FACTORS RELATED TO URINARY IODINE CONCENTRATION OF PREGNANT WOMEN IN THAILAND

Kitti Larpsombatsiri* and Robert S. Chapman

College of Public Health Sciences, Chulalongkorn University, Bangkok 10330, Thailand

ABSTRACT: A cross-sectional study was conducted to assess factors related to urinary iodine concentration (UIC) of pregnant women in Thailand. Subjects came from government hospitals in 8 provinces. These were selected from 29 provinces included in the surveillance system for iodine deficiency in pregnancy of the Ministry of Public Health during 2005-2007. There were 2 provinces from each of the 4 regions of the country i.e. north, northeast, central, and south. There were 800 subjects, 100 from each province. Around 65 percent of them used iodized salt as iodine deficiency disorders (IDD) prevention measure. Median UIC was 9.19 µg/dl. Only 14% of pregnant women had appropriate UIC (in the range of 15.00 – 24.99 µg/dl). Iodine concentration in household salt was measured by test kit developed at Mahidol University. 68.1% of household salt samples had iodine concentration in the range of 30 – 100 ppm. Relationships between UIC and independent variables were analyzed. In bivariate analysis, both salt iodine and use of iodized salt for IDD prevention were statistically significantly positively associated with UIC ($p<0.001$). There were also significant differences by region and province ($p<0.001$). However, in multivariable linear regression analysis, only region and province achieved significance ($p<0.001$) . UIC was higher in the southern region than in other regions. Study findings suggest that IDD prevention measures in Thailand should be reconsidered. To be effective, these measures should be appropriate to Thai culture and also local cultures. Fish sauce and a wide variety of food can be produced to be iodine sources for Thai people, and these measures could potentially prove more effective than iodizing salt. The data in this study were subject to uncertainty, so further research is needed before policies are changed.

Keywords: urinary iodine, pregnant women, iodized salt

INTRODUCTION: Iodine deficiency disorders (IDD) have long been recognized as a public health problem in Thailand. Iodine deficiency can cause a wide range of disorders including endemic goiter, hypothyroidism, cretinism, decreased fertility, miscarriages, stillbirths, congenital anomalies, psychomotor defects, increased perinatal mortality, increased infant mortality, impaired mental function, and mental retardation. Previous research found adverse effects of IDD on learning function and work performance[1]. The children who lived in iodine-deficient area might have IQ 10 points lower than the ones who lived in non-iodine-deficient area[2]. Pregnant women are considered as a high risk group to become iodine-deficient and their fetuses are also vulnerable to the effects of iodine deficiency. Iodized salt has been developed as a principal measure for control and prevention of IDD. Urinary iodine concentration (UIC) is usually included in the surveillance systems for iodine deficiency because it has been accepted to be the most sensitive indicator for assessing iodine nutrition status. This study aimed to examine iodine nutrition status of pregnant women by studying the status of UIC among pregnant women, to examine the iodine concentration of iodine in salt consumed by pregnant women, and to characterize relationships of UIC with iodine concentration in salt, and with other factors.

MATERIALS AND METHODS: This was a descriptive and analytical cross-sectional study concerning the factors related to urinary iodine concentration of pregnant women in Thailand. The data were secondary data from a study already conducted by the Ministry of Public Health (MOPH) of Thailand. The population in the MOPH study was pregnant women who attended the antenatal care clinics (ANC) at the government hospitals in 29 provinces in Thailand during October 2005-September 2007.

Inclusion criteria*:* Pregnant women visiting ANCs at government hospitals who were willing to participate in the interview by using questionnaires.

