The Use of Iodized Salt and Iodine Deficiency Disorders (IDD): The Saudi Arabian Experience

Ibrahim A Bani [1]

[1.] Department Department of Community Medicine, Faculty of Medicine, Jazan University, Jazan, Kingdom of Saudi Arabia
ibrahimbani1984@gmail.com

Abstract: Salt iodization is the universal strategy for elimination of IDD, the quality of iodization program is crucial for achieving this goal. Iodine deficiency (ID) is the world's leading cause of intellectual deficits and associated with increased prevalence of goiter. In the Kingdom of Saudi Arabia (KSA) there is an acute scarcity in IDD data across the country. In this concern, the influence of iodine deficiency disorders (IDD) was comprehensively investigated. The study targeted school children aged between 6 to 12 years to establish baseline information for salt iodization and iodine deficiency disorders in the area. Iodine nutritional status of the targeted population was assessed by measuring of urinary iodine concentration (UIC) which was used also to define, indicate, survey and monitor ID. The results reveal that almost 100% of the households in Jazan area use iodized salt, however only 46.9% use it adequately. Therefore, overall median for the measured UIC is very high (420 µg/l), which in turn indicates an occurrence of excessive iodine intake by the targeted population. This situation might lead to adverse health consequences including iodine-induced hyperthyroidism and autoimmune disease if the relatively high national standard for salt iodization of 70 – 100 ppm remains unrevised.

[Bani I. **The Use of Iodized Salt and Iodine Deficiency Disorders (IDD): The Saudi Arabian Experience**. *Life Sci J* 2014;11(10):286-291] (ISSN:1097-8135). http://www.lifesciencesite.com. 41

Keywords: Iodized Salt, Iodine deficiency; Environmental Epidemiology; Thyroid diseases.

1. Introduction

There are almost no countries in the world where iodine deficiency was not a public health problem. Because of its significant contribution in to the thyroid hormones generation, iodine is considered an essential element for human and animal development. The term iodine deficiency disorders (IDD), which is the world's single greatest cause of preventable mental retardation, refers to all the effects of iodine deficiency on growth and development in a human and animal population (UNICEF, 2008; UNICEF, ICCIDD, 2007). A total of 38 million newborns every year in developing countries, remain unprotected from the lifelong consequences of brain damage associated with iodine deficiency disorders (UNICEF, 2008). Elimination of ID contributes to six of the eight Millennium Development Goals agreed to by UN Member States in 2000 (Zimmermann et al., 2008; UNICEF 2005; Mannar and Dunn 1995). Universal Salt Iodization (USI) strategy to ensure sufficient intake of iodine by all individuals was recommended by the WHO and UNICEF Joint Committee on Health Policy in 1994 (Hurrell 1997). Worldwide, 34 countries have eliminated iodine deficiency disorders through Universal Salt Iodization (USI) (SCN 2007).

Throughout Middle East and North Africa region, 64% of households consume adequately iodized salt with wide variations between countries. Some States including Iran, Lebanon and Tunisia are considered to have achieved the goal of USI (UNICEF 2008). On contrast, domestic using-up of sufficient iodized salt is at least 50% in States like Algeria, Egypt, Jordan, Palestine, Oman and Syria. Whereas, in Sudan, Iraq and Yemen such process remains a challenge (Zimmermann et al., 2008; UNICEF 2008).

In the KSA there is an acute scarcity in IDD data across the country. Some researchers conducted a regional epidemiologic survey to study the iodine status of Saudi school children aged 8–10 years (Al-Nuaim et al 1997). Thus substantially IDD is a serious issue need to be tackled in the KSA taking into account its exceptional demographic situation where: (1) over six millions of people (mainly pilgrims) from all over the world visit the KSA on a regular basis and a few times a year (Malouf 2011; The Telegraph 2012) and; (2) KSA is one of the largest international workforce labor market (above 8.5 million foreign workers) in the world (ARAB NEWS, 2011). This study, therefore aimed at contributing in virtual elimination of IDD from the KSA, and establishing a long term strategy to reduce the IDD prevalence rate with much emphasis on the Jazan Region in the south-western corner of the KSA (Figure 1).

