SciMedCentral

Journal of Human Nutrition & Food Science

Research Article

Iodine Nutrition among the Pregnant and Lactating Women of Kolkata

Anirban Majumder[1]*, Arvinda Jaiswal[2] and Sudip Chatterjee[1]

[1]*Department of Medicine, West Bengal University of Health Sciences, India*
[2]*Department of Home Science, Calcutta University, India*

***Corresponding author**
Anirban Majumder, Department of Medicine, West Bengal University of Health Sciences 26A Gariahat Road South, Kolkata-31, India, Email: *dranirbanmazumdar@gmail.com*

Submitted: 11 December 2015

Accepted: 09 March 2016

Published: 11 March 2016

ISSN: 2333-6706

Keywords
- Gestation
- Iodine deficiency disorder
- Pregnancy
- Thyroid
- Urinary iodine excretion

Abstract

Objective: A cross-sectional study was carried out to assess the factors associated with iodine insufficiency among iodine deficient pregnant and lactating women.

Materials and methods: The present study assessed urinary iodine excretion (UIE) in the spot urine samples from 237 pregnant women, 73 lactating mothers and 59 healthy non-pregnant female controls. The iodine content in household salt samples, method of salt storage and the method of cooking process of the study subjects, the effect of boiling on iodine content of salt were also estimated.

Results: UIE value higher than 150 µg/l in pregnancy, higher than 100 µg/l in normal population and lactating women indicate adequate iodine nutrition. 37% pregnant women, 33% lactating women and 3% healthy non-pregnant female controls were iodine deficient. The household salt samples had poor iodine content (less than15ppm) among majority of these iodine insufficient pregnant women and iodine insufficient lactating women. However, 86% (n=76) iodine insufficient pregnant women and 75% (n=18) iodine insufficient lactating women were consuming branded iodised salt. 10% (n=9) Iodine insufficient pregnant woman, 8% (n=2) of iodine insufficient lactating woman and all iodine insufficient female control (n=2) were consuming salt from unbranded sources. Though most women used to add salt in the initial stages of cooking, 10% iodine sufficient pregnant women, 20% of iodine sufficient lactating women and 16% iodine sufficient female controls were adding salt in the middle or final stage of cooking. Loss of iodine from salt is negligible after simple boiling with water.

Discussion: 37% pregnant women and 33% lactating women exhibited iodine insufficiency. Salt iodine content needs to be higher in India as the current level of iodine supplementation in India, i.e. 15 parts per million was not sufficient to meet the increased demand of pregnancy and lactation. However, when the actual salt iodine content was measured, it was less than15ppm among majority of the iodine insufficient pregnant women (65%), iodine insufficient lactating women (71%) and iodine insufficient female control (100%).The poor iodine content in salt contributes to the substantial gap between supply and demand that occurs in pregnant and lactating women. The iodine content of unbranded and branded salt and the method of salt storage are also important factors. Addition of salt at the beginning of the cooking process reduces iodine content of food. Pregnant women should receive iodine education to cover salt purchase and storage and add salt at the end of the cooking process.

Conclusion: Salt iodine content, unbranded source of salt, method of salt storage and the cooking process are the important factors for iodine insufficiency in pregnant and lactating women of the study population.

ABBREVIATIONS

UIE: Urinary Iodine Excretion; IDD: Iodine Deficiency Disorder; USI: Universal Salt Iodisation; NIDDCP: National Iodine Deficiency Disorder Control Programme; WHO: World Health Organization; ICCIDD: International Council for Control of Iodine Deficiency Disorders; UNICEF: United Nations Children's Fund; USFDA: U.S. Food and Drug Administration; ppm : *Parts Per Million*

INTRODUCTION

Iodine deficiency disease (IDD) is known to be a significant public health problem worldwide [1]. Affected areas include

developing countries of Africa, Asia and Latin America, and also large parts of Central Europe [2]. IDD was recognized as a major public health problem in India after the pioneering work of Prof. V. Ramalingaswami and others [3]. In 1984, the Govt. of India decided to adopt the programme of Universal Salt Iodisation (USI) under which all salt for human consumption was to be fortified with iodine. In 1992, National Iodine Deficiency Disorder Control Programme (NIDDCP) was adopted [4]. However, the ban on the sale of non-iodized salt was lifted in 2000 [5] and was re-imposed in 2005 [6].

