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Comparative Study of Urban and Rural Salts for Iodine Content

Mohammad Rezaul Karim[1*]

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ABSTRACT

Iodine deficiency remains a significant global public health risk, especially in communities that depend on iodized salt as their principal dietary source of iodine. The study was designed to compare the iodine content of salt in urban and rural markets, factors governing the level of iodization, systems for monitoring, and ensuring quality control. Eighty salt samples (40 urban, 40 rural) were collected and analyzed by iodometric titration. The overall mean iodine content was significantly higher in urban salts (28.7 ± 5.1 ppm) than in rural salts (20.3 ± 6.5 ppm), and only 80% of the samples from the city area met established standard, while only half of the mineral and rock salts had enough iodine to be considered good quality of adequate iodine quality of ≥20 mg/kg based on this standard for salt used at household level respectively. Category of packaging, storage conditions and the ready-to-use status of packaging material were identified as important factors affecting iodine retention. Iodine was maintained at higher levels in salts packed inside the sealed or laminated package and stored by the retailer who sells them. Regulatory compliance and presence of iodized brands were stronger in urban than rural markets. These results emphasize the importance of correct packaging, better methods for storage, vendor education and a stronger monitoring system for proper iodization.

INTRODUCTION

One trace component is iodine, which is actively essential for the synthesis of thyroid hormones that are involved in growth, metabolism and neurological growth in humans (Köhrle, 2023; Sorrenti *et al.,* 2021). Although required in relatively small amounts, iodine deficiency has a higher human and social cost, causing goiter, hypothyroidism, mental retardation, as well as stunting growth and brain development (Yang *et al.,* 2024; Zimmermann, 2009). Iodine deficiency disorder (IDD) is one of the most avoidable causes of brain damage worldwide, with millions of people affected, primarily in developing nations (Doggui & El Atia, 2015). Therefore, providing adequate iodine intake through the USI program is acknowledged as the most sustainable and effective means of preventing IDD at a population level (Machamba *et al.,* 2021; Zou *et al.,* 2014).

Salt is an almost universally consumed substance, so iodizing it ensures that people get enough of this important nutrient at a very low cost (Dold *et al.,* 2018; Ullah *et al.,* 2022). The implementation of iodized salt programs in the mid-20th century has led to a dramatic decrease in iodine deficiency worldwide (Hatch-McChesney & Lieberman, 2022). However, even with these successful programs, imbalances in iodine intake remain between urban and rural areas as a result of the discrepancies of awareness, accessibilities, affordability, storage conditions and regulation monitoring (Chyngyshpaeva *et al.,* 2024). Rural areas tend to suffer from availability of nonionized or inadequately iodized salt, poor packaging and a lack of knowledge around the health benefits of iodine (Habib *et al.,* 2021; Sohel *et al.,* 2022).

Deficiency of iodine is still a public health problem in Bangladesh and other countries of the South Asian region, despite decades-long national salt iodization programmes (Khan *et al.,* 2019). Urban consumers are generally better placed to access suitably iodized salt products, not least those marketed in packaged and branded formats, which tend to be more rigorously quality controlled (Katonge, 2024). By contrast, the rural populations often have access to locally produced or unbranded open salt available in the market with suboptimal iodine content due to suboptimal iodization process, inadequate storage and exposure to moisture and sunlight (Sen *et al.,* 2010). These causes result in slow depletion of iodine and salt becomes ineffective, i.e., loses the ability to prevent IDD (Deresa *et al.,* 2023; Halimuzzaman *et al.,* 2024). In addition, differences in socio-economic status, consumer patterns and implementation of food fortification resolutions exacerbate the gap of iodine nutrition status between urban and rural populations (Lacko *et al.,* 2020; Yan *et al.,* 2021).

