge of its functions, though the knowledge was not very correct, as most of them could only mention one function. The government should therefore advocate a constant survey not only on salt testing but also on the knowledge. Through advocating knowledge concerning iodine functions, it will sensitize the participants more on iodine use. The findings are comparable to the findings of Valentina Vidranski et al published in February 2020, which showed that only about 47.1% of the study participants were knowledgeable about the functions of iodine in the body, and they were

aware of the diseases that resulted from inadequate iodine intake but not aware of the effects of excessive iodine intake (30).

This study went further to assess the society's opinion on iodized salt or packed salt as compared to crude salt through a focus group discussion, where most of the participants were found to have negative opinions about iodized or processed salt. The participants associated iodized salt as a cause of various disorders, especially cancers, as they said it was mixed with dangerous chemicals. Also, participants reported that crude salt is good because its concentration is higher than that of processed salt. Therefore, only a small amount of it is needed to make meals taste, which makes it cheaper and better than processed salt. These thoughts are like those published in the article Medical News Today in October 2019, where it is written that many people believe that sea salt (crude salt) is healthier than table salt. Also, the same article has reported that its concentration is higher than that of table salt (32).

Different programs should be started to address the importance of using iodized salt and the effects of using crude salt containing no iodine especially in iodine-deficient areas that are difficult to identify. Also, the programs should focus on eliminating negative notions that are present in society about iodized salt. This will help with the continuous use of iodized salt for the benefit of people's health because if this notion is withheld, people may even reject using packed salt for fear of its negative consequences, which are not true.

Notwithstanding the value of the study, the following limitation is worth highlighting. Studies warn that rapid tests, such as the tool used for this study, are usually erroneous in assessing whether salt is adequately iodized (33). However, care was taken while testing the sample to ensure all salt was finely ground and thoroughly mixed. We believe this finding can start discussions and calls for studies to use recommended titration methods or urine iodine concentration.

Conclusion

As evidenced in this study, all samples of packed salt contained adequate amounts of iodine; however, crude salt use continues to prevail. Low knowledge of the functions and consequences of a lack of iodine persists in the community. Therefore, continued assurance of quality iodized salt while raising community awareness on its importance is essential.

Abbreviations

FGD: Focused Group Discussion
IDD: Iodine Deficiency Disorders
MCG: Microgram
mg/L: Milligram per liter
Ppm: Parts per million
TGP: Total Goiter Prevalence
UI: Urinary Iodine
UIC: Urinary Iodine Concentration
UNICEF: United Nations Children's Fund
USI: Universal Salt Iodation
WHA: World Health Assembly
WHO: World Health Organization

Declarations

Ethical approval and consent to participate

Ethical clearance for conducting this study was obtained from the Catholic University of Health and Allied Sciences research ethics and review committee with registration no CRECU/1530/2020. Permission was requested from the District Medical Officer of Nyamagana District and the street chairpersons of the participants' streets and wards. All data collections observed relevant guidelines and regulations, and informed consent to participate in the study was obtained. Participants were informed that they would not be identified by name, but rather that information would be stored carefully. The purpose of the study was explained clearly to the participants, and they consented to participate, or not participate, and/or withdraw from the study. The participants signed a written informed consent form before the start of the interview and salt sample collection. The participants were assured that their information would not be used against them and that it would not be shared with people who are not members of the research team.

Consent for Publication

Not applicable. No names or identifiers of participants are used in any section.

Availability of data and materials

Data from this study are available within the manuscript provided in tables, quotations, and observation reports. However, the data set (recordings, transcriptions, and notes) used and analysed during the current study are available from the corresponding author on reasonable request and with permission from the Catholic University of Health and Allied Sciences and the Bugando Teaching and Consultant Hospital joint ethical committee.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

DW and NB designed the study. DW collected data. DW, JPN, and EK analysed the data. All authors drafted the manuscript and critically reviewed and provided final approval for publication.

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