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Evaluation of iodine salt intake, salt storage, and urinary iodine among the households in Markazi Province, Iran

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Original Article

Abstract

BACKGROUND: Iodine deficiency is known as a major nutritional health problem in Iran. The aim of this study was to evaluate iodine salt intake, salt storage, and urinary iodine in households of Markazi Province, Iran, in 2014.

METHODS: In this cross-sectional analytical study, 440 households of 11 cities in Markazi Province in 2014 were selected through a multistage random sampling. A structured questionnaire was used to collect information about the type of salt used and awareness about salt storage. Parameters of salts were measured by taking the samples from household salt. Simultaneously, urinary iodine was measured via samples from the elementary students in the household. Data were analyzed using SPSS software.

RESULTS: Of 440 households, 225 households (58.0%) used iodized refined salt. Approximately, 60.0% of households were aware of the correct way of salt storage. The mean urinary iodine concentration (UIC) of children was 19.2 ± 18.3 μg/l. The average iodine concentration in household salts was 29.3 ± 3.8 ppm and only half of the salt-producing companies had iodine levels above 30 ppm. The average of salt heavy metals at the level of production and consumption was at a standard level.

CONCLUSION: The average iodine concentration of salts was less than the standard level. Therefore, in the absence of proper monitoring of the cycle of production and supply of iodized salt, there is a possibility of recurrent iodine deficiency complications in Markazi Province. Enhancing public awareness about salt storage for maintaining the quantity and quality of iodine is recommended.

KEYWORDS: Iodine; Iodized Salt; Urinary Iodine; Excretion Urinary Iodine; Households

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Introduction

Salt is the most important and most consumable food additive for human.[1] In Iran, because of the availability of saltwater resources and having the largest salt domes in the world, there is no concern regarding lack of this valuable material. However, the production of high-quality salt and the amount of required iodine needs a vigorous process to deliver high quality and non-contaminated products. The presence of harmful impurities, such as the combination of heavy metals in the salt product, can be hazardous to the consumer. Salt is usually refined via two methods, i.e., the traditional method of salt washing and re-crystallization method, which the latter provides a higher purity.[2] In Iran, many industries work based on the traditional method because it is simple and inexpensive. Therefore, the industrial units do not try to change their industrial process. In this regard, it is very important to use pure salt in the food industry. According to the associated

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standards, the purity of table salt must be 99.2%.at least [2]

The amount of iodine needed by an adult is an average of 150 µg per day. Iodine deficiency disorders (IDDs) are known among the most important preventable factors for mental disorder in the world.[3-6] In order to prevent and control IDDs, a small amount of this element should be added to the daily diet.[6-10] This procedure needs the lowest costs and provides the highest yield for iodizing the salt for human consumption. Iodizing the salts has been used as the best method for delivering iodine in many countries of the world.[9-14] Measuring the iodine and its impurities in consumed salts of households produced, receiving information about the type of salt and its storage methods, and measuring the urinary iodine and its deficiencies have been proposed among interventions needed to defeat IDDs.[9,12,14-16] Moreover, the status of the Markazi Province in terms of the considered indicators have not been well known, as this information is very valuable for solving existing problems.[2,9,17-19] The aim of this study was to evaluate salt iodine concentration, salt iodine intake, urinary iodine concentration (UIC), and awareness about salt storage in households of Markazi Province, Iran, in 2014.

Materials and Methods

In this cross-sectional study, 440 households in Markazi Province in 2014 were selected through a multistage random sampling. Of 11 cities in this province, 20 urban households and 20 rural households were selected. In each city, according to the residential area of the households (north, south, west, and east), the city was divided into four regions. From each region, 5 clusters were randomly selected based on the present clusters and then a household was randomly selected. To select rural households, all villages around of each city were divided into 4 categories in 4 directions of the city and 5 villages were randomly selected from each category. Within each village, a cluster was randomly selected. To estimate median urinary iodine, according to the World Health Organization (WHO) recommendation, to reach a 95% confidence interval (CI), required samples were between 80 and 120 and an average of 100 persons. Therefore, 100 (25%) of 400 households in the province were examined for urinary iodine.