The level of iodine in salt may also deteriorate during transport and warehousing conditions, for example if salts are kept in a humid or open condition at which it is stored (Ekott & Etukudo, 2019; Fallah *et al.,* 2020). It has been demonstrated that iodine content in salt can drastically reduce within months if not properly packaged or protected from the environment (Maramag *et al.,* 2007). Thus, measurement of iodine in consumer salt, especially covering diverse geographic and social ecotypes will allow for evaluation of how well national iodization programs are working and which areas may need targeted interventions. A comparison of urban and

[1] Upazilla Health Complex, Hathazari, Chattogram, Bangladesh
[*] Corresponding author's e-mail: rezaulnishan437@gmil.com

rural salts is an important source of information on the equity and sustainability of iodine fortification programs. This assessment will check if iodized salt is available to all segments of the population in the right quality and concentration as well as the level of compliance with national standards. Furthermore, policymakers can further strengthen ongoing iodization efforts and implement specific public health campaigns by identifying where in the supply chain, storage on household level or knowledge about this deficiency gaps exist.

LITERATURE REVIEW

From the global perspective, iodine insufficiency is acknowledged to rank as a critical public health problem worldwide, particularly in developing nations, and low as well as middle-income countries (Lin *et al.,* 2025). It has been assessed by the World Health Organization (WHO) and UNICEF that iodine deficiency disorders (IDD) can result in a range of health problems, such as goiter, mental retardation, cretinism as well spontaneous abortion, stillbirth and infant mortality (Aburto *et al.,* 2014; Biban & Lichiardopol, 2017; WHO, 2014). Universal Salt Iodization (USI) was adopted to overcome these complications as it is the most cost-effective, feasible, and sustainable intervention (Kissock *et al.,* 2024). The approach consists of incorporating a controlled amount of iodine into salt for human and animal consumption, thus ensuring an adequate dietary intake of iodine in the population regardless of their dietary habits or socioeconomic status (Iacone *et al.,* 2021).

The benefits of iodization programs have been proven in numerous nations. As an example, Andersson *et al.* (2010) explained that iodine deficiency has been essentially eradicated in countries with well-regulated iodized salt programs such as Switzerland and the United States. Studies in the same countries on other geographically isolated groups (Brazilian Amazon and Guatemala) of iodine-deficiency areas: they showed an enhancement in iodine status, several years after establishment of nationwide salt-iodization programs (Cesar *et al.,* 2020; Hatch-McChesney & Lieberman, 2022). Nevertheless, notwithstanding global success, significant inequalities regarding iodine nutrition persist between urban and rural population.

It is well documented that there is a substantial variance between the iodine content and intake in urban and rural areas (Mohan *et al.,* 2025). Zimmermann *et al.* (2008) showed that rural areas generally have delayed access to sufficiently iodized salt compared with urban communities. This discrepancy is attributed to inadequate surveillance systems, low knowledge and purchasing power and the prevalent sale of unpackaged or coarse salt in rural markets. Roy *et al.* (2016) found that 81% of urban households consumed adequately iodized salt as against only 62% in rural areas India. Comparable findings were also reported from Pakistan (Khattak *et al.,* 2017) and Nepal (Lamichhane *et al.,* 2022) which show a lower quality of iodized salt available in rural communities.

In Bangladesh, culmination of the USI Program commenced in 1989 and has resulted in a remarkable achievement towards improved iodine status of the population. However, later national studies showed an uneven distribution of the level of iodization in different areas. As per National Iodine Deficiency Disorders Survey (International Centre for Diarrheal Disease Research, Bangladesh, 2015), around 80% of the households in urban area had access to adequately iodized salt consumption while in rural areas only 60–65% of the household were consuming salt with recommended levels of iodine. The discrepancies are due to the use of open salt, its incorrect storage as well as a low level of awareness among consumers about the significance of iodine in diet (Lowe *et al.,* 2015). Moisture influence and sun light on the retention of salt iodine in coastal regions of Bangladesh has been found similarly that iodine leaching is faster in more humid environment (Habib *et al.,* 2023).