2. Material and Methods

2.1 Sampling procedure

Multistage random sampling technique was used during the period 15 May – 6 November 2010 (1 Jumada II – 1 Dhul-Qa'da 1431H) for selection of participants proportionate to population size (PPS) in three different topographical areas including Plain, coastal, and Mountain. The population is children aged 6–12 years in primary schools.

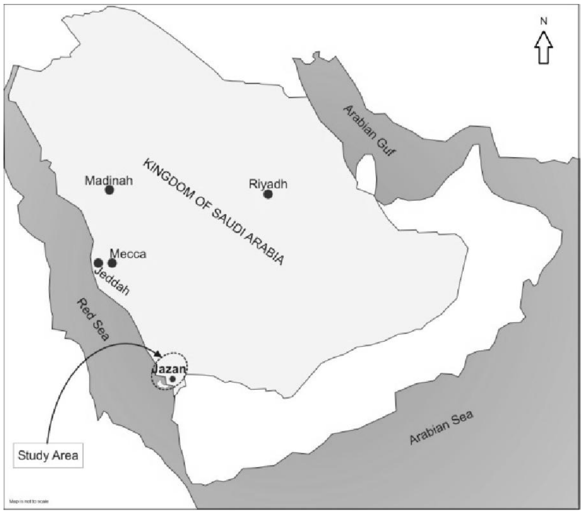

Figure 1. Study Area

The sample size according to the following equation:

$$Sample\ size = 3 \times \frac{Z^2 pq}{d^2}$$

Where Z = (1.96) at 95% confidence level, p = estimated prevalence (45% TGR), q= (1-p), and d = absolute precision (a precision of 10% (CI) was used in the study), 3: design effect. The total sample size was estimated at: 285.

General directorates for male and female education were also contacted to obtain their support and collaboration. The schools were classified according to their location to three groups; schools in plain, coastal, and mountain areas. Almost 70.1% of pupils reside in plain areas, 9.3% in coastal areas and 20.5% in mountain areas. Sample was selected according to the mentioned relative size of each location group. A total of 12 schools were selected (6 males and 6 females schools and distributed as 8, 2, and 2 schools to represent plain, coastal, and mountain areas respectively. A total of 30 students were selected in each school selected randomly from a random-selected class. In case the class is of less than 30 pupils, more than one class to be included. Data regarding age, gender, goiter size, weight and height was collected from the children using children registration and data collection form.

2.1 Salt and Urine specimens' collection and testing

Assessment of iodine deficiency is based on the procedure of WHO/UNCIF/ICCIDD (2007). An amount of 30gm of cooking salt were collected from each pupil's house. Salt samples were packed in pre-labeled plastic bags, and sent to the National Nutrition Institute in Cairo – Egypt for iodine content measurement. Urine samples were collected from all the children participating in the survey in urine collection containers. Then, an aliquot of urine (5-6 ml) transferred to the tube with tight cap, refrigerated. Urine samples were shipped to the Nutritional Intervention Research Unit (NIRU), of the Medical Research Council, (MRC), Cape Town, South Africa (International Laboratory network for Iodine) for determination of urinary iodine content. Goiter is graded according to the guidelines of WHO/UNICEF/ICCIDD (2007).

3. Data analysis

Data was entered and analyzed using SPSS-pc 17 software. Chi-Square test and t-test were used to determine the statistical significance of the differences observed as appropriate.

4. Results

Results for population characteristics, salt iodination and situation of total goiter rate (TGR) in Jazan area are presented in Tables 1 – 10 and Figures 2-4. A total of 311 out of 360 selected children examined; each one of them had completed the household questionnaire and provided salt sample and urine sample (response rate 86.4%) (Table 1).

Table 1. Study population characteristics

population	Frequency	%
Male	131	42.1
Female	180	57.9
Rural	234	75.2
Urban	77	24.8
Plain	202	65
Mountain	57	18.3
Coastal	52	16.7
Total	311	100

5. Discussion

5.1 Salt Iodination

Almost 100% of all households use iodized salt, but only 46.9% of households using adequate iodized salt. WHO/UNICEF/ICCIDD recommends at least 90% of households must be using adequately iodized salt to declare the country free of IDD among other criteria. Applying the WHO/UNICEF/ICCIDD Classification revealed more than 44% of the studied salt samples contained excessive amount of iodine (>40 ppm).

