Journal of Nutritional & Environmental Medicine (2001) 11, 175–180

LABORATORY RESEARCH

Dietary Iodine Intake and Prevalence of Iodine Deficiency Disorders in Adults

MONIKA VERMA MSc AND RITA S. RAGHUVANSHI PhD

Department of Foods and Nutrition, College of Home Science, G.B. Pant University of Agriculture & Technology, Pantnagar 263 145, Uttranchal, India

Abstract

Purpose: *The term iodine deficiency disorders (IDD) reflects the spectrum of health effects owing to iodine deficiency in all age groups. Although environmental iodine deficiency leading to dietary iodine inadequacy is one major factor responsible for IDD, goitre is endemic in Terai, North India, despite iodized salt consumption by the majority of the population. The study was designed to discover the adequacy of iodine in the cooked daily diet of adults, and relate it to the prevalence of IDD in the region as the information on the iodine content of cooked mixed diets is limited.*

Materials and Methods: *Eighty low-income group adults (40 males and 40 females) of Pantnagar, situated in Terai, North India, were randomly selected for the study. Morning urine samples, salt and the diet samples for iodine estimation were collected from selected subjects. The entire population was divided into normal and those having IDD based on their urinary iodine excretion (UIE). Percentage loss of iodine in cooking was calculated by comparing the iodine content of cooked and uncooked food.*

Results: *An overall IDD prevalence of 44% was found, comprising 35% of males and 53% of females. In the studied population, 76% of the subjects consumed salt with 15 mg/kg or more of iodine. The average iodine content in the uncooked and cooked diet samples was 358 and 104 μg respectively indicating a loss of about 70% iodine while cooking. The cooked diets of only 32.5% of the subjects contained adequate iodine for normal functioning of the body.*

Conclusion: *Subnormal iodine content in the cooked daily diet of adults is the main cause of IDD, despite iodized salt consumption in the region because iodine loss while cooking is appreciable. The results of the present study, therefore, stress the need to minimize loss of iodine in cooking by adding salt on cooked food rather than adding salt while cooking.*

Keywords: iodine deficiency disorders (IDD), diet, salt, cooking.

INTRODUCTION

Iodine deficiency is the world's single most significant cause of preventable brain damage and mental retardation [1] affecting 118 countries world-wide. Clinical and subclinical manifestations of iodine deficiency, collectively denoted by the term iodine deficiency disorders (IDD) [2], affect all stages of human life and encompass a variety of conditions including goitre, cretinism, dwarfism, mental retardation, muscular disorders, spontaneous abortions and stillbirths. India is one of the major endemic areas of IDD where 167 million

ISSN 1359-0847 print/ISSN 1364-6907 online/01/030175-06 © Taylor & Francis Ltd
DOI: 10.1080/13590840120083394

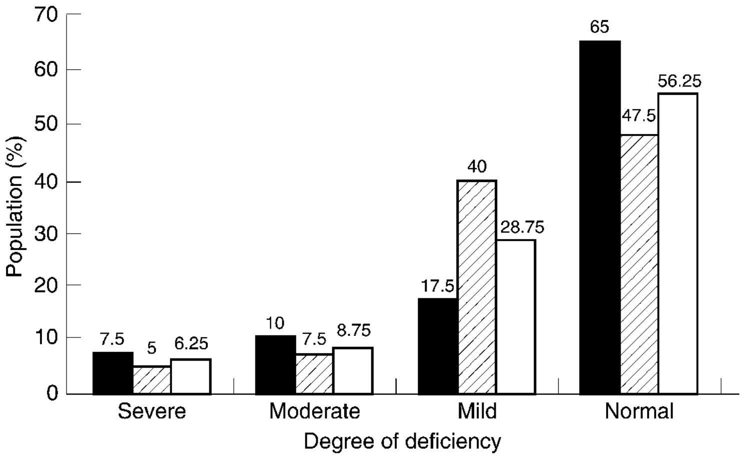

FIG. 1. Urinary iodine excretion of adults (■ males; ▨ females; □ total).