The recommended dietary intake of iodine during pregnancy is higher than 150µg/day recommended for non-pregnant adults and adolescents [7]. In a previous study, we observed that 37% of pregnant women had insufficient iodine nutrition (UIE <150µg/l) and 33% lactating mothers had insufficient iodine nutrition (UIE <100µg/l) [8]. Most studies from India found wide spread iodine deficiency among pregnant and lactating mothers [9-11]. The iodine content of food depends on many factors, such as amount of iodine fortification, its method of transportation (normally done in open wagons) , techniques of storage both in the shops and at homes, methods of cooking, repeated heating of food etc.

In this study, we investigated the factors associated with iodine insufficiency among iodine deficient pregnant and lactating women of Kolkata despite the Universal Salt Iodisation (USI) programme running for decades. The study was carried out on subjects living in and around the city of Kolkata, which is not known to be an iodine deficient region.

MATERIALS AND METHODS

The pregnant study subjects were consecutively recruited from the antenatal clinic of the Ramkrishna Mission Seva Pratishthan Hospital, Kolkata, India. In-hospital lactating mothers who had recently (less than 10 days) delivered their babies were consecutively recruited from the maternity ward. The control subjects were recruited from the female hospital employees. This hospital serves disadvantaged socio-economic group patients at nominal charges. This observational study was approved by the Hospital's Ethics Committee and informed consent was obtained from all subjects.

Inclusion criteria:

1. Age between 20 and 45 years.
2. Pregnant or breast feeding women.
3. Exclusion criteria.
4. Any concomitant acute or chronic illness or disease.
5. Known history of thyroid disorder: present or past.
6. Ingestion of iodine containing products like cough syrups.

All pregnant women attending the antenatal clinic and all lactating women in the maternity ward were approached for the study during the 6 months data collection period. The subjects were explained in their local language regarding the aim and purpose of the study. After they agreed to participate, a consent form was signed by each subject stating that they had understood the purpose of the study and were voluntarily participating.

All subjects were requested to fill up a questionnaire regarding the sources of the salt purchased (branded salt or from low priced open source) and the time of addition of salt (initial stage, middle stage or final stage) during conventional cooking at home.

Estimation of Urinary Iodine Excretion (UIE) of study subjects

After collecting the basic data (age, gestational age for pregnant mothers, date of last childbirth for lactating mothers and presence of any exclusion criteria), the pregnant mothers were requested to give spot urine samples during their routine clinic visit (between 8-10.30 am). In-hospital lactating mothers who had recently (less than 10 days) delivered their babies were requested to participate in the study and their urine samples were collected from the ward. The morning urine samples of the healthy female hospital employees of different departments were collected as control. The urine samples were collected by the respective subjects in the plastic screw capped and labelled containers provided to them. Only small amounts (10-20 ml) of urine were collected from each participant. Evaporation was avoided by tight screw tops, because evaporation artificially increases the concentration [12]. They do not require refrigeration, addition of preservative, or immediate determination and can be kept in the laboratory for months or more, preferably in a refrigerator to avoid unpleasant odour [12]. After the day's collection was over, the samples were placed in an insulated iced box and transported to the laboratory for analysis. Samples were stored in refrigerator of the laboratory and were taken for analysis in each week end.

UIE was assessed using the Ammonium Persulphate method as recommended by the World Health Organization (WHO) [12].

The information provided by each subject was checked against their hospital records. Subjects who were either unaware or withheld significant information were excluded from the study. Finally, data on 237 pregnant women, 73 lactating mothers and 59 healthy non-pregnant female controls were included for analysis.

Estimation of Iodine Content in household salt samples of the study subjects: The subjects were requested to bring 4 teaspoons (20g) of household salt in plastic pouches provided to them. The analysis of iodine content of the salt was done by conventional Iodometric Titration [13].

Estimation of Iodine Content in boiled water samples: Three 100ml potable water samples were boiled in the laboratory for 2 minutes. One sample had no added salt while the other two had 25g and 50g of branded iodised salt respectively. Iodine content of the water from 3 containers were estimated after cooling.

The same process was repeated with 5g of lentils added to the water. Iodine content of the supernatant water from all the samples was estimated after cooling to room temperature. This was done by the Ammonium Persulphate method as recommended by the World Health Organization (WHO) for estimation of Urinary Iodine excretion [12].

RESULTS

On the basis of UIE cut-off values as set by the WHO [12], the three (pregnant, lactating & control) groups of subjects were categorised as insufficient iodine nutrition (cut off for pregnant women UIE <150µg/l and cut off for lactating women & control subjects <100µg/l) and sufficient iodine nutrition (cut off for pregnant women UIE >150µg/l and cut off for lactating women & control subjects >100µg/l).

