Iodine in Table Salt in the Aseer Region, Southwestern Saudi Arabia

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Abstract

Background: Iodine, a micronutrient that plays a significant role in thyroid hormone synthesis, is essential for normal neurological development. Universal Salt Iodization is a plan advocated by the WHO to ensure sufficient iodine intake by all individuals. No accurate data was available about household coverage with iodized salt and salt iodization adequacy in the Aseer region, southwestern Saudi Arabia.

Objectives: To estimate the proportion of households consuming iodized salt in the Aseer region, southwestern Saudi Arabia, and assess salt iodization's adequacy.

Methods: The study was a cross-sectional study on a stratified proportional allocation sample. The household of each child was requested to bring a teaspoonful of table salt consumed in their kitchen. The salt samples were taken in standard, small, self-sealed plastic bags. The Iodine concentration of salt was determined spectrophotometrically.

Results: The study included 3038 samples of table salt. Insufficient iodized table salt samples (less than 15 ppm based on the WHO/UNICEF ICCIDD classification) were observed in 22.3% (95% CI: 20.8% – 23.8%) of the samples. Similarly, insufficient iodized table salt samples (less than 70 ppm based on Saudi Standards, Metrology and Quality Organization "SASO" classification) were observed in 75.7% (95% CI: 74.1% – 77.2%) of the study samples. The present study showed that rural areas significantly had higher insufficient table salt samples than urban areas.

Conclusions: The study showed that the use of insufficient iodized salt in the region is still common. The accessibility of iodized salt can be achieved through iodized salt's marketing and sales. Authorities in the Aseer region should play an influential role in forbidding non-iodized salt in the local markets in the Aseer region.

Key words: Iodine; Table salt; Saudi Arabia

Introduction

Iodine (atomic weight 126.9 g/atom), a micronutrient that plays a significant role in thyroid hormone synthesis, is essential for normal neurological development [1]. Iodine is critical for healthy brain growth in the fetus and young baby. Iodine deficiency harmfully influences the well-being of females, as well as economic productivity and quality of life. It is the most widespread cause of preventable mental impairment throughout the world [2]. Despite the scarcity of necessary public figures on iodine deficiency in Saudi Arabia, the two nationwide surveys, carried out nearly two decades apart, have shown that the Saudi population has adequate iodine nutrition at the public level; however, both surveys and other regional reports showed a grade of mild to moderate iodine deficiency especially in the southern regions based in goiter prevalence [3-5].

Universal Salt Iodization (USI) is a plan advocated by the WHO and UNICEF Joint Committee on Health Policy since 1994 to ensure sufficient iodine intake by all individuals. It indicates that all food-grade salt used in home and food handling should be strengthened with iodine as a harmless and effective strategy for preventing and controlling iodine deficiency disorders in populations living in stable and emergency settings[6]. This policy has been implemented in more than 120 countries worldwide; many have virtually eradicated iodine deficiency disorders or created substantial progress in their control. Saudi Arabia adopted this strategy to recommend the first national survey about iodine deficiency disorders among the Saudi population in 1994–1995 [3]. Salt iodization starts first at the level 70–100 ppm [7], then is subsequently adjusted to a level of 15–40 ppm responding to WHO recommendation [7].

No data was available about household coverage with iodized salt and salt iodization adequacy in the Aseer region, southwestern Saudi Arabia. The current study aimed to estimate the proportion of households consuming iodized salt in the Aseer region, southwestern Saudi Arabia, and assess salt iodization's adequacy.

Subjects and Methods

Design
The study was a cross-sectional study on a representative sample of schoolchildren in the Aseer region, southwestern Saudi Arabia.

Target population
Children of the age category 8–10 years living in the Aseer region were the target group for IDD screening because of their high vulnerability [8]. WHO recommends adding a community-based sample if the proportion of children attending schools is less than 50 % [9]. In Saudi Arabia, school registration is exceeding 90%. Consequently, there was no necessity to obtain samples from external school surroundings.

Sampling and field activities
Using the WHO manual Sample Size Determination in Health Studies [10], at a 95 % confidence interval with a conservative estimate of the expected population proportion of 45 % [3], and with an absolute precision of 2 %, the smallest sample size required for the study was calculated to be 2,377 children. To counteract for a probable loss of cases, a sum sample of 3,000 children was intended to be involved. A stratified proportional allocation sample of schools was chosen. Private letters were sent to their parents, explaining the study's purpose and asking for their written consent. Children lacking parental consent were omitted. The letters also asked parents to bring a sample of table salt used in their home with their children. Likewise, the letter included a simple questionnaire to be filled in by parents regarding their children's sociodemographic conditions. Two days later, the school was reexamined for field activities.