The researchers of the project, who were referring to the selected households, completed the national structured questionnaire on monitoring the storage and consumption of the iodine. Before starting the research, researchers introduced themselves, presented the research permits, and received the informed consent of the household. The data collection tool was a national valid and reliable questionnaire for monitoring the storage and usage of iodized salts based on the national monitoring plan for combating IDDs. To calculate the sample size, given that the amount of iodine in salt in Iran should be 40 ± 10 ppm/g, using the average estimation formula in the society, about 400 households were required to determine salt iodine concentration. Simultaneously with completing the questionnaires, if the household had an elementary school child (8 to 12-year-old children), UIC was measured by taking 10 cc of urine. Otherwise, based on the right-hand rule, the next household on the right of the previous household with an elementary school student was sampled. All of the samples were sent to the laboratory of School of Medicine, Arak University of Medical Sciences, Arak, Iran. The urine samples were frozen and transferred to the laboratory.

To measure the amount of iodine and the soluble and insoluble impurities in salts at the level of consumption, 20 salt samples from 20 head households were selected. The samples were taken from households' salts and the cost of the salt package was paid to the households. The collected salt samples were sent to a specialized laboratory located at the

Deputy of Iran Food and Drug Administration (IFDA) of Arak University of Medical Sciences to determine the iodine content and the amount of impurity and solubility in water. Ultimately, the data were analyzed by SPSS software (version 19, SPSS Inc., Chicago, IL, USA). To analyze the obtained data, descriptive statistics including mean and standard deviation (SD), frequency, and percentage were used. The research plan for this study was approved by the Ethics Committee of Arak University of Medical Sciences with an ethics code of 22-159-92. Also, it is noteworthy that this paper is the result of a research plan with registration number of 1049 in vice-chancellor for research of Arak University of Medical Sciences in 2014 which was implemented during 2014-2016.

Results

This cross-sectional study was conducted on 440 households in Markazi Province. All the interviewees were women. The education level of the participants was as follows: 8 (1.8%) were illiterate, 5 (1.1%) had literacy to read and write, 42 (9.5%) had primary school grade, 118 (26.8%) had secondary school grade, 162 (36.8%) had high school grade, and 105 (23.9%) had university education.

Based on the data collected using this questionnaire, which was taken from Questionnaire of the National Monitoring Plan for Combating Iodine Deficiency Disorders, of 440 interviewees, 225 (58.0%) consumed refined iodized salt, 17 (3.9%) iodized salt, 14 (3.2%) both types of salt, and 154 (35%) did not know what salt was being used by their households. Of 440 interviewees, 44.1% stated the color of salt pockets as white and 55.9% did not know its color.

Of 440 interviewed women, 342 (77.7%) stated the refined iodized salts as the best salt for health, 42 (9.5%) the iodized salt, 10 (2.3%) the use of both salts, and 46 (10.5%) had no idea.

The most important reason for the use of refined iodized salt from households' perspective based on the results of the questionnaire (where participants were allowed to select more than one option) included the lack of sand, gypsum, lead, selenium, and arsenic in the refined salt. From the perspective of 133 (30.2%) households, the best way to maintain iodine quality is to keep the salt away from light and moisture, and adding salt at the end of cooking to food. From the viewpoint of 124 (28.2%) households, the storage of salt in plastic, wooden, pottery, and glass containers and the addition of salt at the end of cooking to food are considered as the most appropriate methods for maintaining the iodine quality. Table 1 summarizes the results of obtained information in this section. It is of note that the participants were allowed to choose more than one option.

Table 1. The ways to maintain iodine in salt from the perspective of households

Row	Ways to keep iodine in salt	n (%)
1	Storing the salt in the plastic, wooden, pottery, and glass containers	5 (1.1)
2	Storing the salt containers away from light and moisture	43 (9.8)
3	Adding the salt at the end of cooking	33 (7.5)
4	Not keeping the salt for a long time (more than 1 year)	3 (0.7)
5	Storing the salt in a plastic, wooden, pottery, and glass containers with a lid and keeping away from light and moisture	66 (15.0)
6	Storing the salt in the plastic, wooden, pottery, and glass containers, and adding it at the end of cooking	124 (28.2)
7	Keeping the container lid closed and keeping the salt away from light and moisture	8 (1.8)
8	Keeping the lid of the salt container always closed and not keeping it for a long time (over 1 year)	18 (4.1)
9	Keeping the lid of the salt container always closed and adding salt at the end of cooking to the food	3 (0.7)
10	Keeping the salt containers away from light and moisture and not keeping the salt for a long time (more than 1 year)	4 (0.9)
11	Adding the salt at the end of the cooking and keeping the salt container away from light and moisture	133 (30.2)

Table 2 presents the mean and SD of salt purity, heavy metals, and insoluble materials. During the sampling and analysis of the salts of households, a total of 19 salt suppliers were identified, and the obtained values (Table 2) were also examined in these suppliers.