Stability of iodine's in salt is influenced by a number of different factors whether the iodine compound used is an iodate or an iodide, salt moisture content, packaging material and length of storage (Biber *et al.,* 2002). Iodate (KIO_3) is more stable than iodide (KI), especially at high temperature and relative humidity (Oshinowo *et al.,* 2004). Uncovered or loosely covered salt rapidly loses the iodine and that due to both its interaction with the air and hygroscopic nature. In a study by Abdurrahim *et al.* (2023) reported that iodine concentration in salts remained high hours after storage when stored in polyethylene or laminated packages compared with salt stored openly. Another Kenyan study (Kenji *et al.,* 2004) found that iodine concentrations in salt stored in open markets for more than three months fell by 30–50%.

The consumer's knowledge and consciousness are also important for the quality of iodized salt. In Ethiopia (Senbeta *et al.,* 2021), education and house-holds with a greater income predicted use of packaged iodized salt and storage in the appropriate manner. In comparison, rural consumers who were poorer and less educated often choose cheaper non-iodized salt or used salt in ways that caused iodine to be rapidly degraded (Gemede *et al.,* 2021). Those campaigns like public health campaign focusing on benefits of iodized salt, were found to have a significantly good impact in improving its practice and knowledge attitude; however, such initiatives are least reached in the most remote rural areas (Lowe *et al.,* 2015).

Analytically, 3 iodine estimation methods have been developed for salt: iodometric titration (IT), spectrophotometry (SP) and rapid test kits (RTKs) (Nepal, 2013). Iodometric titration is generally accepted as the gold standard laboratory procedure because of its accuracy; however, RTKs are frequently deployed in rapid surveys to identify iodine adequacy (Gorstein *et al.,* 2016). Applications of such methods have been reported to provide evidence that iodine content differs not only between brands but also between distribution outlets within a community suggesting variations in production and monitoring (Bashir *et al.,* 2024).

Research Gap

Although universal salt iodization (USI) has been effective in reducing the gaps between urban and rural areas, disparities remain particularly in developing countries such as Bangladesh. There are several general reports regarding the consumption of iodized salt and iodine deficiency disorders at national or regional levels, but limited studies have examined the differences in mean iodine content of household salt from urban and rural retail market. Most of the studies so far either focus on household consumption behavior or urinary iodine concentration without considering the quality, packaging and storage condition of salt available for sale at the consumer level. Further, the potential impact of moisture, exposure to sunlight and packaging material on iodine stability has been demonstrated only in a few publications and yet no holistic assessment combining these parameters with socioeconomic regions/urban–rural was performed. The bulk of data available in Bangladesh is old and at aggregate levels that do not illustrate the variability that now exists within the country between urban and rural areas as the market has changed. Thus, an exhaustive comparison of the levels of iodine in salts for both urban and rural areas is essential to detect any inadequate production, distribution and storage as well as the global impact of salt iodization initiatives on attainment of equitable iodine nutrition across all groups.

Research Questions

1. What are the iodine levels of salts available in urban and rural markets, compared to international recommended levels laid down by WHO as well as those established by national regulations?
2. How is the iodine in salt differ between urban and rural resident?
3. What are the impact of packaging and storage conditions on stability and retention of iodine in salt samples from two areas?
4. What are the primary factors contributing to bad or erratic iodization in rural markets as against urban markets?
5. What is the efficiency and effectiveness of current surveillance systems and quality control protocols to ensure consistency of iodine levels in factory salt?

Research Objectives

a. To assess iodine content of salts purchased from urban and rural markets in relation to WHO and national standards.

b. To compare the iodine status of salts in urban and rural areas to detect rural-urban disparities in salt iodization.

c. To determine the impact of packaging materials and storage conditions on iodine stability/retention in salt samples.

d. To determine the main reasons in rural markets for poor quality of iodization or lack of it.

e. To assess how well current monitoring and quality control mechanisms provide for uniform iodization of salt in different areas.

