Prevalence of iodine deficiency disorders among school children in Saudi Arabia: results of a national iodine nutrition study

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انتشار الاضطرابات الناجمة عن نقص اليود بين أطفال المدارس في المملكة العربية السعودية: نتائج دراسة وطنية للتغذية باليود

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الخلاصة: هدفت هذه الدراسة إلى وضع بيانات محدَّثة عن التغذية باليود لدى تلاميذ المدارس في المملكة العربية السعودية. حيث أجري مسح عنقودي مقطعي لدى تلاميذ المدارس الذين تتراوح أعمارهم بين 8 و 10 سنوات خلال أشهر فبراير/ شباط - أبريل/ نيسان من عام 2012. ففُحِص الأطفال سريرياً بحثاً عن وجود تضخم الغدة الدرقية، وجُمعت عينات من بولهم ومن الملح الذي يستعملونه في منازلهم لتقدير تركيز اليود في البول ومحتوى اليود في الملح. فكان الانتشار الإجمالي لتضخم الغدة الدرقية على المستوى الوطني لدى 4016 طفلاً ‎4.2٪‎. وكان الانتشار ‎5٪>‎ في جميع مناطق البلاد باستثناء المنطقة الجنوبية التي كان الانتشار فيها ‎12.7٪‎. وكان متوسط تركيز اليود في البول لـ 2224 عينة 133 ميكروجرام/ لتر، وكان تركيز اليود في البول ≥ 100 ميكروجرام/ لتر لدى ‎74.3٪‎ من الأطفال الذين شملهم المسح. وأظهر تحليل عينات الملح (ع = 4242) أن ‎69.8٪‎ من الأسر كانت تستهلك كميات ملحاً يحتوي على كميات كافية من اليود. تشير هذه النتائج إلى كفاية اليود على المستوى الوطني، غير أن المنطقة الجنوبية لا يزال فيها انتشار خفيف الدرجة لتضخم الغدة الدرقية، ونسبة الأسر التي تستهلك كميات ملحاً يحتوي على كميات كافية من اليود فيها لا تزال أقل من الموصى به.

ABSTRACT This study aimed at establishing updated data on iodine nutrition among schoolchildren in Saudi Arabia. A cross-sectional cluster survey among schoolchildren aged 8–10 years was conducted during February–April 2012. Children were clinically examined for goitre, urine and household salt samples were collected to estimate urinary iodine concenteration (UIC) and iodine content in salt. The overall goitre prevalence at the national level among 4 016 children was 4.2%. The prevalence was < 5% in all regions of the country except southern region with a prevalence of 12.7%. The median UIC of 2224 samples was 133 μg/L, with 74.3% of the surveyed children with UIC ≥ 100 μg/L. Analysis of salt samples (n = 4242) revealed that 69.8% of households were consuming adequately iodized salt. The findings suggest iodine sufficiency at the national level, however southern region still has a goitre prevalence of mild degree severity and the proportion of households consuming adequately iodized salt is still below recommendations.

Prévalence des troubles dus à une carence en iode parmi les enfants d'âge scolaire en Arabie saoudite : résultats d'une étude nationale sur la nutrition en iode

RÉSUMÉ Cette étude visait à recueillir des données mises à jour sur la nutrition en iode parmi les enfants d'âge scolaire en Arabie saoudite. Une étude transversale par sondage en grappes a été menée auprès enfants d'âge scolaire âgés de 8 à 10 ans entre février et avril 2012. Les enfants ont été soumis à un examen clinique pour le goître, et des échantillons d'urine et de sel de cuisine ont été collectés afin d'estimer la concentration d'iode urinaire et la teneur en iode dans le sel. La prévalence globale du goître au niveau national parmi les 4016 enfants était de 4,2 %. La prévalence était inférieure à 5 % dans l'ensemble des régions du pays, exception faite de la partie sud qui présentait une prévalence de 12,7 %. La concentration médiane d'iode urinaire de 2224 échantillons était de 133 μg/L, 74,3 % des enfants examinés ayant une concentration d'iode urinaire inférieure ou égale à 100 μg/L. Les proportions d'enfants ayant des taux de concentration d'iode urinaire inférieurs à 20, compris entre 20 et 49 et 50 et 99 μg/L, étaient de 2,0 %, 5,3 % et 18,5 % respectivement. L'analyse des échantillons de sel (n = 4242) a révélé que 69,8 % des ménages consommaient du sel adéquatement iodé. Les résultats suggèrent un niveau de consommation en iode suffisant à l'échelle nationale, bien que la partie sud du pays continue d'avoir une prévalence du goître de sévérité moyenne, et que la proportion des ménages consommant du sel adéquatement iodé reste en deçà des recommandations.