SASO recommendation for salt iodization is to add potassium iodate in a range of 70–100 ppm which in turn is considered a very high range compared to WHO/UNICEF/ICCIDD recommended range of only 15–40 ppm. By applying SASO standards, this figure of excessive salt iodine content (>40 ppm) declined up to 1.3% (Table 2). However, 89.4% of the salt had an insufficient amount of iodine. On the other hand, SASO recommends the use of potassium iodate for salt fortification (Sullivan et al., 2000), but in the market both "iodide" and "iodate" used for salt fortification. Potassium Iodide found in 28.3% of the salt samples (Table 3) which indicates monitoring and surveillance system need to be strengthened to ensure salt importers and manufacturers adhere to SASO standards.

Table 2. Assessment of salt iodization in Jazan region, Saudi Arabia, 2010

Iodine content of salt (ppm)	Interpretation	No	%
WHO/UNICEF/ ICCIDD Classification:			
< 15	Insufficient	28	9.0
15–40	Adequate	146	46.9
> 40	Excessive	137	44.1
Saudi Standards ,Metrology and Quality Organization (SASO)			
< 70	Insufficient	278	89.4
70 – 100	Adequate	29	9.3
>100	Excessive	4	1.3
Total		311	100

Source: Hurrell 1997; Pino et al., 1996; Sullivan et al., 2000; WHO/UNICEF/ICCIDD 2007

Table 3. Iodine salt types found in the iodized salt in Jazan region, Saudi Arabia, 2010

Salt Type	Frequency	Valid Percent
Iodide (I^-)	88	28.3
Iodate (IO^{-3})	223	71.7
Total	311	100.0

No significant difference (*P* = 0.89) found in iodine contents of the salt between rural and urban areas (Figure 2; Table 4). However, a remarkable difference (*P* = 0.00) in iodine contents of the salt between the mountain, coastal and plain areas was observed. The plain areas scored the highest percentage (52.5%) of iodized salt followed by coastal (36.5%) and mountain areas (21.1%) (Figure 3; Table 5).

The overall TGR was 10.5% for combined grades I and II (Table 6), the lowest prevalence of goiter (4%, 95% CI 2.00-8.00, grade 1) was found in Jazan coastal area in 1997 (Al-Naim 1997). This level of TGR indicates that the area is still at the mild iodine deficiency stage in comparison with recent studies (Singh et al., 2010; Abuye and Berhane 2007; Kapil et al 2004). TGR was significantly higher in rural than urban areas (P value = 0.004) and among females than males (P value = 0.012) as respectively presented in Tables 6 and 7. Furthermore, TGR was also remarkably higher at P = 0.00 (Table 8) among mountain areas population (26.3%), than plain (8.6%) and coastal areas population (0%).

5.2 Urinary Iodine Concentration (UIC)

Urinary iodine concentration (UIC) showed the heterogeneity of the results with a very wide range and a standard deviation above 238 (Tables 9 10; Figures 2 4). The overall median UIC is very high 420 µg/L, while in 1997, the median UIC was only 110 µg/L in the southern province (Al-Naim, 1997). Both of these UIC values seem to exceed some measurements reported in some reviewed studies i.e. <2.0 µg/dl (Barrett et al., 1996) 46.4 µg/dl (Abdel Monim et al., 2011), 25.5, 30.5, 16 and 14 µg/l (Erdogan et al., 2010). However, the high UIC value of (420 µg/L) exceeded values obtained by other researchers (Zimmermann, 2010; Assey et al., 2006). WHO/UNICEF/ICCIDD guidelines recommend 100-200 µg/l as median for the community with optimal iodine nutrition (WHO/UNICEF/ICCIDD, 2007). Thus the high median value of 420 µg/l obtained for the UIC represents an indicative of excessive iodine intake in the Jazan area.

This result, therefore, might lead to adverse health consequences including iodine-induced hyperthyroidism and autoimmune disease, particularly in the early years of 5-10. The high UIC could be explained by the occurrence of high level of iodine in the salt in the study area. Previous investigations found that 4.9% and 2.6% having UIC less than100 µg/l and less than 50 µg/l respectively (Al-Naim, 1997). However, the current result reveals variations between different groups in UIC (Table 10); furthermore, there is a noticeable difference in the median UIC between males and females (UIC of 483.8 and 368.85 respectively). Other insignificant differences also exist between urban and rural areas, coastal, plain and mountainous areas.