*To whom correspondence should be addressed.
E-mail: kittilarp@yahoo.com

Exclusion criteria: 1) Pregnant women who lived outside the province. 2) Pregnant women who declined to participate in the study or the hospital where they attended ANC clinic did not take part in the study. Primary data were collected by face to face interview using a standardized questionnaires. Hospital informed consent was obtained from each subject. There were 300 subjects for each province in the MOPH study. To select subjects for the current study, data from the 29 provinces were first divided into 2 groups, a complete data group and an incomplete data group. The complete data group was defined by availability of both data about urinary iodine concentration and iodine concentration in salt for more than 50% of the total number of subjects in the province. Simple random sampling was used in sub-sampling for 2 provinces from the provinces where complete data is available in each region (The total number of provinces in the complete data group in each region: 2 provinces from the northern region, 5 provinces from the northeastern region, 6 provinces from the central region, and 3 provinces from the southern region.). After this process, there will be 8 provinces (2 provinces from each region) included in the study using secondary data. Then simple random sampling for 100 subjects from each province, all of whom had data on urinary iodine concentration and iodine concentration in salt, was conducted. So, there were totally 800 subjects. The ages of subjects in the secondary data study ranged from 14 to 47 yr, with mean age of 26.51 yr (SD 6.37). The subjects lived in Phrae and Lampang Provinces in the northern region, Nong Khai, and Maha Sarakham Provinces in the northeastern region, Phetchaburi and Nonthaburi Provinces in the central region, Trang and Satun Provinces in the southern region. The study protocol using secondary data was approved by the ethics committee of Chulalongkorn University.UIC was measured by Sandell-Kolthoff Reaction Method. The results of the test were expressed in micrograms per deciliter (µg/dl). Urine specimens were collected from the subjects just before delivery or just after delivery. The iodine concentration in salt was measured by test kit (I-Kit, developed by Mahidol University). The results of the test were expressed in the unit of part per million (ppm). There were 5 levels of the result shown on the test kit (0, 10, 30, 50, and 100 ppm). Iodine concentrations between test kit levels were also sometimes reported.

Statistical analysis: Descriptive statistics included frequency, percentage, median, mean and standard deviation. Inferential statistics were used to identify relationships between UIC of pregnant women (dependent variable) and the independent variables. In bivariate analysis, UIC was analyzed separately in relation to other variables; age group of the pregnant women, province, region of the country, location of residence (Mueang district or outside Mueang district), current use of iodized salt as IDD prevention, iodine concentration in household salt, and consumption of seafood or other iodine-containing food. Chi-square test was used to study relationships between 2 categorical variables. When UIC was treated as a continuous variable, the non-parametric Kruskal-Wallis test and Mann-Whitney test were used, because UIC had non-normal distribution. Spearman's correlation (non-parametric) and linear regression analysis were used to characterize the relationship between the UIC of pregnant women and the iodine concentration in salt they consumed. All independent variables for which $p<0.20$ in bivariate analysis were included in multivariable models using linear regression (general linear models (GLM) routine in SPSS). The relationships were considered to be statistically significant when $p<0.05$.

RESULTS: Selected subject characteristics are given in table 1. The median UIC in the subjects was 9.19 µg/dl (range 0-897 µg/dl) which was equivalent to mild iodine deficiency and there were pregnant women who had appropriate UIC (UIC in the range of 15.00– 24.99 µg/dl) only 14.0% (112 cases), according to the criteria of WHO/UNICEF/ICCIDD[3]. There was 29.4% of the the study subjects living in Mueang district and 70.6% outside Mueang district. The percentag of the subjects who used iodized salt as a measure

for IDD prevention was 65.8%. The results of iodine concentration in salt showed that 22.2% of the total collected salt had iodine concentration in the range of 0 – 9 ppm, 9.6% had iodine 10 – 29 ppm, 30.2% had iodine 30 – 49 ppm, and 37.9% had iodine 50 – 100 ppm. About consumption of seafood or other iodine-containing food in the past week, 72.8% had done so,12.8% had not, and 14.5% did not answer.

In bivariate analysis, province and region of the country had significant relationships with UIC ($p<0.001$). There was significant relationship between current use of iodized salt as IDD prevention and UIC ($p<0.001$). Iodine concentration in household salt also had significant relationship with UIC ($p<0.001$). The p-value was greater than 0.20 for all other independent variables. Thus, region, province, salt iodine concentration, and using iodized salt for IDD prevention were included in multivariable models. Region and province were perfectly correlated, so they were considered in separate models. However, in multivariable linear regression models, only province and region had significant relationships with UIC of pregnant women ($p<0.001$, tables 2 and 3). Salt iodine concentration and using iodized salt for IDD prevention lost statistical significance. The subjects in the south of Thailand had higher UIC than those in the other regions. In the south, the subjects in Satun Province had higherUIC than those in Trang Province. In Tables 2 and 3, iodine concentration in salt was considered as a fixed factor. When we considered it as a covariate, the p-value of its relationship to UIC was still more than 0.05.