Most of the iodine insufficient pregnant woman (88%), iodine insufficient lactating woman (87.5%) and iodine insufficient female control (100%) were adding salt in the initial stages of cooking. 10% (8+2%) iodine sufficient pregnant women, 20% (6+14%) iodine sufficient lactating women and 16% (7+5%) iodine sufficient female control) were adding salt in the middle or final stage of cooking. It appears from the table, adding salt in the later stages of cooking retains the iodine content of food.

DISCUSSION

UIE is a good marker of recent iodine intake and is widely accepted as a representative best indicator of iodine nutrition status [14]. The UIE levels are used to categorise the iodine nutrition of pregnant and lactating women on the basis of cut-off values set by the WHO [12]. The three (pregnant, lactating & control) groups of subjects are categorised as insufficient iodine nutrition (cut off for pregnant women UIE <150µg/l and cut off for lactating women & control subjects <100µg/l) and sufficient iodine nutrition (cut off for pregnant women UIE >150µg/l and cut off for lactating women & control subjects >100µg/l).

The cut-off values of adequate iodine nutrition in pregnancy are higher (150µg/l) as compared to normal population and lactating women (100µg/l). The recommended dietary intake of iodine during pregnancy and the cut off values for UIE were revised by the Technical Consultation convened by WHO Secretariat in 2007 [14] and were later endorsed by WHO/ICCIDD/UNICEF [12]. The recommended iodine intake during pregnancy was increased from 200 to 250 µg/day and UIE cut off was increased from 100µg/l to 150µg/l. The recommended iodine intake in lactating women is 250ug/day and for women of reproductive age is 150µg/day [12]. This upward revision means that current level of iodine supplementation in salt is inadequate in pregnancy and lactation. Salt with 15parts per million (15ppm) level of iodine and a daily average salt consumption of 10gm will provide only 150µg/day of iodine. Impact of poor iodine nutrition among pregnant women may be far reaching and there is a suggestion of inferior perinatal outcome with insufficient iodine nutrition in respect of respiratory distress at birth [8].

In the present study, it was observed that out of 237 pregnant women, 88 (37%) exhibited insufficient iodine nutrition (UIE <150µg/l) (Table 1) and out of 73 lactating mothers in the study, 24(33%) exhibited iodine insufficiency (UIE < 100µg/l) (Table 1). In contrast, only 2 (3%) female control subjects had iodine deficiency (UIE < 100µg/l) and the rest (97%) had sufficient iodine nutrition status (UIE >100µg/l) (Table 1). There is high prevalence of micronutrient deficiencies amongst the pregnant women in India including iodine, possibly due to the poor dietary intake and low frequency of consumption of food groups rich in micronutrients (pulses, vegetables, fruits, nuts and oil seeds, animal foods) [15]. Kolkata is a iodine replete area and 63% of pregnant women, 67% of lactating women and 97% of female control subjects have sufficient iodine status but a very significant percentage of pregnant women and lactating women are iodine deficient also. Many studies from all over India (Rajasthan, West Bengal, Delhi, Haryana, Uttaranchal, Himachal Pradesh and Maharashtra) reported wide spread iodine deficiency among pregnant and lactating mothers [9-11] despite the fact that most of the women had access to >15ppm iodized salt [11]. The current salt iodisation guidelines (15ppm of iodine at consumer level) are designed to deliver 150µg of iodine per day and we have already pointed out that this is inadequate for pregnant women, whose dietary requirements are much greater (250µg/day) [8]. To cover this increased iodine demand of 250ug/day during pregnancy and lactation, salt iodine content needs to be higher. There was no iodine insufficient pregnant woman when iodine content in household salt samples were above 25 ppm (Table 2). Hence, it appears that the salt iodination program adopted by the Govt of India is adequate for general population but insufficient for the vulnerable population (pregnant and lactating mothers). The U.S. Food and Drug Administration (USFDA) recommends 60-100 mg Kl/kg salt, equivalent to 46-76 mg iodine/kg salt (i.e. 46-76ppm) and all U.S. iodized salt contains 45 mg iodine/kg according to labels [16]. Adequate iodine nutrition among pregnant women is ensured when the salt iodine content raised to 30 mg/kg (i.e.30ppm) at the consumer level [9]. Higher salt iodine content (50mg Iodine per kg salt i.e. 50 ppm) at the site of manufacture can ensure delivery of 300µg/day (or at least 250 ug/day due to