Table 4. Assessment of salt iodization in Rural and Urban areas in Jazan region, Saudi Arabia, 2010

Iodine content of salt (ppm)	Rural		Urban		Total	
	No.	(%)	No.	(%)	No.	(%)
<15	22	9.4	6	7.8	28	9.0
15–40	110	47.0	36	46.8	146	46.9
>40	102	43.6	35	45.5	137	44.1
Total	234	100	77	100	311	100

Chi-Square Value = 0.213; *P Value* = 0.899

Table 5. Assessment of salt iodization in different geographical areas in Jazan region, Saudi Arabia, 2010

Iodine Content (ppm)	Mountain		Coastal		Plain		Total	
	N	%	N	%	N	%	N	%
<15	9	15.8	5	9.6	14	6.9	28	9.0
15–40	36	63.2	28	53.8	82	40.6	146	46.9
>40	12	21.1	19	36.5	106	52.5	137	44.1
Total	57	100	52	100	202	100	311	100

Chi-Square Value = 20.1; *P Value* = 0.00

Table 6. Total Goiter Rate (TGR) in Rural and Urban areas in Jazan region, Saudi Arabia, 2010

Classification of Goiter by palpation	Rural		Urban		Total	
	N	%	N	%	N	%
Grade 0	202	86.3	73	100	275	89.6
Grade 1	18	7.7	0	0	18	5.9
Grade II	14	6.0	0	0	14	4.6
Total	234	100	73	100	307	100

Chi-Square Value = 11.14; *P Value* = 0.004

Table 7. Total Goiter Rate (TGR) by sex in Jazan region, Saudi Arabia, 2010

Classification of Goiter by palpation	Male		Female		Total	
	N	%	N	%	N	%
Grade 0	121	95.3	145	85.6	275	89.6
Grade 1	5	3.9	13	7.2	10	5.9
Grade 2	1	0.8	13	7.2	14	4.6
Total	127	100	180	100	307	100

Chi-Square Value = 8.91; *P Value* = 0.012

Table 8. Total Goiter Rate (TGR) by geographical type in Jazan region, Saudi Arabia, 2010

Classification of Goiter by palpation	Mountain		Coastal		Plain		Total	
	N	%	N	%	N	%	N	%
Grade 0	42	73.7	52	100	181	91.4	275	89.6
Grade 1	8	14.0	0	0	10	5.1	18	5.9
Grade 2	7	12.3	0	0	7	3.5	14	4.6
Total	57	100	52	100	198	100	307	100

Chi-Square Value = 22.35; *P Value* = 0.000

6. Conclusion

The IDD control program in KSA succeeded in reducing the risk of iodine deficiency by applying Universal Salt Iodization (USI), but the present SASO standards for table salt are very high. Almost 100% of households were using iodized salt, but about half of the samples is having excessive iodine content, even though, the TGR has been reduced and the median urinary concentration increased in Jazan region since the last National IDD survey in 1997.

The populations in the mountain areas have the highest TGR and the lowest UIC in the region, but all the population at risk of encountering adverse health consequences of excessive iodine intake including iodine-induced hyperthyroidism and autoimmune thyroid disease, therefore, prompt measures are urgently required and to be accompanied by a periodic IDD surveys in an appropriate interval of 2-3 years.

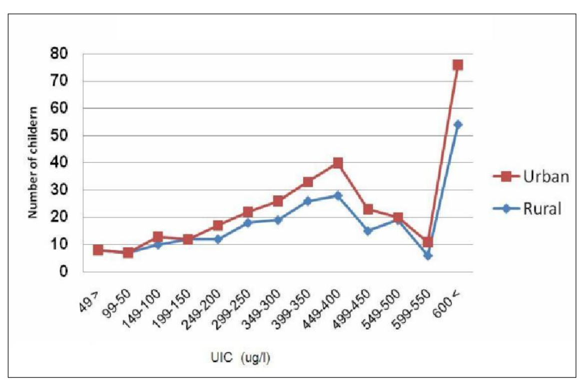

Figure 2. Distribution of urinary iodine (μg/l) in urban and rural areas in Jazan Region, KSA, 2010

Table 9. Basic Statistics for the analyzed Urinary iodine* in Jazan Region, Saudi Arabia, 2010