MATERIALS AND METHODS

Study Area

The research was designed to investigate and comparison of the content of iodine in salt sold in the local marketplace and metropolitan marketplaces. Specifically, samples of urban salt were collected from leading supermarkets and well-known branded retail shops and packaged salt sellers. On the other hand, rural samples were taken from local vendors; small grocery stores and open-air markets in the study areas. The choice of the study area was made based on population, socio-economic status, and proximity to areas with access to iodized salt to achieve an ideal sample based on both urban and rural settings.

Sample Collection

During the study period, an aggregate of 80 levels (40 urban and 40 rural) were sampled for salt. Variety of brands and packing forms (sealed, open salt loose and locally packed) were selected to cover different levels of variation in iodine concentration. About 250 g weight of each sample was collected in airtight polyethylene bags to avoid the loss of iodine. All the samples were adequately labeled with place, brand name, packaging type, and date of collection before being brought to the laboratory in cold storage for controlled environmental condition analysis.

Sample Preparation

All collected salts were initially visually assessed on color, particle size and moisture content. All the samples were mixed well to make them homogeneous prior to analysis. The samples were placed in moisture-free containers before the analyses to reduce iodine volatilization.

Iodine Content Determination

Content of iodine in the salt samples was estimated by iodometric titration method which has long been established as a reliable and standard procedure for quantitative determination of iodine. In the following procedure, 10 g of a known weight of NaCl was dissolved in distilled water and acidified with 10% H_2SO_4. Additional potassium iodide (KI) was included to free the iodine from the iodate in the salt. The released iodine was then titrated against standardized sodium thiosulphate ($Na_2S_2O_3$) solution with starch as an indicator. The end-point was recognized as the colorless solution. Iodine content was computed as ppm using the following equation (Kleks & Davidson, 1966):

Iodine (ppm) = (Titration volume in mL × 21.15 × Normality of sodium thiosulfate × 1000)/(Salt sample weight in g)

Quality Control and Replication

All reagents and glassware were well washed and standardized before use. Triplicate determinations were made on each sample to confirm the accuracy and reproducibility of the data. Background interferences were removed by conducting blank titrations. Calibration

standards were prepared to verify the accuracy of the titration.

Assessment of Packaging and Storage Conditions

The packaging (polyethylene, laminated, paper and open) of each salt sample and the storage conditions (exposed to sunlight and humidity, and time in store) were observed directly and informally discussed with vendors. These qualitative factors were related to iodine content to determine their effect on the stability and loss of iodine during commercial storage and handling.

Data Analysis

All the quantified iodine concentrations were statistically treated to estimate mean, standard deviation and variation coefficient values. Statistical comparison between urban and rural samples was performed using Student's t-test at 5% level of significance ($p < 0.05$). Results were visualized as a table and graph in Microsoft Excel and the R software to show differences.

RESULTS AND DISCUSSION

The average iodine level in urban salt samples was 28.7 ± 5.1 ppm (from 18–34 ppm), and rural salts had a lower average value of 20.3 ± 6.5 ppm (from 12–30 ppm) (Table 1). Also, 80% of the urban salt samples were adequately iodized compared to just 50% in the rural samples.

Table 1: Comparison of Mean Iodine Content Between Urban and Rural Areas.

Region	Mean± SD (ppm)	Minimum	Maximum	% Meeting Standard
Urban	28.7±5.1	**18**	**34**	80
Rural	20.3±6.5	12	30	50

As shown in Figure 1, the mean iodine content of urban salts (28.7 ppm) was significantly higher than that in rural salts (20.3 ppm). The value $p<0.001$ answer this difference is significantly different.