Iodine content in table salt
The household of each child was requested to bring a teaspoonful of table salt consumed in their kitchen. The salt samples were taken in standard, small, self-sealed plastic bags. The technique mentioned by WHO [11] for salt was followed.

Determination of Iodine concentration
Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is commonly used to analyze Iodine content in drinking water, clinical laboratories, and pharmaceutical sectors. In our study, the Iodine concentration was determined spectrophotometrically using Sandel-Kolthoff reaction as it has shown similar results compared to the ICP-MS method. However, ICP-MS was more sensitive [12, 13]. This assay is performed in two steps: an initial digestion step followed by a Sandell – Kolthoff reaction [14]. The digestion step involves the removal of substances that may hinder the activity of Iodine. It is achieved by treating the sample with a strong acid or a base at a high temperature. The digesting agent used in this assay was ammonium persulfate, a non-explosive, and less hazardous chemical than traditional chloric acid [15]. The Sandell-Kolthoff reaction involved reducing the yellow-colored ceric ions by arsenic ions in iodide to form a colorless ion and elemental iodine. This is time-bound to decrease in yellow color intensity measured using a spectrophotometer (Novaspec II, Biochrom Ltd. UK) at 420 nm and is plotted against a standard curve to determine iodine concentration.

Preparation of standard Iodine
The standard stock solution of iodine with a concentration of 100 μgm/mL was prepared by dissolving 0.168 gm Potassium Iodate (KIO3) in distilled water and made up to 1 L. The working standard was prepared by diluting 0.5 mL of standard stock iodine to 100 mL of distilled water in a volumetric flask. The concentration of this operating standard was 0.5 μgm/mL

Determination of Iodine content in table salt

The iodine content in the table salt was determined using the WHO recommended titration method with sodium thiosulphate and starch as an external indicator [16, 17]. A spoonful of table salt was provided from each child's family in a small self-sealed plastic bag. The titration assay involved free iodine from the salt by treating it with sulphuric acid—the free iodine released is then consumed by sodium thiosulphate while titrating. The loss of blue color is considered as the end-point. The volume of sodium thiosulphate used is then used to calculate the concentration of iodine in the salt.

Quality control of iodine measurements

A precision study was done using two samples with different iodide levels analyzed twenty times in duplicate in a single batch (intra-assay) in additional days (inter-assay). The CV measures (which ranged from 5 % to 7 %) were well inside the acceptable limits, denoting reasonable intra- and inter-assay precision. A recovery study was carried out to measure accuracy. The recovery was 97 %, ranging from 92•3 % to 102•8 %. Similarly, precision and accuracy studies were done for salt, and similar results were obtained.

Results

The present study included 3,038 samples of table salt. The present study included 2,646 samples (86.9%) from high altitude areas, and the rest (400) were from low altitude areas. Similarly, the study included 466 samples (15.3%) from rural areas, and the rest (2,576) were from urban areas.

Overall, table salt samples' iodine content ranged from 0 to 112 ppm, with an average of 47•8 ± 27•9 ppm and a median of 55.1 ppm.

Table 1 shows the distribution of table salt samples based on the WHO/UNICEF ICCIDD classification. Insufficient iodized table salt samples (less than 15 ppm) were observed in 22.3% of the study samples (95% CI: 20.8% – 23.8%). Similarly, Table 2 shows the distribution of table salt samples based on Saudi Standards, Metrology and Quality Organization "SASO" classification. Insufficient iodized table salt samples (less than 70 ppm) were observed in 75.7% of the study samples (95% CI: 74.1% – 77.2%).

Table 3 shows the factors associated with insufficient salt iodization in the region (in a binary logistic multivariable regression). The table shows that rural areas significantly had higher insufficient table salt samples by ICCD classification (aOR=4.834, 95% CI: 2.555 – 9.147) or SASO classification (aOR=2.531, 95% CI: 1.231 – 5.319). On the other hand, altitude has no significant role.

Discussion

The present study showed that insufficient iodized table salt samples (less than 15 ppm based on the WHO/UNICEF ICCIDD classification) were observed in 22.3% (95% CI: 20.8% – 23.8%) of the study samples. Similarly, insufficient iodized table salt samples (less than 70 ppm based on Saudi Standards, Metrology and Quality Organization "SASO" classification) were observed in 75.7% (95% CI: 74.1% – 77.2%) of the study samples.

