

Salt Consumption Patterns and Iodine Nutrition Status of Pregnant Women in Coastal Region

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Abstract

Background: Maternal Iodine Deficiency Disorder can result in inevitable cretinism as well as miscarriages, stillbirth and low birth-weight babies. **Objective:** There is a need to find out contributing factors towards urinary iodine concentrations of pregnant women. **Methods:** Therefore, the cross-sectional, descriptive study was conducted to assess the patterns of salt utilization and iodine status of pregnant women living in coastal areas of Mon State in January and May, 2013. **Result:** A total of 144 pregnant women from Pa-Nga village and Kalokepi village in Thanbyuzayat township were asked by using structured questionnaires including age, parity, socioeconomic status and patterns of salt and iodine-rich foods (seaweed, fish, prawn) consumption. Casual urine samples were collected from each pregnant woman and urinary iodine concentrations were measured. Three samples each of the iodized salt and non-iodized salt from local markets were collected for determination of iodine content by the iodometric titration method. Only 83.3% of the study population consumed iodized salt and the remaining (16.7%) consumed non-iodized salt. The median urinary iodine concentration of the study population was 105 µg/L. The mean urinary iodine level of pregnant women who consumed iodized salt and that of pregnant women who consumed non-iodized salt were 110.47 ± 67.34 µg/L and 95.83 ± 70.13 µg/L ($P = 0.336$). Iodine content of the iodized salt and non-iodized salt was 20.6 ± 9.2 ppm and 5.1 ± 1.2 ppm respectively. In conclusion, the median iodine level of pregnant women was lower than that of the optimal iodine nutrition for pregnant women, *i.e.*, 150 - 250 µg/L and the mean iodine content of salt samples was lower than the permissible level of iodine in iodized salt, *i.e.*, 30 - 40 ppm. **Conclusion:** Our findings indicate that iodine nutritional status of pregnant women in this area is insufficient and salt iodization needs to be monitored for the optimal iodine content in iodized salt.

Keywords

Salt Consumption, Iodine Nutrition, Pregnant Women

1. Introduction

Iodine deficiency disorders are a wide spectrum of the effects of iodine deficiency on growth and development starting from the foetal stage and including brain development.

Maternal Iodine Deficiency Disorder can result in inevitable cretinism as well as miscarriages, stillbirth and low birth-weight babies. Iodine requirements sharply increase during pregnancy because of the transfer of iodine and thyroid hormone to the fetus and an increase in maternal needs for thyroid hormone, and a likely increase in maternal renal iodine clearance [1]. Thus, recommended iodine intakes during pregnancy are 250 µg/day compared with 150 µg/day for non-pregnant women. The corresponding median urinary iodine concentration (UIC) that indicates optimal iodine nutrition increases from 100 - 199 µg/L to 150 - 250 µg/L during pregnancy [2].

In Myanmar, for IDD elimination, the salt legislation and implementation of universal salt iodization have been launched since 1997. Due to regular supplies of iodised salt, visible goitre rate among children (6 - 11 years) has dropped from 33% (1994) to 5.5% (2004). However, school-based surveys conducted in March 2008 showed that there were certain pockets areas (Mon and Rakhine State) where 81% and 72% of households have been consuming iodized salt [3]. Although, pregnancy is a critical time for iodine needs, iodized salt consumption patterns of pregnant women living in the coastal regions may be variable because non-iodized salt, produced by unregistered small-scale factories including solar salt production, could be available.

Measurements of urinary iodine levels in school-aged children are often used for assessment of iodine deficiency disorder in populations because of the vulnerability of children to iodine deficiency and access in school-based survey. Adequate nature of iodine nutrition in school-aged school cannot be assumed that iodine status of pregnant women is optimal. Therefore, contributing factors towards urinary iodine concentrations of pregnant women need to be measured as an indicator for iodine nutrition status of really risk population.

2. Objectives

- To determine urinary iodine concentration of casual urine samples of pregnant women as an indicator of iodine nutrition status.
- To measure the iodine content of salt consumed by the pregnant women in coastal area.
- To identify the consumption patterns of salts, fish sauce and iodine rich foods among pregnant women living in coastal area.