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Introduction

Iodine is an essential micronutrient and its deficiency has several adverse effects on growth and development because of inadequate thyroid hormone production (*1*). Iodine deficiency disorder (IDD) refers to all the effects of iodine deficiency on growth and development that can be prevented by correction of the deficiency (*2*). Most consequences of IDD are invisible and irreversible but at the same time preventable. The World Health Organization (WHO) describes iodine deficiency as "the single most important preventable cause of brain damage" (*3*). Even in developed countries, marginal iodine sufficiency may lead to intellectual compromise (*4*). Worldwide, ~30% of school-aged children were iodine deficient in 2011 (*5*).

IDD results from insufficient iodine in the environment and inadequate iodine intake from food (*6*). Salt iodization as a safe, cost-effective and sustainable strategy to ensure sufficient iodine intake was recommended by WHO and United Nations Children's Fund (UNICEF) in 1994 (*7*). It is now recognized that the most effective way to achieve the virtual elimination of IDD is through universal salt iodization (USI) (*8*). Many countries and 71% of the world's population are estimated to be covered by iodized salt (*8*).

The only national survey to assess iodine status in Saudi Arabia was carried out in 1994–1995 (*9,10*). The national median urinary iodine concentration (UIC) was 180 μg/L and the prevalence of goitre ranged between 4% in an urban costal community to 30% in the high-altitude Asir Region. The study recommended adoption of a USI strategy. Taking into consideration the outcomes of the study, the Saudi Standards Metrology and Quality Organization recommended an iodine content in salt of 70–100 ppm. Following the WHO/UNICEF/International Council for the Control of Iodine Deficiency Disorders (ICCIDD) guidelines, the range of the recommended fortification level was changed to 15–40 ppm in 2010 (*11*).

A survey report in Hail Region, in the north of Saudi Arabia, in 2004, revealed that less than one-third of families were using iodized salt as the main source of salt (*12*). In contrast, a study in Jizan in 2010 reported that almost all households were consuming iodized salt (*13*).

Since the first national survey in 1994–1995, sociocultural and economic development, urbanization, changes in dietary habits and lifestyle, as well as adoption of USI strategies, have potentially had an effect on iodine nutrition in Saudi Arabia. Therefore, this study aimed to establish updated national data on goitre prevalence and median UIC and to assess the proportion of households consuming adequately iodized salt.

Methods

Study setting & design

Saudi Arabia is a large country that encompasses 80% of the Arabian Peninsula with an area of nearly 2 million km^2. The land is primarily desert with rugged mountains in the south-west. The country is broadly divided into five geographical/administrative territorial entities: central, eastern, western, northern and southern regions with 13 primary subdivisions. The estimated population according to the 2010 census was ~27 million (*14*).

The study was cross-sectional national survey among primary-school children aged 8–10 years, based on the 30 cluster sampling methodology recommended by WHO/UNICEF/ICCIDD (*15*).

