



Pregnant Women's Iodine Status and Their Knowledge, Attitude, and Practice towards Iodized Salt in Esfarayen and Jajrom Cities in 2016-2017

Zohreh Sadat Sangsefidi; MSc^{1,2}, Zahra Sadat Sangsefidi; MD³, Elham Sadat Sharifian; MSc⁴
& Habibeh Sadat Shakeri; MD*⁵

¹ Department of Nutrition, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

² Nutrition and Food Security Research Center, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.

³ School of Medicine, North Khorasan University of Medical Sciences, Bojnurd, Iran.

⁴ Department of Statistics and Epidemiology, School of Medicine, North Khorasan University of Medical Sciences, Bojnurd, Iran.

⁵ Department of Endocrinology, Imam Hasan Hospital, North Khorasan University of Medical Sciences, Bojnurd, Iran.

ARTICLE INFO

ORIGINAL ARTICLE

Article history:

Received: 24 Jul 2019

Revised: 3 Sep 2019

Accepted: 17 Dec 2019

*Corresponding author:

drhssh@yahoo.com

Department of Endocrinology, Imam Hasan Hospital, North Khorasan University of Medical Sciences, Bojnurd, Iran.

Postal code: 945315174

Tel: +98 58 3151

ABSTRACT

Background: Evaluation of status of iodine during pregnancy is crucial. Therefore, this study was conducted to investigate it in pregnant women and to evaluate their knowledge, attitude, and practice toward consuming iodized salt.

Methods: In a cross-sectional study, 150 pregnant women were selected by census method based on the inclusion criteria. The participants' status of iodine was measured by measuring their urinary iodine concentration. Furthermore, the women's knowledge, attitude, and practice were investigated regarding iodized salt intake by a valid questionnaire. **Results:** Median concentrations of the urinary iodine in total population and Esfarayen people 139.05 (92.0-216.5) and 131.19 (211.43-86.43) µg/l, respectively which were lower than the World Health Organization recommendations (150-249 µg/l), while it was within the recommended range in Jajrom people 176.12 (101.76-248.62) µg/l. Although most people in the total population and Esfarayen people had moderate level of knowledge, attitude, and practice, most mothers in Jajrom had good knowledge and attitude scores along with moderate scores of practices. A significant direct correlation was found between attitude level and urinary iodine concentration ($P = 0.043$, $r = 0.17$). **Conclusions:** In total population, the median urinary iodine concentration was lower than the recommended level. Furthermore, knowledge, attitude, and practice of most people were at the moderate level.

Keywords: Iodine; Pregnancy; Knowledge; Attitude; Practice

Introduction

Iodine is a nutrient essential for the synthesis and secretion of thyroid hormones, regulation of basic metabolism, and growth of nervous, cognitive, and movement systems (Zimmermann, 2009). In this regard, iodine is of great importance as a nutrient in certain groups, such as

pregnant women (Glinioer, 2007). Among the vulnerable groups, pregnant women are at higher risk due to the critical role of iodine in producing thyroid hormones, brain growth and development, and fetus nervous system. Iodine deficiency during pregnancy can cause many problems such

This paper should be cited as: Sangsefidi ZS, Sangsefidi ZS, Sharifian ES, Shakeri HS. *Pregnant Women's Iodine Status and Their Knowledge, Attitude, and Practice towards Iodized Salt in Esfarayen and Jajrom Cities in 2016-2017. Journal of Nutrition and Food Security (JNFS), 2020; 5 (1): 12-19.*