Basic Statistics		Value
Valid No.		311
Mean		448.6093
Median		420.7000
Mode		313.20
Std. Deviation		238.61243
Variance		56935.890
Skewness		0.880
Std. Error of Skewness		0.138
Kurtosis		1.545
Std. Error of Kurtosis		0.276
Range		1467.00
Minimum		22.00
Maximum		1489.00
Percentiles	10	154.8400
	80	652.9000

* All concentration in µg/l

Table 10. Comparison of the urinary iodine concentrations (µg/l) between different groups

Category	Med.	Mean	Min.	Max.	Std.
Sex					
Male	483.8	516.4	57.2	1186.3	212.5
Female	368.8	399.2	22.0	1486.9	244.8
Rural	415.2	439.8	22.0	1489.0	249.7
Urban	436.1	475.2	101.	1186.3	199.9
Plain	423.9	455.7	22.0	1286.8	245.0
Mountain	409.9	431.9	57.2	1489.0	250.3
Coastal	404.8	439.1	101	1186.3	200.1

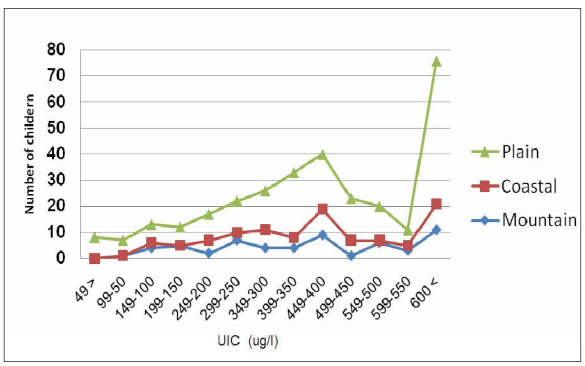

Figure 3. Distribution of urinary iodine (µg/l) in plain, coastal and mountain areas in Jazan Region, KSA, 2010

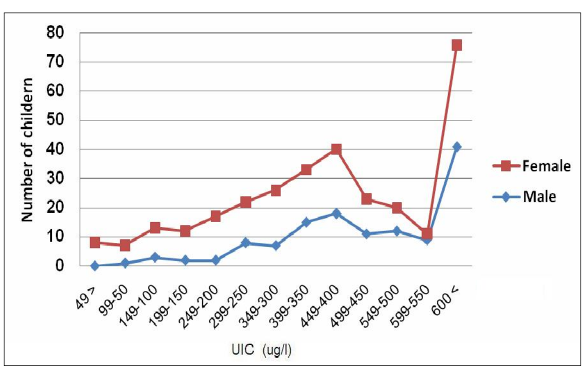

Figure 4. Distribution of urinary iodine (µg/l) of males and females in Jazan Region, KSA, 2010

Acknowledgements:

With much appreciation, this research was financially supported by Jazan University. The author also gratefully acknowledges the inputs of the administration and staff of Directorates of Education, Health of the Jazan District. More importantly the author acknowledged the project team who contributed as well as the research assistants who took part in data collection and data entry.

Corresponding Author:
Prof Ibrahim Bani
Department of Community Medicine, Faculty of Medicine, Jazan University, Jazan,
Kingdom of Saudi Arabia
Email: ibrahimbani1984@gmail.com

References

1. Abdel Monim, MHM, Abdelsalam AE, Amal MS. Endemic goitre in the Sudan despite long-standing programmes for the control of iodine deficiency disorders. Bull World Health Organ 2011; 89:121–126. doi:10.2471/BLT.09.075002.
2. Abuye C and Berhane Y. The goitre rate, its association with reproductive failure, and the knowledge of iodine deficiency disorders (IDD) among women in Ethiopia: Cross-section community based study. *Public Health* 2007, 7:316. doi:10.1186/1471-2458-7-316.
3. Al-Naim A. Iodine Deficiency in Saudi Arabia. Ann Saudi Med.1997*;*17, (3): 293-297.
4. Assey VD, Greiner T, Mzee RK, Abuu H, Mgoba C, Kimboka S, Peterson S. Iodine deficiency persists in the Zanzibar Islands of Tanzania. Food and nutrition bulletin 2006; 27(4): 292-299. PMID: 17209470.
5. Arab news. 2011. Labor minister explains expat time-bar plan. *arab news.com*, Published: May 31, 2011. Available at: http://arabnews.com/saudiarabia/article442386.ece (accessed on February 15th, 2012).
6. Barrett, BC, Sbah B, Brahim A. Analyses of iodine deficiency disorder and eradication strategies in the high Atlas Mountains of Morocco. Report No. ERI #96-19. 1996; Department of Economics, Utah State University, Logan, Utah, USA. Available at: http://ageconsearch.umn.edu/bitstream/28368/1/eri9619.pdf (accessed on December 31st, 2011).
7. Hurrell, RF. Bioavailability of iodine. European Journal of Clinical Nutrition 1997; 51 (Suppl. l1): S9–S12.
8. Erdogan G, Erdogan MF, Delange F, Sav H, Gullu S and Kamel N. Moderate to severe iodine deficiency in three endemic giotre areas from the Black Sea region and the capital of Turkey.