Study participants & sampling

The sampling frame of the study included all 13 626 primary schools in Saudi Arabia (public and private), representing the primary sampling units (*16*). For good regional representation, the country was stratified into the five geographical regions. Using a probability proportionate to size sampling method, 30 clusters were drawn randomly from the primary sampling units in each region (*15*). A comprehensive list of all children in the target age group was prepared for each selected school. Children were chosen at random by a systematic random technique to include the total number needed from each school. Twenty-six children per cluster was estimated for a sample size of 780 children for every region. An absolute precision of ± 3% with 95% confidence interval (CI) and design effect of 2 for anticipated 10% goitre prevalence were the assumptions for sample size estimation (*15*). Sample size was then increased by 10% to compensate for non-response. The anticipated goitre prevalence was decided with reference to pervious national and local studies (*9,17*).

A total of 4311 school children (52.2% male and 47.8% female) aged 8–10 years participated in the study, with 31.8%, 36.7% and 31.6% aged 8, 9 and 10 years respectively.

Data collection

Data on participants' age, gender, educational class and locality were collected. All children were examined for goitre. Clinical examination of the thyroid was performed by physicians who had undergone training in goitre palpation. Goitre classification was according to the criteria recommended by WHO/UNICEF/ICCIDD as Grade 0, 1 or 2. The sum of Grades 1 and 2 provided the total goitre rate (TGR) (*2*).

Casual urine samples were collected from a random subsample of 50%, selected systematically to provide urine for estimation of UIC. Urine samples were collected in sterile disposable cups and transferred into sealed 10-mL tubes. Samples were transported to the Central Laboratory for Nutrition in Riyadh and stored at −18 °C until analysis.

The ammonium persulfate method described by Dunn et al. was used for measuring iodine in urine (*18*). Classification of the severity of IDD was according to WHO cut-off points of UIC (*2*).

Samples of ~20 g of routinely consumed salt were collected by requesting all participants to bring them from their homes. Each sample was screened for iodine content using a rapid test kit (RTK). Twenty-five percent of the iodated salt samples screened by RTK were randomly selected for iodine level determination using an iodometric titration method (*2*). All salt analysis were done centrally under quality control measures in the Central Laboratory for Nutrition in Riyadh.

Training and survey technique

To collect valid, standardized survey data, 3 training workshops, including field training, were carried out for the recruited physicians, nurses and health inspectors. Physicians were assigned to examine thyroid size clinically; nurses for collection of urine and salt samples; and health inspectors for coordinating school visits and obtaining a list of the eligible target students. Training emphasized standardization of thyroid gland examination and goitre grading system according to the WHO/UNICEF/ICCIDD guidelines, and urine and salt sample collection, storage and transportation (*2*).

Statistical analysis

Data processing and statistical analyses were performed using *Epi Info* version 3.5.4 statistical package (Centers for Disease Control and Prevention, Atlanta, GA, USA).

As the continuous variable of UIC was not normally distributed, the results were described as median and percentiles and the differences were evaluated by the nonparametric Kruskal–Wallis *H* test and Mann–Whitney *U* test as appropriate. Other continuous variables were expressed as mean and standard deviation (SD). Categorical data were summarized by frequencies and percentage. The percentage and 95% CI for goitre and household iodized salt consumption were calculated. The χ^2 test was used to test for differences in proportions. Effect size was expressed as odds ratio (OR) and 95% CI. National estimates were adjusted according to the total number of children per region compared to the national total. Analysis for complex sampling design took into consideration sampling stratification, clustering and regional weights and permitting estimates adjustment. All tests were two-sided and the level of significance was set at $P < 0.05$.

Ethical considerations

The ethical issues of this study were reviewed and approved by the Ethical Committee of the Ministry of Health, Saudi Arabia. Approval was also obtained from the Education Authority. Written informed consent was obtained from the parents/guardians of participating children.

Results

Prevalence of goitre

Complete data for goitre were obtained for 4016 children with no significant differences compared with the number of total participants with regard to gender (P = 0.193), age (P = 0.237) or educational class (P = 0.323). TGR at the national level was 4.2% (95% CI: 3.9–4.5%); 3.6% for Grade 1 and 0.6% for Grade 2 (Table 1). The prevalence was < 5% in all parts of the country except the southern region, which scored 12.7%; 10.8% for Grade 1 and 1.8% for Grade 2 (Table 1). TGR was significantly higher in girls (7.1%) than boys (3.1%) (OR: 2.4; 95% CI :1.8–3.3%; P < 0.001), but no age-related difference was found (P = 0.431).