Table 1 Selected subject characteristics

Characteristics	**Frequencies (n = 800)**	**Percentage**
Age (yr)		
< 20	119	14.9
20 – 24	210	26.2
25 – 29	228	28.5
30 – 34	143	17.9
≥ 35	100	12.5
Mean = 26.51 SD = 6.37		
Minimum = 14 Maximum = 47		
Median = 26.00		
Current use of IDD prevention measures*		
None	159	19.7
Iodized salt	531	65.8
Iodinated water	15	1.9
Thyroid medication	2	0.2
Missing	100	12.4
Iodine concentration in salt collected from household (ppm)		
0 – 9	178	22.2
10 – 29	77	9.6
30 – 49	242	30.2
50 – 100	303	37.9
Urinary iodine concentration collected near time of delivery (µg/dl)		
< 2.00	106	13.2
2.00 – 4.99	130	16.2
5.00 – 9.99	182	22.8
10.00 – 14.99	138	17.2
15.00 – 24.99	112	14.0
≥ 25.00	132	16.5
Median = 9.19		
Minimum = 0.00 Maximum = 897.00		
Mean = 19.61 SD = 5.23		

* Adds to 807 because subjects could choose >1 item

Table 2 Multivariable analysis considering region (Dependent variable: UIC)

Parameter	Coefficient	95% confidence interval	p-value
Region (fixed factor)			<0.001
North	-20.572	-33.890 to -7.613	0.002
Northeast	-24.818	-38.537 to -11.099	<0.001
Central	-24.674	-36.458 to -12.889	<0.001
South (reference group)	0		
Iodine concentration in salt (ppm) (fixed factor)			0.370
0.00 – 9.00	-7.829	-21.516 to 5.859	0.262
10.00 – 29.00	-4.690	-20.085 to 10.705	0.550
30.00 – 49.00	-9.138	-19.797 to 1.521	0.093
50.00 – 100.00 (reference group)	0		
Current use of iodized salt as IDD prevention (covariate)	3.819	-7.280 to 14.918	0.500

Table 3 Multivariable analysis considering province (Dependent variable: UIC)

Parameter		Coefficient	95% confidence interval	p-value
Province (fixed factor)				<0.001
North	Phrae	-33.313	-50.136 to -16.489	<0.001
	Lampang	-27.302	-45.697 to -8.907	0.004
Northeast	Nong Khai	-32.480	-49.899 to -15.061	<0.001
	Maha Sarakham	-34.459	-51.305 to -17.613	<0.001
Central	Phetchaburi	-39.061	-54.401 to -23.720	<0.001
	Nonthaburi	-27.214	-43.315 to -11.114	0.001
South	Trang	-27.281	-45.237 to -9.326	0.003
	Satun (reference group)	0		
Iodine concentration in salt (ppm) (fixed factor)				0.540
0.00 – 9.00		-9.591	-23.531 to 4.349	0.177
10.00 – 29.00		-7.981	-23.761 to 7.799	0.321
30.00 – 49.00		-0.912	-12.841 to 11.017	0.881
50.00 – 100.00 (reference group)		0		
Current use of iodized salt as IDD prevention (covariate)		0.378	-11.178 to 11.933	0.949

DISCUSSION: Iodine deficiency during pregnancy and early childhood can result in impaired development of the brain and consequently in impaired mental function of children. The most commonly accepted and applied method to prevent iodine deficiency is salt iodization. The surveillance systems of iodine deficiency in pregnant women usually use urinary iodine concentration as an indicator because it is sensitive; 90% of ingested iodine is excreted in 24-hour urine[4]. The median UIC for pregnant women in population must be 150 – 249 μg/L, that is equivalent to 15.00 – 24.99 μg/dl in this study. The median UIC in the subjects was 9.19 μg/dl, which was classified as mild iodine deficiency and there was only 14% of the subjects whose UIC was in the range of 15.00 – 24.99 μg/dl. UIC was significantly higher in the south than in other regions, and was higher in the southern provinces Satun and Trang than in other provinces. Even so, urinary iodine concentration was significantly higher in Satun than in Trang (Table 3)