as congenital defects, abortion, stillbirth, increased premature mortality, mental and physical growth disorders, goiter, deafness and muteness, bilateral lower limb paralysis, strabismus, and hypothyroidism. In addition, iodine deficiency in mothers causes complications such as goiter and hypothyroidism (Delange, 2000, Skeaff, 2011, Zimmermann, 2007, 2012). Urinary iodine is considered as an indicator for assessing iodine status. According to the World Health Organization (WHO), the recommended range of urinary iodine during pregnancy is 150-249 µg/L (WHO, 2001). In spite of serious efforts and intervention strategies conducted for preventing iodine deficiency, the urinary iodine levels were lower than the recommended values in some communities such as Australia (Charlton *et al.*, 2010a, Charlton *et al.*, 2010b), Northern Spain (Aguayo *et al.*, 2013), Poland (Gietka-Czernel *et al.*, 2010), and the United States (Caldwell *et al.*, 2013). The results of studies in different societies such as Australia (8, 9), Sri Lanka (Yoganathan *et al.*, 2014), Norway (Garnweidner-Holme *et al.*, 2017), and England (Combet *et al.*, 2015) showed that pregnant women did not have the required knowledge, attitude, and practice associated with iodine. In addition, increasing the individuals' knowledge and educating them regarding the importance of iodine use is considered as one of the important factors in dealing with iodine deficiency (Jooste *et al.*, 2005, Umenwanne and Akinyele, 2000). One way to provide iodine is using iodized salt (Zimmermann, 2009). In Iran, the edible salt-enrichment program has been implemented nationally since 1989, which has increased the iodine intake, especially in high-risk groups and reduced goiter in different parts of the country (Azizi and Mehran, 2004). However, findings from some studies in Iran reported that levels of urinary iodine in pregnant women were below the recommended level. For example, in a national study conducted in 10 different provinces of Iran, pregnant women had a low concentration of urinary iodine (Delshad *et al.*, 2016). The results of studies by Rostami *et al.* in Urmia (Rostami *et*

al., 2012a, Rostami *et al.*, 2012b) and Nazeri *et al.* in Tehran (Nazeri *et al.*, 2016) also showed that the urinary iodine concentration was lower than the recommendations in pregnant women. Moreover, only one study in Iran was conducted to assess the knowledge, attitude, and practice of pregnant women about iodine salt intake (Hamzavi Zarghani *et al.*, 2016). However, no study has ever investigated the nutritional status of iodine in pregnant women and their awareness, attitude, and practice regarding iodine salt in North Khorasan province, including Esfarayen and Jajrom cities. Iodine plays a significant role during pregnancy and its deficiency causes irreparable complications. We are also faced with limited studies in assessing knowledge, attitude, and practice of pregnant women about iodized salt in Iran. Furthermore, studies showed that the urinary iodine concentration was low in Iranian pregnant women. Considering the above-mentioned ideas and scarce information on the iodine status in pregnant women in northern Khorasan province including Esfarayen and Jajrom cities, this study was conducted. The aim was to determine the nutritional status of iodine in pregnant women (in their first trimester), who referred to the urban health centers in Esfarayen and Jajrom cities during 2016-2017. Furthermore, the participants' level of knowledge, attitude, and practice was investigated in relation to iodized salt consumption.

Materials and Methods

A cross-sectional study was conducted among pregnant women in the first trimester referring to urban health centers in Esfarayen and Jajrom, northern Khorasan which had criteria for entering the study, during 2016-2017.

Studied population: Participants were included according to the following criteria: Pregnant women in the first trimester who referred to urban health centers in Esfarayen and Jajrom in 2016-2017; had no lack of history of thyroid disorders, cardiovascular diseases, infectious diseases, or other systemic internal diseases; and did not use anti-thyroid, psychiatric, or opioid drugs.

Moreover, the normal levels of thyroid stimulating hormone (TSH) and free thyroxin (FT4) of mothers in the first trimester of pregnancy calculated by routine examinations were also considered as an inclusion criterion. Considering the total population of pregnant women in Esfarayen and Jajrom, the time span, and the research inclusion criteria, eligible individuals were selected from all urban health centers of the two cities by census method. Finally, 100 and 50 pregnant women from Esfarayen and Jajrom cities were studied.

Data collection: General information including demographic data, height, pre-pregnancy weight, pregnancy information, and abortion history were collected using a general information questionnaire about the participants' health records. In addition, urine samples (30 cc) were taken from all participants to measure the urinary iodine concentration. Urinary iodine concentration was measured by the sandell-kolthoff method (acid digestion method) (Nazeri *et al.*, 2016) and the results were expressed in microgram iodine per liter of urine. To assess the level of knowledge, attitude, and practice of individuals towards iodized salt, a valid questionnaire previously designed for the Iranian population was used (Mirmiran *et al.*, 2013). This questionnaire included 24 items: 10 questions to assess knowledge, 8 questions for the field of attitude, and 6 questions to investigate the participants' practice. In knowledge section, if the answer was "yes" and "correct", it received 3 scores; if the answer was "No" and "wrong", it received 1 score, and if the answer was "I do not know", it received 2 scores. The participants' attitude was measured on the basis of a Likert criterion, where 1 score was dedicated to "strongly disagree" opposition and 5 scores were dedicated to "strongly agree". With regard to the practice section, each question with the correct answer received 1 score and incorrect answers received no score (Mirmiran *et al.*, 2013).