Urinary iodine

The median UIC at national level was found to be 133 μg/L (20–80th percentile: 88–167 μg/L) and scored > 100 μg/L in all regions of the country (Table 2). The highest level (157 μg/L) was observed in the eastern region and the lowest (119 μg/L) in the southern region (Table 2). The difference in median UIC between regions was significant (P < 0.001). About three quarters (74.3%) of children at the national level

Table 1 Goitre grade by palpation in school children aged 8–10 years at national and regional levels, in Saudi Arabia, 2012

Region	No. examined	% children according to grade of goitre			
		Grade 0	Grade 1	Grade 2	TGR (95% CI)
Central	945	95.9	3.0	1.1	4.1 (3.9–4.4)
Western	872	96.6	3.3	0.1	3.4 (3.7–4.1)
Eastern	785	98.1	1.8	0.1	1.9 (1.7–2.2)
Northern	768	95.2	4.6	0.3	4.9 (4.3–5.4)
Southern	646	87.3	10.8	1.8	12.7 (12.5–13.8)
National[a]	4016	95.8	3.6	0.6	4.2 (3.9–4.5)

[a] *Adjusted according to total number of children per region compared to the national total.*
There was a significant difference of TGR between regions (χ^2 = 105.1; df = 4; P < 0.001).
CI= confidence interval; TGR = total goitre rate.

Table 2 UIC at national and regional levels, Saudi Arabia, 2012

Region	No. examined	Median[a] (20–80th percentiles)	Mean (SD)	% participants with median UIC < 100 µg/L
Central	470	123 (75–152)	116.9 (45.3)	32.8
Western	491	138 (91–170)	129.9 (45.8)	25.3
Eastern	408	157 (106–194)	149.8 (57.2)	14.7
Northern	495	134 (90–166)	127.7 (45.2)	22.7
Southern	360	119 (78–155)	117.1 (43.3)	24.3
National[b]	2224	133 (88–167)	128.2 (48.2)	25.8

[a] Normal range = 100–199 µg/L.
[b] Adjusted according to total number of children per region compared to national total.
There was a significant difference in median UIC among regions (Kruskal–Wallis H test; χ^2 = 79.0; df = 4; P < 0.001).
SD = standard deviation; UIC = urinary iodine concentration.

had optimal iodine nutrition (UIC ≥ 100 µg/L). Mild, moderate and severe IDD were found in 18.5%, 5.2% and 2.0% of children respectively, with significant differences among the regions (*P* < 0.001) (Table 3). No children had median UIC >300 µg/L (excessive iodine intake). Median UIC did not differ significantly with regard to gender (*P* = 0.887) or age (*P* = 0.623).

TGR among iodine-sufficient participants (UIC >100 µg/L) was 3.5% compared to 8.6% among iodine-deficient participants (UIC <100 µg/L), with a significantly reduced risk of goitre among iodine-sufficient participants (OR = 0.39, 95% CI: 0.24–0.63; *P* < 0.001). Figure 1 depicts the significant inverse relationship between UIC and prevalence of goitre (χ^2 = 31.9, df = 3; *P* < 0.001).

Iodine content of salt

Among the 4242 salt samples collected, 68.7% (95% CI: 67.3–70.1%) were found to be iodized using the RTK (Table 4), with significant regional differences (*P* < 0.001). The northern region had the lowest number (53.8%) of iodized salt samples and the western region had the highest (80.6%). We tested 775 representative iodized salt samples using iodometric titration methods for validation of salt samples that tested positive for iodine with the RTK. The results revealed adequate (≥ 15 ppm) iodine content in salt in 95.2% (95% CI: 93.9–96.5) of the samples, with a mean 50.4 (SD 21.8) and median 51 ppm concentration. The national weighted estimate of the proportion of households consuming adequately iodized salt was 69.8%. An obvious relationship was noticed between household consumption of iodized salt and both goitre prevalence and median UIC. A significant inverse relationship (*P* = 0.038) was found in relation to goitre prevalence and a positive relationship (*P* < 0.001) with median UIC.