Table 2. The mean and standard deviation (SD) of heavy metals, iodine content, purity, and insoluble materials in the total samples

Variable	Min	Max	Mean ± SD
Percentage of Purity	99.100	99.400	99.270 ± 0.115
Percentage of insoluble materials	12.000	19.000	14.990 ± 1.470
Iodine (γ/g)	23.000	36.000	29.300 ± 3.820
Lead amount (ppb)	0.045	0.083	0.060 ± 0.011
Cadmium content (ppb)	0.005	0.070	0.040 ± 0.013

Min: Minimum; Max: Maximum; SD: Standard deviation

The mean and SD of urinary iodine of 118 urine samples taken in this study was 18.38 ± 19.90 µg/l, with the lowest and highest values being 1.1 and 100.2 µg/l, respectively. These items are listed in table 3.

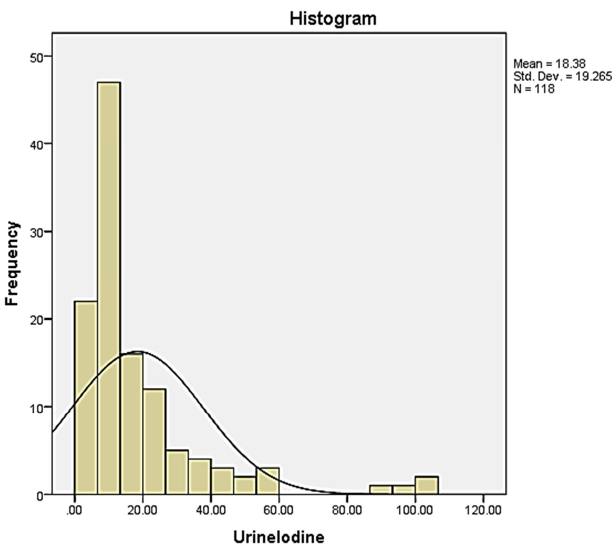

Figure 1. Skewed distribution curve of urinary iodine concentration (UIC) (µg/l)

The histogram of urine iodine amount is plotted in figure 1. The frequency of UIC was a positive skewness distribution.

Discussion

Investigating the storage and consumption of the iodized salt in the households in Markazi Province revealed that 65.0% of households consumed the iodized salt and about 35.0% of them were not aware of the salt type they were consuming. Based on the results of the study, about 60.0% of the households in the province were aware of the correct way of keeping the salt in order to maintain iodine quality. According to the results of Azizi et al., who studied the adequacy of iodization in Yazd Province, Iran, 86.0% of Yazd households used the refined salt and the way of keeping the salt was correct in 48.0% of them.[20]

The results of this study indicate that despite the informative programs on iodized salt in the last decades in Markazi Province, awareness of families about the refined iodized salt is not optimal such that it is necessary to inform and educate them in this regard. Furthermore, improving the behavior of salt storage to maintain the quantity and quality of iodine requires extensive education and information.

Based on the results of this study, the average lead concentration in various brands of salt was 0.064 ppm. The lead content of the manufacturing companies was at least 0.04 ppm and the maximum was 0.08 ppm. The average cadmium concentration in various salt brands was 0.044 ppm, with the minimum and maximum concentrations being 0.030 and 0.062 ppm, respectively. Therefore, it can be concluded that salt production companies met the standard limits of heavy metals.

Table 3. The mean, median, and standard deviation (SD) of urine iodine

Variable	N	Minimum	Maximum	Median	Mean ± SD
The amount of urine iodine (µg/l)	118	1.10	100.20	11.15	19.92 ± 18.38

SD: Standard deviation

Hedayatifar measured the concentration of lead, cadmium, mercury, and arsenic in the salt using the graphite furnace atomic absorption in Lorestan Province, Iran, and reported that the amount of the heavy metals was below the maximum level reported by the Codex.[18]

The mean amount of iodine in consumed salts was 29.3 ± 3.8 γ. The minimum and maximum iodine in producing companies was 25 γ and 36 γ, respectively. Only half of the salt producers (out of 19 identified brands) had iodine levels above 30 γ. The recommended amount of salt iodine in Iran, based on existing standards, should be 40 ± 10 γ of salt. If this amount is less than 30 γ or more than 50 γ, the iodine level in salt is not considered as optimum. According to the results of Azizi et al.,[20] who studied the adequacy of iodization in Yazd Province, 5.0% of the household salts had the iodine less than 15 γ, 45.0% between 15-30 γ, 45.0% between 30-50 γ, and 5.0% had more than 50 γ, which is optimum compared to the iodine level in salts of the Markazi Province. Moreover, in the study of Mehdinia et al., who investigated the iodine levels in iodized salts distributed in Semnan Province, Iran, in 2004,[21] of 16 types of distributed iodized salt in Semnan Province, the mean iodine in 31.0% of iodized salts was outside the acceptable range of 30 to 50 γ. About 12.5% of salts had less than 30 γ of iodine and 18.7% had the iodine over 50 γ. Based on the results of this study, more accurate monitoring and control of iodized salt production process is necessary at the provincial level,[21] which is consistent with our study.