After calculating the scores in each section, the scores were categorized into three levels based on

the score tertiles. Later, participants with scores of lower than, in the middle of, and above the higher tertiles were considered to have low, moderate, and high scores, respectively. Finally, three levels of poor, moderate, and good were defined for sections of knowledge, attitude, and practice.

Data analysis: Statistical Package for Social Science (SPSS) was used to analyze the collected data. First, general characteristics of the studied population were described by mean and standard deviation, median and intermediate quartile (IQR), and frequency distribution tables. After examining the normality distribution of quantitative variables by Kolmogorov-Smirnov test, independent sample *t-test* and Man-Whitney U-test were run to compare the normal and abnormal variables between the two groups, respectively. Comparison of the qualitative variables was also performed by chi-square test. In addition, the correlation between quantitative variables was investigated by Spearman test. In all statistical analyzes, the confidence level was 95%.

Ethical considerations: This research was approved by Ethics Committee of North Khorasan University of Medical Sciences. The consent forms were also collected from all participants.

Results

Characteristics of study population: General profile of the studied participants is shown in **Table 1**. The results showed that most mothers (40%) had diploma and associate degree and no significant difference was observed between the two cities with regard to the level of education ($P = 0.61$). Furthermore, most mothers in the whole population had no history of abortion (76%) and smoking (97.3%). No significant difference was observed between the two cities in terms of these variables ($P > 0.05$). In addition, mean age and pre-pregnancy body mass index (BMI) were 27.43 ± 5.56 years and 24.92 ± 6.68 kg/m², respectively. No significant difference was observed between the two cities in terms of these characteristics ($P > 0.05$).

Urinary iodine status in study population: Based on the findings, the median concentration of urinary iodine was 139.05 (92.0-216.5) µg/L for all participants. Although the median urinary iodine concentration differed between Esfarayen and Jajrom 131.2 (86.4-211.0), 176.1 (101.7-248.6), respectively), no significant difference was found between the two cities ($P = 0.06$).

Knowledge regarding iodized salt intake in study population:

The frequency distribution of individuals in terms of knowledge regarding iodized salt intake is presented in **Table 2**. The results showed that among total the population, 34.2% had a moderate knowledge, 32.9% had good knowledge, and the rest were at the poor level of knowledge. While most people (43.4%) had a moderate level of knowledge in Esfarayen, most people (58%) had good knowledge in Jajrom. The frequency of people with poor knowledge in Esfarayen was also more than Jajrom ($P < 0.001$).

Attitude regarding iodized salt in study population: **Table 2** presents the distribution of individuals in terms of attitude regarding iodized salt intake. Based on the findings, 36.6% of the total population had moderate attitude, 35.2% had

a good attitude, and the rest were at the poor level of attitude. Although in Esfarayen, most participants (45.7%) had moderate attitude, most people (72%) had a good level of attitude in Jajrom ($P < 0.001$).

Practice regarding iodized salt intake in study population: The frequency distribution of individuals in terms of practice regarding iodized salt intake is shown in **Table 2**. Based on the findings, 58.5% of all mothers were at the moderate level of practice, 16.6% were at the good level of practice, and the rest were at the poor level practice. In each city, most participants were at the average level of practice ($P < 0.001$).

Correlation of urinary iodine concentration with knowledge, attitude, and practice regarding iodized salt intake: **Table 3** includes findings related to the correlation of urinary iodine concentration with knowledge, attitude, and practice regarding iodized salt intake. The results showed a significant direct correlation between the attitude score and urinary iodine concentration ($P = 0.043$, $r = 0.17$). However, knowledge or practice scores had no significant correlation with urinary iodine concentration.

Table 1. General characteristics in the study population

Variables	Total (n =150) N (%)	Esfarayen (n =100) N (%)	Jajrom (n = 50) N (%)	P-value
Education level				
Illiterate	2 (1.3)	2 (2)	0 (0)	0.61 ^a
Elementary	11 (7.3)	8 (8)	3 (6)	
Secondary school and high school	47 (31.3)	29 (29)	18 (36)	
Diploma and associate degree	60 (40)	38 (38)	22 (44)	
Bachelor's degree and higher	30 (20)	23 (23)	7 (14)	
Abortion				
Yes	36 (24)	26 (26)	10 (20)	0.45 ^a
No	114 (76)	74 (74)	40 (80)	
Smoking				
Yes	4 (2.7)	3 (3.0)	1 (2.0)	0.73 ^a
No	146 (97.3)	97 (97.0)	49 (98.0)	
Age (y)	27.43 ± 5.39 ^c	27.76 ± 5.52	26.77 ± 5.11	0.29 ^b
Pre-pregnancy body mass index (kg/m ²)	24.92 ± 5.18	24.85 ± 5.84	25.05 ± 3.57	0.82 ^b

^a: Chi-square test; ^b: Independent sample t-test; ^c: Mean ± SD

Table 2. Frequency distribution of study population in terms of knowledge regarding iodized salt intake.