people are at risk, 54 million people have goitre, 6.6 million have mild neurological defects and 2.2 million are cretins [3]. The Terai region of North India falls within an area of endemic goitre in India with an overall goitre prevalence ranging from 34 to 50% [4]. Environmental iodine deficiency leading to dietary inadequacy is one of the main factors responsible for IDD, but studies conducted in the Terai area indicate goitre endemicity in children of the region despite the adequate availability and consumption of iodized salt [5]. A study conducted at the National Institute of Nutrition indicated appreciable losses of iodine during the cooking of various food items [6]. Therefore, in an attempt to find out the factors leading to IDD despite adequate iodized salt intake, the present study was conducted to discover the adequacy of iodine in the cooked daily diet of adults and relate it to the prevalence of IDD in the region.

MATERIALS AND METHODS

The study population comprised 80 randomly selected low-income group adults (40 males and 40 females) of Pantnagar, in the district of Udham Singh Nagar, situated in the Terai region of North India.

Sample Collection

About 20 g salt samples and 10% of the weighed diet samples consumed by the subjects at all their meals in a day were collected in self-sealing polythene packets at the survey site. Morning urine samples in glass vials treated with chromic acid and cleaned with deionized water were collected from the subjects on the day following the collection of the diet samples.

Urinary Iodine Estimation

The collected urine samples were stored in a refrigerator at 4°C until analyzed for iodine content using the standard laboratory method [7]. On the basis of urinary iodine excretion, subjects were classified into four groups with urinary iodine excretion less than 2, 2 to 4.9, 5 to 9.9 and 10 $\mu g\ dl^{-1}$ indicating severe, moderate, mild and no deficiency, respectively.

Salt Iodine Estimation

The iodine content of the salt samples was estimated using the iodometric titration method [8].

Dietary Iodine Estimation

The collected diet samples were brought to the laboratory and were dried at 60°C in an oven for approximately 7–8 hours. The samples were powdered finely and stored for estimation of iodine content using the standard technique [9]. The iodine value was calculated as the total iodine content of the cooked food consumed in a day.

Calculation of the Percentage Iodine Loss in Cooking

(1) The estimated iodine content in salt samples was multiplied by 10 to calculate the total intake of iodine through salt as the average salt intake is 10 g per person daily [10].
(2) A pilot study was conducted on 10% of the subjects in which both twenty-four hour recall survey and the food weighing method were used to check the reliability of the twenty-four hour recall survey. The values obtained by both these methods were found to be well correlated. Therefore, the twenty-four hour recall method was used for the rest of the subjects and iodine intake in the food items consumed by the subjects was calculated using the iodine values of commonly consumed food items [11].
(3) The sum of (1) and (2) represented the iodine content of raw food in the daily diet of the adults.
(4) The iodine content in the cooked diet samples was obtained by estimating the iodine in the diet samples collected from the subjects.
(5) Percentage iodine loss while cooking was calculated by using the formula:
Iodine in uncooked food − Iodine estimated in cooked food/Iodine in uncooked food × 100

RESULTS

Urinary Iodine Excretion

The iodine status of the population was found by measuring the urinary iodine excretion of the subjects. IDD prevalence was calculated as 44%, comprising 35% of males and 53% of females. Severe, moderate and mild iodine deficient status was found in 6, 9 and 29% of the total population. The average urinary iodine excretion (UIE) in the severe, moderate and mild iodine deficient groups and in the normal population was 0.76, 3.97, 8.09 and 12.88 μg/dl, respectively. Median UIE values were 10.48, 9.76 and 10.26 μg/dl for males, females and the total population, respectively. Mean UIE for the total population of adults was 9.94 μg/dl.

Salt Iodine Content

It was observed that none of the subjects in the selected population consumed salt devoid of iodine and 76% of the subjects in the total population consumed salt with 15 mg/kg or more iodine (Table 1).