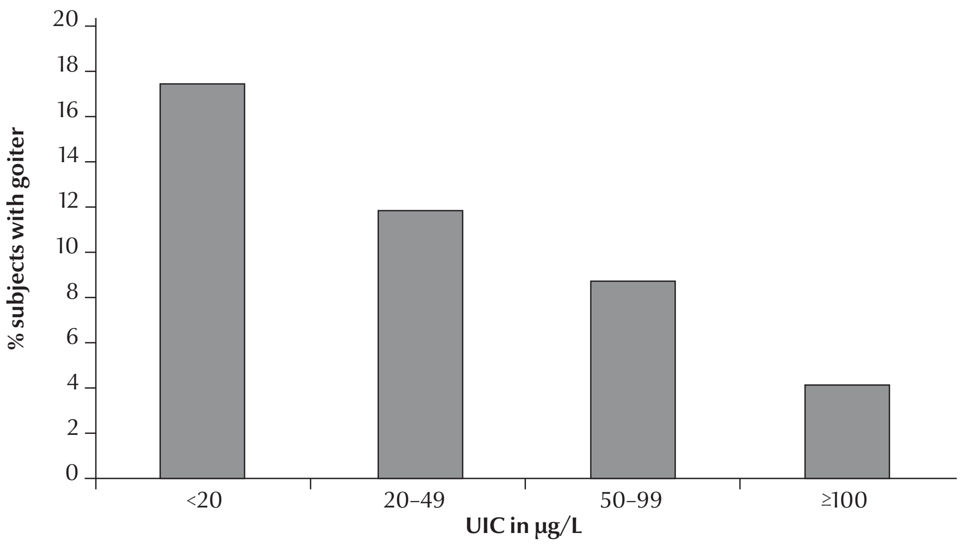

Figure 1 Prevalence of goitre among participants with different UICs (χ^2 = 31.9; df = 3; *P* < 0.001) (UIC = urinary iodine concentration).

Table 3 **Distribution of participants according to UIC at national and regional levels, Saudi Arabia, 2012**

Region	No. examined	% children according to range of Median UIC (µg/L)[a]					
		< 20	20–49	50–99	100–199	200–299	≥ 300
Central	470	2.7	6.9	23.2	64.8	2.4	0
Western	491	2.0	4.1	19.2	72.9	1.8	0
Eastern	408	1.2	4.7	8.8	66.9	18.4	0
Northern	495	1.2	6.1	15.3	75.3	2.0	0
Southern	360	1.7	4.7	17.9	75.8	0	0
National[b]	2224	2.0	5.2	18.5	70.0	4.3	0

[a] Normal range = 100-199 µg/L
[b] Adjusted according to total number of children per region compared to national total.
There was a significant difference in UIC among regions ((χ^2 = 52.8; df = 12; P < 0.001).
UIC = urinary iodine concentration.

Discussion

Since the first national survey in 1994–1995, national data about IDD in Saudi Arabia have been lacking. There have been a few regional studies, mostly from the southern part of the country, with no information about household consumption of iodized salt; hence the importance of the present survey.

The median UIC and goitre prevalence observed in this study suggest iodine sufficiency in the Saudi Arabian population at the national level. They also substantiate the findings of the first national survey and indicate the sustainability of meeting the iodine nutritional needs of the population (*2*). Early studies indicated that iodine concentration in Saudi Arabian staple food contains adequate iodine (*19*). Upgraded studies are needed to describe and quantify different sources of iodine in the Saudi Arabian diet and the pattern of consumption.