Variables	Total (n = 150) N (%)	Esfarayen (n = 100) N (%)	Jajrom (n = 50) N (%)	P-value ^a
Knowledge level				
Poor	49 (32.9)	36 (36.4)	13 (26.0)	< 0.001
Moderate	51 (34.2)	43 (43.4)	8 (16.0)	
Good	49 (32.9)	20 (20.2)	29 (58.0)	
Attitude level				
Poor	40 (28.2)	36 (39.1)	4 (8.0)	< 0.001
Moderate	52 (36.6)	42 (45.7)	10 (20.0)	
Good	50 (35.2)	14 (15.2)	36 (72.0)	
Practice level				
Poor	36 (24.8)	36 (37.9)	0 (0)	< 0.001
Moderate	85 (58.6)	59 (62.1)	26 (52)	
Good	24 (16.6)	0 (0)	24 (48)	

^a: Chi-square test

Table 3. Relationship between urinary iodine concentration and some of the studied variables

Variables	Correlation coefficient	P-value
Knowledge	0.03	0.68
Attitude	0.17	0.043
Practice	0.19	0.1

Discussion

According to the present survey, median concentrations of urinary iodine in total population and in Esfarayen were less than the WHO recommendations, while it was within the recommended range in Jajrom. However, no significant difference was observed in urinary iodine concentration between the two cities. Our results also indicated that most mothers in total population and in Esfarayen were at the moderate levels of knowledge, attitude, and practice regarding iodized salt intake. However, in Jajrom, most mothers had a good level of knowledge and attitude, but moderate level of practice. Furthermore, a significant direct correlation was observed between the attitude toward iodine intake and urinary iodine concentration.

Similar to our study, findings of other studies showed that urinary iodine concentration in pregnant women was less than the recommendations in Urmia (Rostami *et al.*, 2012a, Rostami *et al.*, 2012b) and Tehran (Nazeri *et al.*, 2016). Studies in

Australia (Charlton *et al.*, 2010a, Charlton *et al.*, 2010b), Northern Spain (Aguayo *et al.*, 2013), the United States (Caldwell *et al.*, 2013), and Poland (Gietka-Czernel *et al.*, 2010) also reported that the urinary iodine concentration in pregnant women was below the recommended level.

Research findings from Sri Lanka among pregnant women also showed that most participants had an unfavorable level of knowledge, attitude, and performance regarding iodized salt intake (Yoganathan *et al.*, 2014). In addition, researchers in England (Combet *et al.*, 2015) and Norway (Garnweidner-Holme *et al.*, 2017) found that pregnant women did not have a good level of knowledge about iodine intake. According to the study findings in Australia, knowledge and performance of pregnant women about iodine and its dietary sources were unfavorable (Charlton *et al.*, 2010a, Charlton *et al.*, 2010b).

In contrast to our research, Bakhshandeh *et al.* in Iran reported that then mean urinary iodine was within the recommended range in pregnant women

(S.Bakhshandeh-Nosrat *et al.*, 2004). Other Iranian studies over the pregnant women in Tehran indicated that individuals had good levels of knowledge, attitude, and performance regarding iodized salt consumption. Moreover, a significant relationship was found between maternal performance and urinary iodine concentration in this survey (Hamzavi Zarghani *et al.*, 2016). In addition, studies in Japan (Fuse *et al.*, 2011), China (Meng *et al.*, 2013), and Switzerland (Andersson *et al.*, 2010) reported that urinary iodine concentration in pregnant women was within the recommended range.

The difference between our research results and some studies can be due to the differences in sample size, characteristics of the study population, dietary habits, geographical location, culture, and health system.