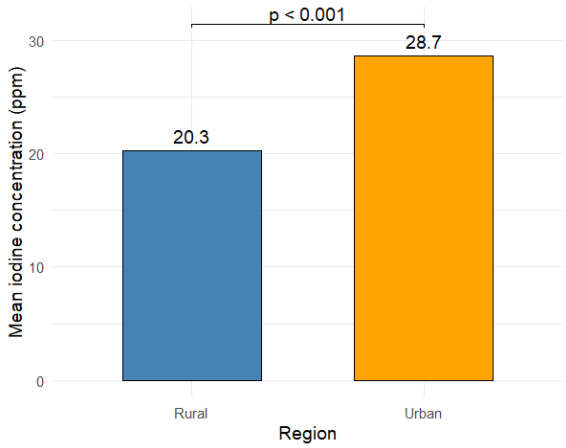

Figure 1: Statistical Comparison Between Urban and Rural Iodine Levels.

Iodine content was found to be the highest for salts sold in sealed packets, with a mean iodine concentration of 30.4 ± 3.1 ppm and 94.1% samples meeting the recommended standard (Table 2). Iodine remained relatively high (28.5 ± 3.8 ppm) also in laminated packets, for which there was 81.8% compliance. On the other hand, unsealed or open salts had the least iodine content (16.8 ± 5.4 ppm) and only 25% of such samples conformed to iodization requirement.

Table 2: Iodine Content of Salts by Packaging Type.

Packaging Type	Mean Iodine± SD (ppm)	Meets Standard (%)
Sealed packet	30.4±3.1	94.1
Laminated	28.5±3.8	81.8
Loose/Open	16.8±5.4	25.0

The iodine loss of salt stored on hidden store shelves was the most serious while that for covered store shelves was lowest (29.5 ppm) in which no iodine loss occurred, 93.3% of samples satisfied the standard (Table 3). However, salt kept at open-air market stalls resulted in a 28% loss of iodine down to the mean concentration of 18.7 ppm, with only 40% of samples meeting the standard. The worst was for salts kept in open baskets placed under

sunlight, for them the average iodine content originated at 15.6 ppm with a loss of 35%, only 20% compliance were obtained.

The comparison of the iodine content between branded and local made (unbranded) salt samples is presented in Table 4. The results are manifest with branded salts having a significantly higher mean iodine content (30.1 ppm) and 90% of samples adhering to recommended iodization level. On the other side, local or unbranded salts had significantly lower average iodine content (17.8 ppm), and only 35% of them met the standard.

Despite having the highest (average) iodine concentration and iodization standard compliance 83.3%, salts from vendors who, by being aware of the nutritional benefit of iodine selling salt had both significantly higher mean buying costs than those sold in retail shops (Table 5). Vendors who had low awareness were selling salts with the lowest mean iodine content (14.7 ppm), and only 16.7% of salt samples met the standard, whereas vendors with a moderate level of awareness sold salts that had lower mean iodine levels (20.5 ppm) and compliance of 50%.

The results indicate that the iodine value decreases with an increase in storage period (Table 6). Salts stored for <1 month maintained the highest mean iodine content (28.8 mg/kg), with no measurable loss of iodide. Salt kept for 1–3 months, however, exhibited a decline of 14.6% in the mean iodine content to a level of 24.6 ppm. The greatest decline was observed in samples stored for over three months, iodine concentration fell to 18.7 ppm, corresponding to a 35.1% loss.

Table 7 confirms, urban areas are far more iodization compliant than rural ones. Among the urban samples 32 of the 40 (80%) were adequate in iodine content and only 8 (20%) were inadequately iodate. In rural samples, however, only 20 (50%) met the standard and another 20 had an iodine level that did not reach recommended target.

Packaging type has the highest positive correlation with iodine (r = 0.78), which means that that sealed or

Table 3: Effect of Storage Conditions on Iodine Retention

Storage Condition	Mean Iodine (ppm)	% Loss	Meets Standard (%)
Store shelf (covered)	**29.5**	**0**	93.3
Market stall (open air)	18.7	28	40.0
Open basket/sunlight	15.6	35	20.0

Table 4: Iodine Concentration of Salts by Brand Type

Brand Type	Mean Iodine (ppm)	Meets Standard (%)
Branded	30.1	90
Local/Unbranded	17.8	35

Table 5: Vendor Awareness and Its Relationship with Iodine Content.