In our study, the average purity was 99.2% in all brands of consumed salts. There was no statistically significant difference in purity between the companies. The mean percentage of insoluble materials was 14.9%, and the percentage of insoluble materials by producing companies was at least 12.0% and at most 16.0%. According to available standards for salt, the total amount of the substances in insoluble water in household's salt was at a maximum of 0.16 g. Therefore, only one company with an average of 0.19 g had the amount more than standard, and the rest of them and salt producers were optimum in this regard. According to the results of Amiri Raftani and Solaimani who studied the purity and iodine content of salts in Kermanshah Province, Iran, in 2017, 25.0% of the tested salts had a purity less than the permissible minimum of 99.2%.[22]

In our study, the mean urinary iodine in the samples was 19.2 ± 18.3 µg/l. The normal distribution curve for urinary iodine is skewed to the right and the median urinary iodine level is below 20 µg/l (i.e., 11.15 µg/l). Since the urinary iodine levels less than 100 µg/l are considered as low, the households of the study area may have an inadequate iodine level. Measuring the urinary iodine is the most important monitoring indicator for iodine programs since the low iodine excretion indicates the inadequate intake of iodine.[23] In the study of Azizi et al., in Yazd Province in 2007, the mean urinary iodine in 120 students was 248 µg/l and 5.8% of them had urinary iodine less than 50 µg/l, suggesting the appropriate iodization in the area.[20] This result is inconsistent with the results of the present study. Similarly, in the study of Nazeri et al., who investigated the urinary iodine and iodine intake in households in southern Tehran, Iran, in 2009,[24] the mean urinary iodine in the population under study was 48 µg/l. Also, in 64.8% of households, the average iodine salt intake was less than 10 γ, indicating the inadequate iodine in the area; this result is consistent with the results of the present study. In the study of Azizi et al., monitoring the prevalence of goiter and urinary iodine in 8-10-year-old students in Fars Province, Iran, in 1998,[8] the mean iodine excretion in the studied population was 30 µg/dl, which was more than 10 µg/dl in 89.0% of the cases, suggesting that iodine in this region reached the WHO optimal level.

Conclusion

According to the findings of the present study, due to lack of proper and continuous monitoring of the cycle of salt production in the market, there is a risk of the recurrent iodine deficiency complications in Markazi Province. Furthermore, it is necessary to implement educational and informational interventions for promoting the use of iodized refined salt, the storage of refined iodized salts, and awareness level about the side effects of iodine deficiency. Overall, performing periodic evaluations to assess the change in the behavior of storing the refined iodized salts, UIC, purity of salts, and iodine content in salts consumed in this area is of great necessity.

Conflict of Interests

Authors have no conflict of interests.