These observations may be related to the fact that the southern provinces were close to the sea, and that iodine is abundant in seawater and in marine plants and animals. It is also found in some minerals and in soil. The iodine in soil can be leached by repeated flooding, and carried to the sea. That may be the reason people who live in the area near the sea have less possibility to be affected by iodine deficiency. Another reason

may be the difference in use of sodium chloride-containing seasonings among different regions. In the southern region, the most common sodium chloride-containing seasoning added in food was salt. On the other hand, the most common sodium chloride-containing seasoning added in food for all of the other regions was fish sauce[5]. In Thailand, there are only a few fish sauce producers fortifying their products with iodine. The number of salt producers whose salt contained iodine in the appropriate level are much more than the number of fish sauce producers who fortified their products with iodine[6]. However, there was substantial difference between urinary iodine concentrations of pregnant women in Trang and Satun Provinces, it may be the effect of high variations in the level of urinary iodine concentrations. In Satun Province, very high urinary iodine levels were seen in some pregnant women especially the one who had urinary iodine level as high as 897 μg/dl, that was the upper limit in the range of urinary iodine levels of all subjects in the study. The extraordinarily high urinary iodine level like this, which was not found in Trang Province, somewhat affected the overall picture of urinary iodine levels in the study subjects and resulted in difference between these two provinces.

In this study, we cannot conclude that current use of iodized salt is an effective prevention measure against IDD. At the same time, due to uncertainties in the data, we cannot rule out its effectiveness. Different cultures and lifestyles among people in different countries should be considered when we study about iodized salt. Most Thai people usually use salt for cooking food, but only some people add it to food as table salt, conceivably, the high temperatures during cooking reduce iodine levels.

CONCLUSIONS: We demonstrated that pregnant women in the study areas continued to face iodine dificiency, even though most subjects used iodized salt for IDD prevention and most salt iodine concentrations were in the range of 30–100 ppm. Study findings suggested that region and province are more important determinants of UIC than salt iodine. Further research is required to confirm this. Thailand's policies regarding IDD prevention in pregnant women and their babies should be re-examined. For further study, UIC of pregnant women and neonatal TSH should be evaluated for association. That will provide more accurate evaluation of iodine nutrition status of both pregnant women and their children. Moreover, further research on UIC of children will advance understanding about the magnitude of the IDD problem and how we can manage this problem effectively. Appropriate sources of iodine-containing food that can be applied appropriately to local lifestyles and eating patterns of Thai people should also be studied.

ACKNOWLEDGEMENTS: The authors are grateful to the Director-General of the Department of Health and the Director of the Nutrition Division, Department of Health, MOPH, for advice and support.

REFERENCES :

1. Hetzel BS, Dunn JT, Stanbury JB. 1987. The Prevention and Control of Iodine Deficiency Disorders. Amsterdam: Elsevier Science Publishers B.V.

2. Hetzel BS, Pandav CS. 1996. The Conquest of Iodine Deficiency Disorders. (2nd edition). New Delhi: Oxford University Press.

3. WHO/ UNICEF/ ICCIDD. 2007. Assessment of Iodine Deficiency Disorders and Monitoring their Elimination: A Guide for Programme Managers. 3rd ed. Geneva : WHO publ. ISBN : 9789241595827.

4. Glinoer D. 2006. Iodine nutrition requirements during pregnancy. Thyroid 2006; 16 : 947 - 8.

5. Nutrition Division, Department of Health, Ministry of Public Health. 2007. Sodium chloride intake in Thai population survey.

6. Nutrition Division, Department of Health, Ministry of Public Health. 2009. Iodine Deficiency Disorders in Thailand.