Average Iodine Intake Through Diet in Uncooked Food

The average iodine intake through salt and through uncooked food was 338 and 358 μg respectively (Table 2) indicating that IDD was endemic in the region despite the adequate availability and consumption of iodized salt. Salt provided roughly 95% of the total iodine

TABLE 1. Iodine content of salt samples (mg/kg of salt)

mg iodine/kg of salt	Deficient (35)		Normal (45)		Total (80)	
	N	%	*N*	%	*N*	%
0	–	–	–	–	–	–
1–15	7	20.0	12	26.7	19	23.8
$\geqslant 15$	28	80.0	23	73.3	61	76.2

TABLE 2. Dietary iodine intake (μg) and percentage loss while cooking

Classification of IDD	Iodine intake through: Salt	Uncooked diet with salt	Cooked diet with salt	Percentage loss while cooking
Severe (5)	296 ± 129	319 ± 128	86 ± 25	73.2
Moderate (7)	304 ± 208	329 ± 209	101 ± 38	69.3
Mild (23)	344 ± 170	365 ± 173	99 ± 41	72.8
Iodine deficient (35)	329 ± 169	351 ± 171	98 ± 37	72.2
Normal (45)	334 ± 187	363 ± 188	109 ± 41	69.9
Total population (80)	338 ± 177	358 ± 180	104 ± 40	70.9

consumed by the subjects. There was a significant positive correlation ($r = 0.235$ $p < 0.05$) between UIE and total dietary iodine intake in uncooked food.

Average Iodine Intake Through Cooked Food and Percentage Loss After Cooking

Average iodine in the cooked diet sample was 104 μg, indicating a loss of about 70% iodine through cooking (Table 2). The diet of 67.5% of the subjects from the total population was deficient in iodine (Table 3) and no significant difference was found in the iodine intake of normal and deficient subjects. This indicates the non-availability of iodine from uncooked food or the role of other factors such as malnutrition, poor sanitation, low socio-economic status and food goitrogens in the aetiology of IDD. Median iodine intake per day was 89.19, 93.74 and 91.5 μg for the iodine deficient, normal and total population, respectively. A positive but non-significant correlation ($r = 0.118$) was found between UIE and the iodine content of cooked food. The iodine content in cooked food was less than 150 μg in 89% of the subjects.

TABLE 3. Distribution of iodine intake through cooked diet among iodine deficient and normal subjects

Iodine intake (μg)	Deficient (35)		Normal (45)		Total (80)	
	N	%	*N*	%	*N*	%
$\geqslant 150$	2	5.7	7	15.6	9	11.3
120–150	9	25.7	8	17.8	17	21.3
90–120	6	17.2	11	24.4	17	21.3
60–90	16	45.7	16	35.5	32	40.0
< 60	2	5.7	3	6.7	5	6.2

DISCUSSION

The urinary iodine level reflects an individual's iodine consumption as 90% of the body's iodine is excreted through urine, and thus the excretion of iodine is used as a biochemical marker of iodine intake [7]. Urinary iodine estimation revealed a 44% iodine deficiency status in adults. Median UIE values of 10.48, 9.76 and 10.26 μg/dl for males, females and the total population respectively indicate mild endemicity of IDD in females and in both males and females of the region following the criteria given by ICCIDD/WHO/UNICEF (1994) [12] and the modification proposed by Karmarkar and Pandav (1999) [13].

The results show that 76% of the subjects consumed salt with an adequate iodine content. The average daily iodine intake through salt and uncooked food in both the deficient and the normal group was greater than the minimum iodine requirement of 120–150 μg, and sufficient to meet the growth and functional needs of the body. The results reveal endemicity of IDD, implying the non-availability of iodine from salt for body metabolism. Average iodine in the cooked diet samples was found to be 104 μg, indicating a loss of about 70% through cooking. This revealed that, although the uncooked diet of the subjects contained more than the recommended levels of iodine, the amount which the subjects received after cooking was not sufficient to meet the body's physiological requirements. High losses of iodine while cooking can be attributed to the volatile nature of the compound. Thus, to prevent losses while cooking it is advisable to sprinkle salt on food after cooking rather than adding salt while cooking as has been done traditionally. Further, storage of salt in hot and humid conditions near the cooking area may also lead to iodine loss.