Table 1: Showing the categorised insufficient iodine nutrition and sufficient iodine nutrition among the pregnant women (n=237), lactating women (n=73) and Female Control Subjects (n= 59):

Subject	No. of subjects	Insufficient iodine nutrition	Sufficient iodine nutrition
Pregnant women	237	88 (37%)	149 (63%)
Lactating women	73	24 (33%)	49 (67%)
Female Control Subjects	59	2 (3%)	57 (97%)

The subjects were divided into six groups based on urinary iodine excretion status –

1. Iodine insufficient pregnant woman (n=88)
2. Iodine sufficient pregnant woman (n=149)
3. Iodine insufficient lactating woman (n=24)
4. Iodine sufficient lactating woman (n=49)
5. Iodine insufficient female Control (n=2)
6. Iodine sufficient female Control (n=57)

loss during transportation) of iodine when the daily average salt consumption was calculated as 10g.

It is clear that when salt iodine content was low (less than15ppm) iodine insufficiency was noted in pregnancy, in lactation and in controls. Branded salt generally carries a label stating that it contains over 30 ppm of iodine at the time of packaging. It is conventionally assumed that a loss of 50% of the iodine will occur by the time the salt reaches the kitchen of the consumers [17]. Those consumers who actually had a household salt iodine content of over 25ppm could meet the increased demand of pregnancy. However, the majority of our subjects had a household salt iodine content of less than 15ppm in spite of using branded salt (Tables 2,3). A heterogenous group of manufacturers, large and small, sell branded salt in the Indian market. Some of them do not even mention the iodine content of their product.

It is well known that the concentration of iodine in salt decreases significantly (almost 50%) from the production site to the consumers due to loss from transportation [17] and also due to lack of proper storage in the household [18]. The loss of iodine may occur from commonly practised storage methods (i.e., glass jar, plastic jar, earthen ware pot, cut open salt packet etc) and also from higher environmental temperature (37 degrees C) and from higher environmental humidity commonly found in India [19,20]. Suboptimal iodine content (less than 15ppm) in household salt samples of iodine insufficient women (pregnant & lactating) might be due to poor storage methods in Indian household.

While cooking food, it is customary to add salt in the initial stages of cooking in this part of the country. The few subjects (10% iodine sufficient pregnant women, 20% of iodine sufficient lactating women and 16% iodine sufficient female control) who added salt in the middle or final stage of cooking had higher iodine content in their food (Table 4). The loss of iodine in food depends upon type of cooking method and time of addition of salt during cooking [21]. On the other hand, only boiling of food was not associated with much loss of iodine (Table 5). But another study showed the loss of iodine during boiling was as high as 40.23% [21].

Till the levels of universal salt iodisation is stepped up (as done in US), pregnant women should receive Iodine Education in the form of nutrition consultation in each antenatal visit:

1. Use only branded iodised salt during pregnancy and nursing period.
2. Iodised salt should be stored properly (in air tight glass jar).
3. Iodised salt should preferably be added in the later stages of cooking.
4. Consumption of salt from open unbranded sources should be avoided.

The results of this study may not be generalisable to all the pregnant women in Kolkata as it was a hospital based convenient sampling in an urban setting. Our study was conducted in an iodine replete area and it may be assumed that higher levels of perinatal iodine deficiency would exist in iodine deficient regions.

However, the possible adverse health effects of Universal Salt Iodization are also a concern. In a study of >200 Chinese adults, subclinical hypothyroidism was more common in those supplemented with a 400 µg iodine tablet than in those given placebo [22]. In contrast, studies in Denmark [23] and New Zealand [24], showed an increased prevalence of transient hyperthyroidism. The incidence of thyrotoxicosis was increased

Table 2: Estimation of iodine content in household salt samples of the subjects.

Groups	No. of subjects	< 15 ppm	15-20ppm	20-25ppm	25-30ppm	> 30ppm
1) Iodine insufficient pregnant woman	88	61(69%)	23(26%)	4(5%)	-	-
2) Iodine sufficient pregnant woman	149	3(2%)	93(62%)	20(13%)	21(14%)	12(8%)
3) Iodine insufficient lactating woman	24	17(71%)	5(21%)	2(8%)	-	-
4) Iodine sufficient lactating woman	49	0	2(4%)	9(18%)	18(37%)	20(41%)
5) Iodine insufficient Female Control	2	2 (100%)	-	-	-	-
6) Iodine sufficient Female Control	57	0	4(7%)	6(11%)	32(56%)	15(26%)

It appears from the above data that UIE was in normal range (UIE >150ug/l) in pregnancy if the household salt iodine content was 25 ppm or more.