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References

1. Delshad H, Mehran L, Azizi F. Appropriate iodine nutrition in Iran: 20 years of success. Acta Med Iran 2010; 48(6): 361-6.
2. Javaheri J, Delavar M, Khodayari M. Examination of iodine and purity of salts in different level with surveying of storage and consumption habits and urine iodine measurement in Markazi Province's households in 2015 year [Project]. Arak, Iran: Arak University of Medical Sciences; 2015. [In Persian].
3. Wang Z, Zhu W, Mo Z, Wang Y, Mao G, Wang X, et al. An Increase in Consuming Adequately Iodized Salt May Not Be Enough to Rectify Iodine Deficiency in Pregnancy in an Iodine-Sufficient Area of China. Int J Environ Res Public Health 2017; 14(2): 206.
4. Pasdar Y, Mohammadi G, Mansouri A, Alghasi S, Darbandi M, Mahmoodi M, et al. Iodine content in salt used in Kermanshah, 2013-2014. J Mazandaran Univ Med Sci 2016; 26(135): 144-8. [In Persian].
5. Mohammadi M, Azizi F, Hedayati M. Iodine deficiency status in the WHO Eastern Mediterranean Region: A systematic review. Environ Geochem Health 2018; 40(1): 87-97.
6. Mekonnen TC, Eshete S, Wasihun Y, Arefaynie M, Cherie N. Availability of adequately iodized salt at household level in Dessie and Combolcha Towns, South Wollo, Ethiopia. BMC Public Health 2018; 18(1): 1152.
7. Emami A, Shahbazi H, Sabzevari M, Gawam Z, Sarkissian N, Hamedi P, et al. Goiter in Iran. Am J Clin Nutr 1969; 22(12): 1584-8.
8. Azizi F, Sheikholeslam R, Hedayati M, Mirmiran P, Mahdavi A, Delshad H. Goiter survey and urinary iodine concentration in 8 to 10-year-old schoolchildren from Fars Province in 1996. Iran J Endocrinol Metab 2001; 3(1): 37-42.
9. Knowles JM, Garrett GS, Gorstein J, Kupka R, Situma R, Yadav K, et al. Household coverage with adequately iodized salt varies greatly between countries and by residence type and socioeconomic status within countries: Results from 10 national coverage surveys. J Nutr 2017; 147(5): 1004S-14S.
10. Azizi F, Mehran L. Experiences in the prevention, control and elimination of iodine deficiency disorders: A regional perspective. East Mediterr Health J 2004; 10(6): 761-70.
11. De Benoist B., Delange F. Iodine deficiency: Current situation and future prospects. Sante 2002; 12(1): 9-17.
12. Mo Z, Wang XF, Mao GM, Zhu WM, Xu PW, Zou Y, et al. Goitre and urinary iodine in coastal and inland areas with low and high iodized salt coverage in Zhejiang province, China. Asia Pac J Clin Nutr 2017; 26(4): 671-9.
13. Manousou S, Dahl L, Heinsbaek TB, Hulthen L, Nystrom Filipsson H. Iodine deficiency and nutrition in Scandinavia. Minerva Med 2017; 108(2): 147-58.
14. Khattak RM, Khattak MNK, Ittermann T, Volzke H. Factors affecting sustainable iodine deficiency elimination in Pakistan: A global perspective. J Epidemiol 2017; 27(6): 249-57.
15. Zahidi A, Zahidi M, Taoufik J. Assessment of iodine concentration in dietary salt at household level in Morocco. BMC Public Health 2016; 16: 418.
16. Nepal AK, Raj Shakya P, Gelal B, Lamsal M, Brodie DA, Baral N. Household salt iodine content estimation with the use of rapid test kits and iodometric titration methods. J Clin Diagn Res 2013; 7(5): 892-5.

17. Das DK, Chakraborty I, Biswas AB, Sarkar GN, Shrivastava P, Sen S. Iodine deficiency disorders among school children of Dakshin Dinajpur District, West Bengal. Indian J Public Health 2005; 49(2): 68-72.
18. Hedayatifar R. Determination of lead, cadmium, mercury and arsenic in salt by the graphite furnace atomic absorption spectrometry. Feyz 2013; 16(7): 617-8. [In Persian].
19. Kapil U. Successful efforts toward elimination iodine deficiency disorders in India. Indian J Community Med 2010; 35(4): 455-68.
20. Azizi F, Delshad H, Amouzegar A, Hedayati M, Hosseini M, Mehraein M. Assessment of iodine intake in Yazd province 17 years after universal salt iodization (The Fourth National Survey: 2007). J Shaheed Sadoughi Univ Med Sci 2010; 18(3): 263-70. [In Persian].
21. Mehdinia S, Nasehinia H, Gharib-Bolok R, Azizi R, Rezai M. A Survey of iodine concentration in the iodine salts distributed in the province of Semnan in autumn 2004. Koomesh 2005; 6(4): 285-90. [In Persian].
22. Amiri Raftani Z, Solaimani S. Evaluation of the purity and iodine content of edible salts in the supply level of Kermanshah province. Iran J Nutr Sci Food Technol 2018; 15(9): 17-23. [In Persian].
23. Heidari Z, Arefhosseini SR, Hedayati M, Vaghef-Mehrabany E, Ebrahimi-Mameghani M. Iodine status, and knowledge about iodine deficiency disorders in adolescent school girls aged 14-19 years, 2016. Health Promot Perspect 2019; 9(1): 77-84.
24. Nazeri P, Mirmiran P, Delshad H, Hedayati M, Azizi F. Evaluation of Urinary Iodine Concentration and Iodine Content of Households Salt in South of Tehran. Iran J Endocrinol Metab 2010; 12(3): 294-9. [In Persian].