Awareness Level	Mean Iodine (ppm)	Meets Standard (%)
High (knows iodine importance)	29.0	83.3
Moderate	20.5	50.0
Low (unaware of iodization)	14.7	16.7

Table 6: Duration of Storage and Iodine Depletion.

Storage Duration	Mean Iodine (ppm)	% Iodine Loss
<1 month	28.8	0
1–3 months	24.6	14.6
>3 months	18.7	35.1

Table 7: Regional Compliance with Iodization Standards.

Region	Samples	Compliant	Non-Compliant	Compliance (%)
Urban	40	32	8	80
Rural	40	20	20	50

appropriately wrapped packaging for salt supports better iodine content than opened, or non-closed packaged salts contain more iodine in them (Table 8). There was also a moderate positive correlation with vendor awareness (r = 0.65). In comparison, storage at sunlight or high humidity presented moderate negative correlation (r = -0.52), while long-term storage for over 1 month also negatively influenced the iodine content (r =-0.48).

Table 9 presents a comparison of major monitoring and quality control indices between salt markets in urban and rural areas. The results suggest that the regulation is enforced quite tightly in urban areas, and there is a high degree of compliance to iodization among salt producers; as opposed, enforcement is likely lax in rural areas due to poor implementation, monitoring and follow up activities. The concentration of iodized variants is even higher in urban than rural markets, where there is only moderate availability and a greater prevalence of local, non-iodized brands. Furthermore, urban consumers are much more educated about the importance of iodine we have found than our rural counterparts, where education campaigns have not been run.

Table 8: Correlation between Factors Influencing Iodine Retention.

Factor	Correlation Coefficient (r)
Packaging type (sealed vs. open)	0.78
Vendor awareness	0.65
Storage in sunlight/humidity	-0.52
Storage duration (>1 month)	-0.48

Table 9: Evaluation of Monitoring and Quality Control Systems

Monitoring Parameter	Urban Area	Rural Area	Remarks
Regulatory enforcement	Strict	Weak	Limited follow-up in rural markets
Availability of iodized brands	High	Moderate	Many local non-iodized products
Consumer awareness	High	Low	Gaps in rural education campaigns

Discussion

The present study compared the iodine content of salt samples across urban and rural markets, and examined determining iodization factors, including examination of if and how monitoring and quality control systems are operating. The results indicate a remarkable difference in urban and rural salt iodization, suggesting targeted programs to achieve uniform levels of iodine throughout the country. Our findings showed that the mean iodine content of salt from urban areas was higher (28.7 ppm) than in rural areas (20.3 ppm), yielding 80% coverage in the urban versus up to 50% coverage in rural area. This difference is consistent with a national survey in Bangladesh that found 50% of households consume salt that it not sufficiently iodized and rural populations are particularly disadvantaged due to reduced access, lower awareness (Khan *et al.,* 2019). Furthermore, a report from northern Bangladesh also showed that iodine content of salt does not provide enough to keep maternal iodine status adequate during pregnancy in rural areas while universal salt iodization policies are implemented (Shamim *et al.,* 2012).

The sealed packet salt group was observed to have a higher iodine content (30.4 ppm) as on its compliance (94.1%) compared to laminated salt (28.5 ppm, 81.8%) and loose/ open salts (16.8 ppm, 25%). This is in agreement with the results obtained by Shawel *et al.* (2010) reported that packaging material is critical for iodine retention, and moisture absorption had the most significant effect on iodine loss. In addition, the iodine loss in salt wares exposed to sunlight and stored in the open baskets was found to be very high, clearly indicating that good storage is required for preventing a decrease of iodine levels (Habib *et al.,* 2023; Halimuzzaman *et al.,* 2024; Vithanage *et al.,* 2016).