- To identify contributing factors towards urinary iodine levels of pregnant women living in coastal area.

3. Materials and Method

Study design

The study design was a cross-sectional, descriptive study.

Sample size calculation

Using the data on effective iodized salt consumption was 48.23% [4], with absolute precision 8% and 95% Confidence Interval, the sample size was 150 pregnant women using the following formula, $n = z_{(1-\alpha/2)}^2 pq/d^2$.

Study population and study area

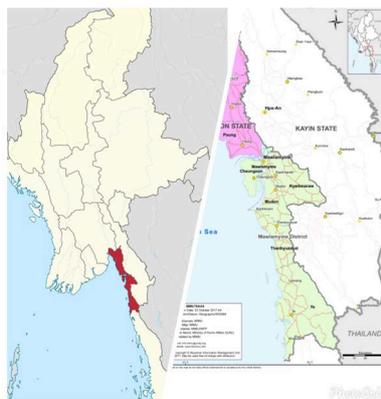
All eligible 144 pregnant women were recruited from selected villages (Pa-nga village and Kalokepi village) at n Thanbyuzayat township in Mon State.

Study Period

From January 2013 to August 2013.

Sampling

Among coastal areas of Myanmar, Mon State was purposely chosen due to logistic reasons. Two study sites (villages) in the coastal area of Mon State was randomly chosen; one for a village with the presence of solar salt production (Pa-nga village) and the other with the absence of it (Kalokepi village). Inclusion criteria were—the pregnant women in good general health without thyroid disorders, other chronic illness, or medications, and those with no history of iodine supplements use.



Thanbyuzayat, Mon State

Data collection

In pilot survey, free listing was undertaken to explore the names of locally available sea foods (such as salt, fish, prawn, crab, squid, clam/mussel, octopus etc. on randomly selected ten pregnant women. Without prompting, they were asked to write down. And then pile sorting was conducted to identify commonly consumed foods among them. Based on these findings, food frequency questionnaires for consumption pattern of iodine rich foods were constructed.

After taking informed consents, the women will be interviewed to complete the structured questionnaires that include background characteristics, parity and salt consumption patterns (types of used salt in cooking and in fish sauce/paste or dried fish/prawn making, places of salt accessibility and frequency of iodine rich food consumption).

Measurement of urinary iodine

A casual urine sample from each woman was collected in a acid-washed 20 ml plastic bottles containing 2 ml 4N hydrochloric acid. The urine samples were kept and transported on ice to the Laboratory of Nutrition Research Division. The urinary iodine concentration was measured using the method A using Ammonium Persulfate, the Sandell-Kolthoff reaction, as recommended by the International Council for Control of Iodine Deficiency Disorder (ICCIDD) [5]. Three samples each of the iodized salt and non-iodized salt from local markets were collected for determination of iodine content by the iodometric titration method [6].

Data entry and analysis

Data entry and analysis was carried out by using SPSS 11.5 for Windows. Urinary iodine level of pregnant women was presented as median values. The comparison of mean urinary iodine was calculated by student t-test and relation between urinary iodine level and associated factors were calculated with X² test. P-values < 0.05 is considered as a statistical significance.

Ethical considerations

The proposal was submitted to the Institutional Ethical Review Committee, Department of Medical Research (Lower Myanmar) for approval.

4. Findings

A total of 144 pregnant women were recruited in this study. Among 144 pregnant women, 88 were from Pa-nga village and 56 were from Kalokepi village. The mean age of pregnant women was 29.92 ± 6.58 years ranging from 16 to 46 years. Most of the pregnant women were in 2nd trimester.

In **Table 1**, about 50% and 60% of pregnant women were between 30 - 39 year old and at the 2nd trimester of pregnancy respectively.

Salt consumption pattern

Only 83.3% of the study population consumed iodized salt and the remaining (16.7%) consumed non-iodized salt. Among 144 pregnant women, 28 pregnant women used solar salt for making dried fish for household.