Table 3: Sources of the salt purchased for household cooking (as per questionnaire).

Subjects	No. of subjects	Branded iodised salt	Unbranded source salt	Unaware of source
1) Iodine insufficient pregnant women	88	76 (86%)	9 (10%)	3 (4%)
2) Iodine sufficient pregnant women	149	142 (95%)	-	7(5%)
3) Iodine insufficient lactating women	24	18 (75%)	2(8%)	4(17%)
4) Iodine sufficient lactating women	49	45(92%)	1(2%)	3(6%)
5) Iodine insufficient female control	2	-	2(100%)	-
6) Iodine sufficient female control	57	57(100%)	-	-

Higher percentage of iodine sufficient pregnant woman (86%), iodine sufficient lactating woman (92%) and iodine sufficient female Control (100%) were consuming salt from branded sources.

Table 4: Addition of salt at different stages of cooking (as per questionnaire):

Subjects	No. of subjects	Initial Stage	Middle Stage	Final Stage
Iodine insufficient pregnant woman	88	77(88%)	11(12%)	-
Iodine sufficient pregnant woman	149	134(90%)	12(8%)	3(2%)
Iodine insufficient lactating woman	24	21(87.5%)	3(12.5%)	-
Iodine sufficient lactating woman	49	39(80%)	3(6%)	7(14%)
5) Iodine insufficient female control	2	2(100%)	-	-
5) Iodine sufficient female control	57	48 (84%)	4 (7%)	5 (9%)

Table 5: Impact of boiling water and lentils with iodised salt.

Sample	Item description	Iodine content before boiling (µg/100g)	Iodine content after boiling (µg/100ml)
1.	Water(no added salt)	31.15	30.60
2.	Water (with 25g iodised salt)	186.89	183.15
3.	Water (with 50g iodised salt)	373.80	366.32
4.	5gm Boiled lentils (no added salt)	30.00	30.00
5.	5gm Boiled lentils (with 25g iodised salt)	116.52	114.28
6	5gm Boiled lentils (with 50g iodised salt)	216.63	206.6

From the above table it is quite evident that there is negligible loss of iodine after boiling with water in an open pan.

following periods of mandatory salt iodization, compared with when supplementation was not required, in both Spain [25] and Zimbabwe [26].

CONCLUSION

Almost one third of pregnant and lactating women in our study were found to be iodine deficient with respect to the newer guideline on iodine nutrition by WHO [12]. This iodine insufficiency was observed despite the Universal Salt Iodisation Programme of Govt of India running for decades. Salt iodine content, unbranded source of salt, method of salt storage and the cooking processes are important factors for iodine insufficiency in pregnant and lactating women of the study population. Iodine Education at each antenatal visit is a viable option for iodine insufficient pregnant women to combat iodine deficiency.