Vendor awareness was a major determinant of iodine content and a high level of vendor awareness was associated with high levels of iodine and compliance. This result is in accordance with a study of Haq *et al.* (2025), which emphasized the need for consumer and vendor education to guarantee availability of sufficiently iodized salt. The study also found that most of the rural vendors did not have enough knowledge on iodation which resulted in non-compliance. Urban areas had higher and better compliance in this study, which was consistent with the finding of an association between strictness of regulatory enforcement and availability of brands of iodized salt that could be observed (Knowles *et al.,* 2017). By contrast, rural markets encountered problems like little or no regulatory control and a greater presence of non-iodized local products. The wide gap highlights the importance of efforts to reinforce monitoring and regulation in rural regions so that even levels of iodization will be affected.

Findings

a) Urban salts had an average iodine content (28.7 ppm) which was significantly greater than that for rural

product (20.3 ppm).

b) Eighty percent of the salt samples from urban areas were appropriately iodized, compared with 50% from rural areas.

c) The packed salts (sealed packet and laminated) contained more iodine (28.5–30.4 ppm) compared to loose/open salts (16.8 ppm).

d) Storage conditions were the main factor to influence iodine content: salts presented to sunlight, air or humidity lost 28–35% of iodide while covered storage was effective for preserving iodide.

e) Vendor awareness positively correlated with the quality of iodization.

f) Compliance of branded salts with iodization was significantly better (90%) than local/unbranded salts (35%).

g) Longer storage (>3 months) materially reduced iodine content, referring to reduction of iodine in the course of storage.

h) Weak regulatory enforcement, inadequate monitoring in the rural market and low consumer awareness resulted into inferior quality iodization.

i) Correlation analysis found that packaging ($r = 0.78$) and vendor knowledge ($r = 0.65$) were positively associated with iodine retention, while the exposure to sunlight/humidity ($r = -0.52$) and long storage period ($r = -0.48$) were negatively associated with it.

Recommendations

a) Encourage the use of packaged, sealed and laminated salt rather than loose/open salts to minimize iodine loss.

b) Establish salt handling programs for vendors in rural markets to raise awareness on the role of iodine and the correct handling of salt.

c) Improve regulation of monitoring and enforcement, especially in the rural salt sector, to guarantee that all salts are adequately iodized.

d) Promote awareness campaigns for consumers about the benefits of iodized salt, and the dangers of a lack of iodine.

e) Develop recommendations for storage and distribution to reduce iodine loss during transport and retail presentation.

f) Encourage random quality checks and testing of salts at retail outlets in urban as well as rural markets.

Limitations

a) The analysis was restricted to urban and rural markets included in the sample such that findings may not be generalizable.

b) Cross-sectional measurements of iodine were not adjusted for seasonal changes or long-term changes in iodine content.

c) Interviews with vendors were driven by self-reported awareness, possibly causing reporting bias.

d) The analysis did not consider any changes in iodine content during cooking or home storage that would have an impact on the estimations of dietary intake.

CONCLUSION

This study shows marked differences in iodine content of salt between urban and rural areas, the iodization level was higher and more uniform in urban than in rural area, probably on account of better packaging, storage, enforcement along with vendor awareness. On the other hand, low levels of iodine were consistently found in rural salts and that was mainly due to less than acceptable packaging (loose/open), sunlight/humidity exposure, long time for storage, poor vendor knowledge and weak monitoring. These results underscore that targeted interventions are required, such as campaigns to increase the use of adequately packaged salts, and vendor and consumer education, coupled with improved regulatory enforcement are necessary along with regular quality control checks for compliance under iodized standards. It would be interesting for future studies to follow up on this research by determining iodine content in food longitudinally throughout both the growing season and post-harvest, and examining how cooking practices, as well as home storage conditions, affect iodine retention. Furthermore, assessing impact of education and regulation on rural markets may inform policy aiming at an equitable and sustainable iodine nutrition in all regions.

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