In a survey from Gorgan in Iran (S.Bakhshandeh-Nosrat *et al.*, 2004), the pregnant women who were in different trimesters of pregnancy were investigated; whereas, in the present study, we evaluated only women who were in their first trimester of pregnancy. Evidences indicated that urinary iodine concentration was different in various trimesters of pregnancy (Stilwell *et al.*, 2008). In addition, in a research from Tehran in Iran on the pregnant women (Hamzavi Zarghani *et al.*, 2016), the knowledge, attitude, and practice scores were different from our study. Therefore, the abovementioned reasons may lead to differences in the results.

In the case of studies conducted in Japan (Fuse *et al.*, 2011), China (Meng *et al.*, 2013), and Switzerland (Andersson *et al.*, 2010), the discrepancies were caused by various dietary habits, culture, and health system in different countries. The study populations in China (Meng *et al.*, 2013) and Switzerland (Andersson *et al.*, 2010) were pregnant women in different trimesters of pregnancy, while in the current survey, we examined only women who were in the first trimester of pregnancy.

The main strength of our study was examining the concentration of TSH and Free T4 to ensure the normal functioning of thyroid gland in participants.

Our research had some limitations including small sample size, not assessing the amount of iodine in household salt, lack of evaluating the iodine intake from other dietary sources, and the cross sectional design of study. Moreover, only one urine sample was used to evaluate the urinary iodine status; the random urine sample in one day cannot accurately determine the nutritional status of iodine in a person due to seasonal and day-to-day variations in urinary iodine concentration. Furthermore, the attitude is a mental concept and is not objective.

Conclusions

In conclusion, our study indicated that urinary iodine concentration in mothers in total population was less than WHO recommendations. In addition, the majority of mothers in total population had moderate knowledge, attitude and practice regarding iodized salt intake. A significant direct correlation was found between the attitude level and the concentration of urinary iodine. According to the results of this study, more studies should be carried out using a larger sample size and in different provinces to confirm these findings. In addition, due to the seasonal and day-to-day changes in urinary iodine concentration, it is recommended to evaluate the urinary iodine status several times and with several urine samples. We also suggest the future researchers to investigate the amount of iodine in household salt and iodine intake from other dietary sources. Additionally, educational courses are recommended on the importance of iodine and iodized salt intake especially during pregnancy.

Acknowledgements

The authors thank North Khorasan University of Medical Sciences for supporting this research. They also appreciate the participants and Esfarayen Faculty of Medical Sciences for their cooperation.

Authors' contributions

Shakeri HS and Zohreh Sadat Sangsefidi designed the study. Zahra Sadat Sangsefidi collected the data. Sadat Sharifian E performed the statistical analysis. Zohreh Sadat Sangsefidi wrote the manuscript. Shakeri HS critically revised the

manuscript and submitted the final version. All authors read and approved the final version of the manuscript.

Conflicts of interest

The authors declare that there is no conflict of interests regarding publication of this paper.

References

Aguayo A, et al. 2013. Urinary iodine and thyroid function in a population of healthy pregnant women in the North of Spain. *Journal of trace elements in medicine and biology.* **27 (4)**: 302-306.

Andersson M, et al. 2010. The Swiss iodized salt program provides adequate iodine for school children and pregnant women, but weaning infants not receiving iodine-containing complementary foods as well as their mothers are iodine deficient. *Journal of clinical endocrinology & metabolism.* **95 (12)**: 5217-5224.

Azizi F & Mehran L 2004. Experiences in the prevention, control and elimination of iodine deficiency disorders: a regional perspective. *Eastern mediterranean health journal.* **10 (6)**: 761-770.

Caldwell KL, et al. 2013. Iodine status in pregnant women in the National Children's Study and in US women (15–44 years), National Health and Nutrition Examination Survey 2005–2010. *Thyroid.* **23 (8)**: 927-937.

Charlton KE, Gemming L, Yeatman H & Ma G 2010a. Suboptimal iodine status of Australian pregnant women reflects poor knowledge and practices related to iodine nutrition. *Nutrition.* **26 (10)**: 963-968.

Charlton KE, Yeatman HR & Houweling F 2010b. Poor iodine status and knowledge related to iodine on the eve of mandatory iodine fortification in Australia. *Asia Pacific journal of clinical nutrition.* **19 (2)**: 250.

Combet E, Bouga M, Pan B, Lean M & Christopher C 2015. Iodine and pregnancy—a UK cross-sectional survey of dietary intake, knowledge and awareness. *British journal of nutrition.* **114 (1)**: 108-117.

Delange F 2000. The role of iodine in brain development. *Proceedings of the nutrition society.* **59 (1)**: 75-79.