REFERENCES

1. Zimmermann MB, Andersson M. Update on iodine status worldwide. Curr Opin Endocrinol Diabetes Obes. 2012; 19: 382-387.
2. Zimmermann MB, Andersson M. Prevalence of iodine deficiency in Europe in 2010. Ann Endocrinol (Paris). 2011; 72: 164-166.
3. srinivasan S, Sinha A, Subramanyan Ta, Deo Mg, Ramalingaswami V. Himalayan Endemic Deafmutism. Lancet. 1964; 2: 176-178.
4. Kapil U. National Iodine Deficiency Disorder Control Programme (NIDDCP) in India: Current status and failure strategies. Journal of Indian Thyroid Society. 2007: 37-49.
5. Kapil U. Progress made in elimination of Iodine Deficiency Disorders and Possible Impact of Lifting Ban on sale of non-iodised salt. J Academy of Hospital Adm. 2000: 33-41.
6. Sankar R, Pandav CS. Ban on sale of non-iodized salt for human consumption: a step in the right direction. Natl Med J India. 2005; 18: 169-171.
7. Dworkin HJ, Jacquez JA, Beierwaltes WH. Relationship of iodine ingestion to iodine excretion in pregnancy. J Clin Endocrinol Metab. 1966; 26: 1329-1342.
8. Majumder A, Jaiswal A, Chatterjee S. Prevalence of iodine deficiency among pregnant and lactating women: Experience in Kolkata. Indian J Endocrinol Metab. 2014; 18: 486-490.
9. Ategbo EA, Sankar R, Schultink W, van der Haar F, Pandav CS. An assessment of progress toward universal salt iodization in Rajasthan, India, using iodine nutrition indicators in school-aged children and pregnant women from the same households. Asia Pac J Clin Nutr. 2008; 17: 56-62.
10. Yadav K, Srivastava R, Badhal S, Palanivel C, Chandrakant S, Karmarkar MG. Iodine nutrition of pregnant women in India: evidence of significant iodine deficiency. Indian Journal of Medical Specialities. 2010.
11. Menon KC, Skeaff SA, Thomson CD, Gray AR, Ferguson EL, Zodpey S, et al. The effect of maternal iodine status on infant outcomes in an iodine-deficient Indian population. Thyroid. 2011; 21: 1373-1380.
12. WHO/UNICEF/ICCIDD. Assessment of iodine deficiency disorders and monitoring their elimination: a guide for programme managers, 3rd ed. Geneva: World Health Organization. 2016.
13. Tyabji R. The use of iodized salt in the prevention of IDD. In: A handbook of Monitoring and Quality Control. New Delhi. 1985; 18–29.
14. WHO Secretariat, Andersson M, de Benoist B, Delange F, Zupan J. Prevention and control of iodine deficiency in pregnant and lactating women and in children less than 2-years-old: conclusions and recommendations of the Technical Consultation. Public Health Nutr. 2007; 10: 1606-1611.
15. Pathak P, Kapil U, Kapoor SK, Saxena R, Kumar A, Gupta N, et al. Prevalence of multiple micronutrient deficiencies amongst pregnant women in a rural area of Haryana. Indian J Pediatr. 2004; 71: 1007-1014.
16. Dasgupta PK, Liu Y, Dyke JV. Iodine nutrition: iodine content of iodized salt in the United States. Environ Sci Technol. 2008; 42: 1315-1323.
17. Shawel D, Hagos S, Lachat CK, Kimanya ME, Kolsteren P. Post-production losses in iodine concentration of salt hamper the control of iodine deficiency disorders: a case study in northern Ethiopia. J Health Popul Nutr. 2010; 28: 238-244.

18. Jayashree S, Naik RK. Iodine losses in iodised salt following different storage methods. Indian J Pediatr. 2000; 67: 559-561.

19. Wang GY, Zhou RH, Wang Z, Shi L, Sun M. Effects of storage and cooking on the iodine content in iodized salt and study on monitoring iodine content in iodized salt. Biomed Environ Sci. 1999; 12: 1-9.

20. Bhatnagar A, Maharda NS, Ambardar VK, Dham DN, Magdum M, Sankar R. Iodine loss from iodised salt on heating. Indian J Pediatr. 1997; 64: 883-885.

21. Rana R, Raghuvanshi RS. Effect of different cooking methods on iodine losses. J Food Sci Technol. 2013; 50: 1212-1216.

22. Sang Z, Wang PP, Yao Z, Shen J, Halfyard B, Tan L, et al. Exploration of the safe upper level of iodine intake in euthyroid Chinese adults: a randomized double-blind trial. Am J Clin Nutr. 2012; 95: 367-373.

23. Laurberg P, Jørgensen T, Perrild H, Ovesen L, Knudsen N, Pedersen IB, et al. The Danish investigation on iodine intake and thyroid disease, DanThyr: status and perspectives. Eur J Endocrinol. 2006; 155: 219-228.

24. Thomson CD, Campbell JM, Miller J, Skeaff SA. Minimal impact of excess iodate intake on thyroid hormones and selenium status in older New Zealanders. Eur J Endocrinol. 2011; 165: 745-752.

25. Galofré JC, Fernández-Calvet L, Ríos M, García-Mayor RV. Increased incidence of thyrotoxicosis after iodine supplementation in an iodine sufficient area. J Endocrinol Invest. 1994; 17: 23-27.

26. Todd CH, Allain T, Gomo ZA, Hasler JA, Ndiweni M, Oken E. Increase in thyrotoxicosis associated with iodine supplements in Zimbabwe. Lancet. 1995; 346: 1563-1564.

Cite this article

Majumder A, Jaiswal A, Chatterjee S (2016) Iodine Nutrition among the Pregnant and Lactating Women of Kolkata. J Hum Nutr Food Sci 4(1): 1078.