Figure 1 shows that, 16.7% of pregnant women in this area consumed solar salt.

Table 2 shows that 25.7% of pregnant women consumed seaweed (wet or dried) and only 2.1% of pregnant women did not eat marine fish. High percentage of pregnant women consumed marine fish, prawn, crab, squid and calm/mussel 1 - 3 day.

In **Table 3**, mean Iodine content of the iodized salt and non-iodized salt were 20.6 ± 9.2 ppm and 5.1 ± 1.2 ppm, respectively.

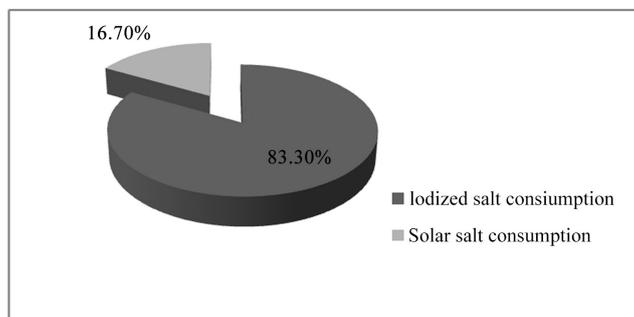


Figure 1. Salt consumption of pregnant women.

Table 1. Background characteristic of pregnant women.

	Frequency	Percent
Age group		
• <20 years	11	7.6
• 20 - 29 years	55	38.2
• 30 - 39 years	68	47.2
• ≥40 years	10	6.9
Trimester		
• 1 st trimester	19	13.2
• 2 nd trimester	83	57.6
• 3 rd trimester	42	29.2

Table 2. Dietary intake iodine rich food s of pregnant women.

	No consumption	1 - 3 days Per month	1 - 3 days Per week	4 - 6 days Per week	Daily
Sea weed	107 (74.3%)	16 (11.1%)	18 (12.5%)	1 (0.7%)	2 (1.4%)
Sea water fish	3 (2.1%)	7 (4.9%)	70 (48.6%)	12 (8.3%)	52 (36.1%)
Prawn	36 (25.0%)	22 (15.3%)	73 (50.7%)	4 (2.8%)	9 (6.3%)
Crab	52 (36.1%)	40 (27.8%)	51 (35.4%)	-	1 (0.7%)
Squid	62 (43.1%)	40 (27.8%)	39 (27.1%)	2 (1.4%)	1 (0.7%)
Clam/Mussel	131 (91.0%)	6 (4.2%)	7 (4.9%)	-	-
Fish sauce	49 (34.0%)	31 (21.6%)	54 (37.5%)	4 (2.8%)	6 (4.2%)
Fish paste	24 (16.7%)	25 (17.4%)	62 (43.1%)	(1.4%)	31 (21.5%)
Dried fish	18 (12.5%)	40 (27.8%)	76 (52.8%)	5 (3.5%)	5 (3.5%)

Table 3. Iodine content of salt samples.

	Iodized salt	Non iodized salt
Sample 1	20.7 ± 2.19	5.85 ± 0.78
Sample 2	29.7 ± 2.9	5.85 ± 0.78
Sample 3	11.4 ± 1.13	3.7 ± 0.70
Mean	20.85	5.13
SD	9.15	1.24

Urinary iodine concentration of pregnant women

The median urinary iodine concentration of the study population was 105 µg/L ranging from 5 µg/L to 295 µg/L. The mean urinary iodine level of pregnant women who consumed iodized salt and that of pregnant women who consumed non-iodized salt were 110.47 ± 67.34 µg/L and 95.83 ± 70.13 µg/L ($P = 0.336$).

Figure 2 illustrates that, only 38 (26.4%) pregnant women had optimal urinary iodine level that is >150 µg/L. Nearly half of pregnant women (45.1%) had urinary iodine level < 100 µg/L.

According to **Table 4**, percentage of pregnant women with urinary iodine concentration < 150 µg/L were not much differ among gestation of pregnant women.