Based on WHO/ICCIDD/UNICEF criteria, 2 primary criteria of sustainable elimination of IDD (< 50% of population with UIC < 100 µg/L and < 5% goitre prevalence) were met. However, efforts are still needed to reach the third criterion of > 90% of households consuming adequate iodized salt (*2*). The study also highlighted significant regional variations, especially in household consumption of iodized salt, and revealed a still higher goitre prevalence in the southern region despite 2 decades of USI.

Goitre prevalence

Goitre prevalence is an index of the degree of long-standing iodine deficiency. A prevalence of 5% is taken as the maximum above which iodine deficiency is designated as a public health problem (*2*). In the present study, an estimated TGR of 4.2% at the national level was below this margin and indicate a reduction of goitre prevalence compared to that reported in the first national survey (4–30%) (*9*). Four regions out of 5 scored TGR < 5% and only the southern region was higher at 12.7% to be classified as a mild degree of severity according to WHO epidemiological criteria for establishing IDD severity, based on goitre prevalence in schoolchildren (*2*).

The southern region of Saudi Arabia is mostly high altitude and high goitre prevalence has been reported in previous studies (*9,13,17*). High goitre prevalence is a characteristic of mountainous regions in other countries because of leached soil iodine (*6,20*). In contrast, reflecting different ecological patterns, the coastal, nonmountainous the eastern and western regions in Saudi

Table 4 **Proportion of households consuming adequately iodized salt, at the national and regional levels, Saudi Arabia, 2012**

Region	No. of salt samples	% (95% CI) iodized salt screened by RTK	% (95% CI) adequately iodized salt[a]
Central	932	79.7 (77.0–82.2)	75.9 (73.2-78.7)
Western	968	80.6 (77.9–83.0)	76.7 (74.0-79.4)
Eastern	683	63.8 (60.1–67.4)	60.7 (57.0-64.4)
Northern	1042	53.8 (50.8–56.9)	51.2 (48.2-54.2)
Southern	617	64.0 (60.1–67.8)	60.9 (57.1-64.8)
National	4242	68.7[b] (67.3–70.1)	69.8[c] (68.4-71.2)

[a] Validated by iodometric titration method at 95.2% of salt samples with iodine content ≥15 ppm.
[b] For total salt samples, unadjusted for national estimate.
[c] Adjusted for national estimate according to total number of children per region compared to national total.
There was a significant difference in iodized salt samples among regions (χ^2 = 237.1; df = 4; P < 0.001).
CI = confidence interval; RTK = rapid test kit.

Arabia appeared to have the lowest goitre prevalence of 1.9% and 3.4% respectively. These results confirm the findings of the first national survey (*9*).

Historically, few individual studies have estimated goitre prevalence among school-aged children. A prevalence of 0.9% among male children aged 6–15 years was found in Riyadh in 1988 (*21*); 24% in Asir (2001) with higher levels in high altitude (27%) than low altitude (13%) areas (*17*), and a study in Jizan (2010) reported a prevalence of 11% (*13*).

Girls in the present study were at higher risk of developing goitre than boys were, which could be attributed to the increased physiological demand for iodine during puberty, which begins 2 years earlier in girls (*22,23*). The higher goitre rate among girls was consistent with earlier observations (*13*). Compared to neighbouring countries, goitre prevalence in the present study was higher than in Bahrain (1.7%) but lower than in Oman (10%), Jordan (33.5%) and Egypt (21.4%) (*24*).

Urinary iodine

Urinary iodine level is used as a valuable indicator for the assessment of IDD because 90% of iodine in the body is excreted through urine. It is a sensitive indicator of recent changes in iodine intake and a median UIC of 100 µg/L indicates that there is no iodine deficiency in the population (*2*).

Within the optimal range, the national median UIC in the present survey (133 µg/L) was lower than 180 µg/L reported in the 1994–1995 survey. This reduction could be attributed to the adjustment of salt iodine concentration in Saudi Arabia code from 70–100 ppm to 15–40 ppm in accordance with WHO recommendations. At the national level, 74.3% of participants had optimal iodine nutrition compared to 77% reported in the 1994–1995 survey (*9*). Both surveys reported the lowest UIC level in the southern region.