The present study showed that rural areas significantly had higher insufficient table salt samples by ICCD classification (aOR=4.834, 95% CI: 2.555 – 9.147) or SASO classification (aOR=2.531, 95% CI: 1.231 – 5.319). The rural-urban difference in the present study can be explained because people use rock salt as a source of table salt being very cheap compared to other types of table salts in the market.

Iodization of salt was proposed to combat iodine deficiency disorders. Salt was selected because it is widely available, and the cost of iodization is meager, besides being useful, simple, and does not cause adverse chemical reactions. A systematic review showed that in 2000–2006, 64% of households consume adequately iodized salt throughout the Eastern Mediterranean Region. In Egypt, Lebanon, Oman, and the Syrian Arab Republic, household consumption of adequately iodized salt is at least 50%. Nevertheless, challenges remain for about 1% of Sudan's population, 28% of Iraq, and 30% in Yemen [18]. Based on the Sudan Household Health Survey (SHHS) dataset, a sample of 24,507 families was examined, and 18,786 cooking salt samples were tested for iodine levels with rapid salt-testing kits. The percentage of families using adequately-iodized salt increased from less than 1% in 2000 to 14.4% in 2012 [19].

A study in Jazan studying 311 households showed that 89.4% used insufficient table salt samples (based on SASO classifications), and the figure was 10% for WHO/UNICEF ICCIDD classification. The study showed no urban-rural differences [20].

A Saudi national study, included 4,242 salt samples. Samples were screened for iodine content using a rapid test kit (RTK). The study showed that 68.7% (95% CI: 67.3–70.1%) were found to be iodized using the RTK, the rest 31.3%, were found to be not correctly iodized. The study showed significant regional differences [7].

A study examined twenty-five data sets from eighteen population surveys which assessed household iodized salt by both the RTK and a quantitative method (i.e., titration or WYD Checker) were obtained from Asian (nineteen data sets), African (five), and European (one) countries. It showed that using RTK in assessing salt iodization is a questionable practice. The study concluded that the RTK is not suited for the assessment of adequately iodized salt coverage.

Table 1. Assessment of salt iodization in Aseer region, Saudi Arabia (based on WHO/UNICEF/ICCIDD Classification)

The iodine content of salt (ppm)	Number	%	Interpretation
<15 ppm	677	22.3	Insufficient
14-40 ppm	193	6.4	Adequate
>40 ppm	2168	71.3	Excessive
Total	3038	100	

Total 3038 100

WHO (World Health Organization), UNICEF (United Nations Children's Fund), ICCIDDs (International Council for Control of Iodine Deficiency Disorders).

Table 2. Assessment of salt iodization in Aseer region, Saudi Arabia (Saudi Standards, Metrology, and Quality Organization "SASO" Classification)

The iodine content of salt (ppm)	Number	%	Interpretation
<70 ppm	2299	75.7	Insufficient
70-100 ppm	724	23.8	Adequate
>100 ppm	15	0.5	Excessive
Total	3038	100	

Table 3. Binary logistic multivariable analysis to show factors associated with insufficient salt iodization in Aseer region, Saudi Arabia.

Factor	WHO/UNICEF ICCIDD Classification	Saudi Standards, Metrology and Quality Organization "SASO" Classification
	aOR (95% CI)	aOR (95% CI)
High vs. low altitude	0.858 (0.464 - 1.586)	0.711 (0.324 – 1.559)
Rural vs. urban	4.834 (2.555 – 9.147)	2.531 (1,203 – 5.319)

WHO (World Health Organization), UNICEF (United Nations Children's Fund), ICCIDDs (International Council for Control of Iodine Deficiency Disorders).

Quantitative assessment, such as titration or WYD Checker, is necessary to estimate adequately iodized salt coverage [21].

Conclusion

The present study results showed that the use of insufficient iodized salt in the region is still common. To tackle this problem, recommendations should stress promoting advocacy and communication and guaranteeing adequately iodized salt. Advocacy and communication play a vital part in eradicating iodine deficiency by urging and educating people at all levels about the value of iodine and iodized salt. Fruitful communication efforts need to reach out to particular audiences, including community heads, the media, schoolteachers, the general public, and schoolchildren's fathers. Universal access to iodized salt is compulsory for IDD eradication. The accessibility of iodized salt can be achieved through iodized salt's marketing and sales. Authorities in the Aseer region should play an influential role in forbidding non-iodized salt in the local markets in the Aseer region.

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