Delshad H, et al. 2016. Inadequate iodine nutrition of pregnant women in an area of iodine sufficiency. *Journal of endocrinological investigation.* **39 (7)**: 755-762.

Fuse Y, et al. 2011. Iodine status of pregnant and postpartum Japanese women: effect of iodine intake on maternal and neonatal thyroid function in an iodine-sufficient area. *Journal of clinical endocrinology & metabolism.* **96 (12)**: 3846-3854.

Garnweidner-Holme L, Aakre I, Lilleengen AM, Brantsæter AL & Henjum S 2017. Knowledge about iodine in pregnant and lactating women in the Oslo area, Norway. *Nutrients.* **9 (5)**: 493.

Gietka-Czernel M, et al. 2010. Iodine status of pregnant women from central Poland ten years after introduction of iodine prophylaxis programme. *Endokrynologia Polska.* **61 (6)**: 646-651.

Glinioer D 2007. The importance of iodine nutrition during pregnancy. *Public health nutrition.* **10 (12A)**: 1542-1546.

Hamzavi Zarghani N, et al. 2016. Iodine Intake Knowledge, Attitude and Practice in Pregnant Women and its Relation to Iodine Status During Pregnancy. *Iranian journal of endocrinology and metabolism.* **17 (6)**: 469-476.

Jooste P, Upson N & Charlton KE 2005. Knowledge of iodine nutrition in the South African adult population. *Public health nutrition.* **8 (04)**: 382-386.

Meng F, Zhao R, Liu P, Liu L & Liu S 2013. Assessment of iodine status in children, adults, pregnant women and lactating women in iodine-replete areas of China. *PLoS One.* **8 (11)**: e81294.

Mirmiran P, et al. 2013. Iodine nutrition status and knowledge, attitude, and behavior in Tehranian women following 2 decades without public education. *Journal of nutrition education and behavior.* **45 (5)**: 412-419.

- Nazeri P, et al.** 2016. Iodine status in pregnant women, lactating mothers, and newborns in an area with more than two decades of successful iodine nutrition. *Biological trace element research*. **172 (1)**: 79-85.
- Rostami R, et al.** 2012a. Evaluation of accessibility of iodinated salt and nutritional iodine status during pregnancy. *Iranian journal of public health*. **41 (8)**: 56.
- Rostami R, Beiranvend A & Nourooz-Zadeh J** 2012b. Nutritional iodine status in gestation and its relation to geographic features in Urmia County of northwest Iran. *Food and nutrition bulletin*. **33 (4)**: 267-272.
- S.Bakhshandeh-Nosrat , HR.Bazrafshan , MR.Rabie & N.Aghili** 2004. An assessment of urinary Iodine and serum TSH concentration in pregnant women referred to Deziani Hospital in Gorgan, Iran, 2004. *Journal of Gorgan University of medical sciences*. **6 (2)**: 78-82.
- Skeaff SA** 2011. Iodine deficiency in pregnancy: the effect on neurodevelopment in the child. *Nutrients*. **3 (2)**: 265-273.
- Stilwell G, et al.** 2008. The influence of gestational stage on urinary iodine excretion in pregnancy. *Journal of clinical endocrinology & metabolism*. **93 (5)**: 1737-1742.
- Umenwanne E & Akinyele I** 2000. Inadequate salt iodization and poor knowledge, attitudes, and practices regarding iodine-deficiency disorders in an area of endemic goitre in south-eastern Nigeria. *Food & nutrition bulletin*. **21 (3)**: 311-315.
- WHO** 2001. Assessment of iodine deficiency disorders and monitoring their elimination. A guide for programme managers. WHO/NHD/01.1, Geneva: WHO.
- Yoganathan T, Arasaratnam V, Hettiarachchi M, Liyanage C & Anusha Y** 2014. Knowledge, attitude and practice among pregnant mothers regarding usage of iodized salt in Jaffna, . In *Sri Lanka Conference Proceedings*.
- Zimmermann MB** 2007. The adverse effects of mild-to-moderate iodine deficiency during pregnancy and childhood: a review. *Thyroid*. **17 (9)**: 829-835.
- Zimmermann MB** 2009. Iodine deficiency in pregnancy and the effects of maternal iodine supplementation on the offspring: a review. *American journal of clinical nutrition*. **89 (2)**: 668S-672S.
- Zimmermann MB** 2012. The effects of iodine deficiency in pregnancy and infancy. *Paediatric and perinatal epidemiology*. **26 (s1)**: 108-117.