In the present study, there was a considerable improvement in iodine nutritional status in the southern region, as demonstrated by the reduction in the proportion of participants with median UIC < 50 µg/L and 50–99 µg/L from 18.0% and 27% to 6.4% and 17.9% respectively. This suggests a marked effect of the USI strategy in that vulnerable locality. A study conducted in Jizan in the southern region among 311 children aged 6–13 years, in 2010 reported a high level of UIC (421 µg/L) (*13*). Such a high value was not seen in the present study. A further investigation and periodic monitoring should be considered.

A significant inverse relationship (OR = 0.39; $P < 0.001$) was recognized between UIC and goitre prevalence, consistent with other studies (*9,25*). No significant gender difference in median UIC was found in the present study compared to a higher value among male participants in the first national survey (*9*).

Salt iodization

Worldwide, salt iodization is accepted as a safe, cost-effective and sustainable strategy to ensure sufficient intake of iodine (*7*). The present work demonstrated a higher UIC and lower goitre prevalence among children of households consuming iodized salt, which indicates the contribution of iodized salt prophylaxis to prevention of IDD, as established in international studies (*8*).

Studies of household consumption of iodized salt in Saudi Arabia are scarce. A report from Hail in northern Saudi Arabia in 2004 described the pattern of household salt consumption and pointed to the prevalent pattern of consumption of noniodized salt in that area. Only 27.7% of households were consuming iodized salt as an exclusive source of salt, 31.6% were consuming noniodized salt and 40.7% were consuming iodized salt as a table salt and not for cooking purposes (*12*). In contrast, a study in Jizan in south-western Saudi Arabia in 2010 reported that almost all households were consuming iodized salt (*13*).

At the national level, the present survey revealed that 69.8% of households were consuming adequately iodized salt, however, noniodized salt is still available in the markets and preferred by many households in some regions. The lowest rate of households consuming iodized salt was found in the northern region (53.8%), and the highest rate was in the western region (80.6%). No regional or sub-regional locality attained the WHO/UNICEF/ICCIDD criterion of >90% of households consuming adequately iodized salt (*2*). The marked variations among regions imply the need to study factors affecting such disparities and preferences of households with regard to salt consumption.

The iodine content of iodized salt measured by iodometric titration revealed a mean of 50.4 ± 21.8 ppm and median of 51 ppm that was higher than the recommended level (15–40 ppm). This draws attention to the need for a good monitoring system to ensure commitment and proper quality control systems of salt producers. As a result of nonmandatory regulation, several salt producers still fortify salt according to the previous code (70–100 ppm). It is essential to change legislation to mandate the iodine salt adjustment (15–40 ppm) instead of just recommending it.

In other countries in the region, the proportion of households consuming iodized salt was 11.0%, 29.5%, 68.5%, 78.7, 88.3% and 92.0% in Sudan, Yemen, Oman, Egypt, Jordan and Lebanon respectively (*26*).

Study limitations

Our study had some limitations. In spite of good training to assure inter-rater agreement, clinical assessment of goitre by many physicians is still liable to variations. Application of more reliable sonography for goitre assessment will be considered in future surveys. Difficulties in recruiting the ideal number of children in some clusters in Jizan in the southern region were encountered because of high absenteeism during the survey period as a result of heavy rain. Another problem regard goitre examination was encountered in Hail in the northern region, where an exceptionally high goitre prevalence was recorded compared with all other clusters in the northern region; this needs confirmation to exclude any observer bias. However, these limitations did not compromise the results because of their limited population weight. A local confirmatory survey will be arranged in Hail and Jizan.

Conclusion

Our findings suggest that Saudi Arabia is iodine sufficient at the national level, however the southern region still has goitre with a mild degree of severity. The proportion of households consuming adequately iodized salt is still below WHO/ICCIDD/UNICEF recommendations. There is a need to strengthen the legislation to ban the sale of noniodized salt and to launch public health awareness programmes. The government is advised to establish a proper surveillance system for monitoring sustainability.

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