European Journal of Epidemiology 2001; 16: 1131-1134. DOI: 10.1023/A:1010959928862.
9. Kapil U, Sethi V, Goindi G, Pathak P, Singh P. Elimination of iodine deficiency disorders in Delhi. Indian J Pediatr. 2004; 71(3):211-2. PMID: 15080406.
10. Malouf A. 2011. Holidaying in the Kingdom. *the gulf*: business news & analysis, Published August 2011. Available at: http://www.thegulfonline.com/Articles.aspx?ArtID=3769 (accessed on February 15th, 2012).
11. Mannar MGV, Dunn TJ. *Salt Iodization for The Elimination of Iodine Deficiency*. Publication No. ISBN 90-70785-13-7. 1995. International Council for Control of Iodine Deficiency Disorders. Downloaded (on January 1st, 2012) from: http://www.micronutrient.org/resources/Salt_CD/4.0_useful/4.1_fulltext/pdfs/4.1.1.pdf.
12. 12. Pino S, Fang S, Braverman LE. Ammonium persulfate: a safe alternative oxidizing reagent for measuring urinary iodine. Clin Chem 1996; 42(2): 239-243. PMID:8595717.
13. SCN (Standing Committee on Nutrition). 2007. Universal Salt of Iodization (USI). *SCN News #* 35, ISSN: 1564–3743. United Nations System Available at: http://www.unsystem.org/scn/Publications/SCNNews/scnnews35.pdf (accessed on December 21st, 2011).
14. Singh, MB, Marwal R, Lakshminarayana J. Assessment of Iodine Deficiency Disorders in School Age Children in Jodhpur district of Rajasthan. J Hum Ecol. 2010, 32(2): 79-83.
15. Sullivan KM, May S, Maberly G. Urinary iodine assessment: A manual on survey and laboratory methods. 2n ed. PAMM and UNICEF, 15 June 2000.
16. The Telegraph. 2011. Hajj pilgrimage 2011: by numbers. *The Telegraph*, News–World–Middle east. Available at: http://www.telegraph.co.uk/news/worldnews/middleeast/saudiarabia/8867639/Hajj-pilgrimage-2011-by-numbers.html (accessed on February 15th, 2012).
17. UNICEF. *Sustainable Elimination of Iodine Deficiency*. Report No. HQ98-0761/Frank Fournier. 2008 . ISBN: 978-92-806-4304-6. Downloaded from (on Sunday January 1st, 2012): http://www.unicef.org/publications/files/Sustainable_Elimination_of_Iodine_Deficiency.pdf.
18. UNICEF. *Roadmap Toward Achievement of Sustainable Elimination of Iodine Deficiency*: Operational Guidance: 2005 and Beyond. 2005. Downloaded from (on Sunday January 1st, 2012): http://www.ceecis.org/iodine/01_global/00_mp/01_00_unicef_guidance_05.pdf.
19. WHO, UNICEF, ICCIDD. *Assessment of iodine deficiency disorders and monitoring their elimination*. A guide for programme managers. 3rd Edition; 2007. Geneva: WHO.
20. Zimmermann MB, Jooste PL, Pandav CS. Iodine-deficiency disorders. Lancet 2008; 372: 1251–1262.
21. Zimmermann M Low iodine intakes in weaning infants. IDD Newsletter, 2010; 38(4): 1–3.

7/1/2013