The diets of only 32.5% of the subjects contained sufficient iodine to meet the body's functional needs. The majority of the population (67.5%) consumed sub-normal amounts of iodine in their daily diet and this could be one of the major reasons for the high prevalence of IDD in the region. However, a general iodine deficiency in the cooked diets of both iodine deficient and normal subjects indicates the possible role of other goitrogenic factors, such as food goitrogens [14], poor sanitation [15], lower socio-economic status and general malnutrition [16] in the aetiology of IDD. A positive but non-significant correlation between UIE and the iodine content in the cooked diet samples was due to the uneven loss of iodine from the diets of the subjects as no standardized cooking practices were followed by the people of the community and the diets of only 11% of the subjects in the total population contained more than 150 μg of iodine.

CONCLUSION

The results of the present study suggest that iodine values calculated from raw foods give a wrong impression with regard to iodine intake as losses while cooking are appreciable. Therefore, mere consumption of iodized salt does not indicate iodine adequacy in the daily diet of adults. It can be concluded from the results that subnormal iodine intake, along with other goitrogenic factors, was responsible for the persistence of IDD despite the adequate availability and consumption of iodized salt in the region. The findings therefore stress the need to minimize cooking losses of iodine by adding salt to food items after cooking and storing salt in sealed airtight containers away from fire. The findings indicate a need to study further the chemical ways in which iodine losses can occur from salt or food items during cooking.

REFERENCES

[1] WHO/UNICEF/ICCIDD. Micronutrient Deficiency Information System. Global prevalence of iodine deficiency disorders. Geneva: World Health Organisation, 1993.
[2] Hetzel BS. Iodine deficiency disorders and their eradication. Lancet 1983; 2: 1129–9.
[3] Status Report on National Iodine Deficiency Disorders Control Programme (NIDDCP). Policy and

Advocacy Meeting on IDD. New Delhi: Ministry of Health and Family Welfare, Government of India, 1994.
[4] Raghuvanshi RS. Problems of endemic goitre in Terai region, and possible measures to control. In: Proceedings of the Workshop on Iodine Deficiency Disorders Control and Women and Child Development Pantnagar. 19–20 January, National Service Scheme, Lucknow and UNICEF, New Delhi 1994; 16–21.
[5] Mittal M, Tandon M, Raghuvanshi RS. Iodine status of children and use of iodized salt in Terai region of North India. J Trop Pediatr 2000; 46: 300–2.
[6] Ranganathan S, Reddy V. Human requirements of iodine and safe use of iodized salt. Nutrition News, NIN, Hyderabad 1995; 6:1.
[7] Dunn JT, Crutchfield H, Gutakunst R, Dunn D. Methods for measuring iodine in urine. International Council for Control of Iodine Deficiency Disorder 1993; 18–27.
[8] Tyabji R. The use of iodized salt in the prevention of IDD. In: A handbook of Monitoring and Quality Control. New Delhi: UNICEF/ROSCA, 1985; 18–29.
[9] Henry RJ. Clinical Chemistry: Principles and Techniques. New York: Harper and Row Publishers, 1964; 938–41.
[10] Diet and nutritional status of specific groups of urban population 1975–79. In: National Nutrition Monitoring Bureau (NNMB) report. National Institute of Nutrition, Hyderabad, India, 1984; 25–40.
[11] Raghuvanshi RS. Iodine profile of food and foliage. In: Pandav CS, Rao AR (eds) Iodine Deficiency Disorders in Livestock, Ecology and Economics. New Delhi: Oxford University Press, 1997; 179–93.
[12] WHO/UNICEF/ICCIDD. Report of joint consultation of indicators for assessing IDD and their control programmes. Geneva: World Health Organization, 1992.
[13] Karmarkar MG, Pandav CS. Interpretation of indicators of iodine deficiency disorders. Recent experiences. Nat Med J Ind 1999; 12: 113–17.
[14] Clements FW. Naturally occurring goitrogen. Br Med Bull 1960; 16: 133–7.
[15] Gaitan E, Medira A, De rouen TA, Zia MS. Goitre prevalence and bacterial contamination of water. J Clin Endocrinol Metab 1980; 51: 957–61.
[16] Ingenbleek Y, Luypaert B, Nayer PDE. Nutritional status and endemic goitre. Lancet 1980; 1: 388–92.