In **Table 5**, the mean urinary iodine level of pregnant women who consumed iodized salt and that of pregnant women who consumed non-iodizes salt were 110.47 ± 67.34 µg/L and 95.83 ± 70.13 µg/L ($P = 0.336$). Pregnant women with urinary iodine concentration < 150 µg/L was a little bit higher in women who used solar salt for consumption.

In **Table 6**, 3 pregnant women did not consume sea water fish and their Urinary iodine concentration was less than 150 µg/L.

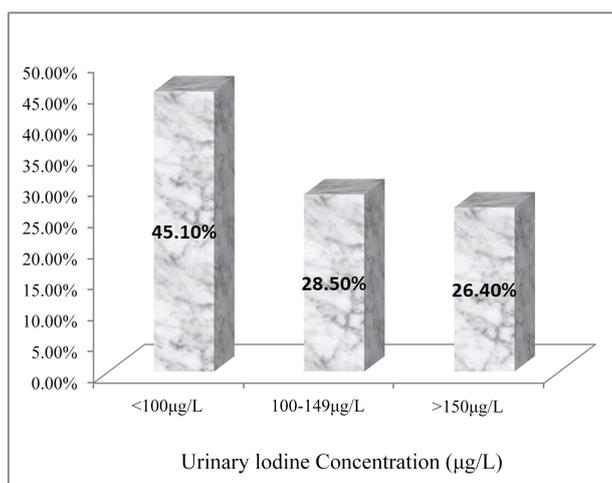


Figure 2. Urinary iodine concentration of pregnant women.

Table 4. Urinary iodine concentration of pregnant women according to trimester and distribution of concentrations.

Trimester	Number	Urinary iodine concentration (µg/L)		Urinary iodine concentration distribution	
		Median	Range	<150 µg/L	≥ 150 µg/L
1 st	19	110	5 - 255	13 (68.4%)	6 (31.6%)
2 nd	83	105	5 - 245	61 (73.5%)	22 (26.5%)
3 rd	42	90	5 - 295	32 (76.2%)	10 (23.8%)

P-value = 0.4

Table 5. Urinary iodine concentration of pregnant women according to type of salt used for consumption and distribution of concentrations.

Type of salt used for consumption	Number	Urinary iodine concentration ($\mu\text{g/L}$)		Urinary iodine concentration distribution	
		Median	Range	<150 $\mu\text{g/L}$	≥ 150 $\mu\text{g/L}$
Solar salt	24	102.5	10 - 235	20 (83.3%)	4 (16.7%)
Iodized salt	120	105.5	5 - 295	86 (71.7%)	34 (28.3%)

P- value = 0.3

Table 6. Urinary iodine level of pregnant women according to consumption pattern of sea foods and salt containing foods.

Consumption of		Urinary iodine level <150 $\mu\text{g/L}$	Urinary iodine level ≥ 150 $\mu\text{g/L}$	Total
Sea water fish	No	3 (100%)	0	3
	Yes	107 (73%)	38 (27%)	141
Prawn	No	25 (69.4%)	11 (30.6%)	36
	Yes	103 (95.4%)	5 (4.6%)	108
Crab	No	37 (71.2%)	15 (28.8%)	52
	Yes	69 (75.0%)	23 (25.0%)	92
Squid	No	44 (70.9%)	18 (29.1%)	62
	Yes	62 (75.6%)	20 (24.4%)	82
Calm/Mussel	No	95 (72.5%)	36 (27.5%)	131
	Yes	11 (84.6%)	2 (15.4%)	13
Fish sauce	No	34 (69.4%)	15 (30.6%)	49
	Yes	72 (75.8%)	23 (24.2%)	95
Fish paste	No	19 (79.2%)	5 (20.8%)	24
	Yes	87 (72.5%)	33 (27.5%)	120
Dried fish	No	16 (88.9%)	2 (11.1%)	18
	Yes	90 (71.4%)	36 (28.6%)	126

5. Discussion

In this study 16.7% of study population used solar salt for consumption. And 28 (19.4%) pregnant women used solar salt for making dried fish for household consumption. This may be due to the study villages are located in costal area of Mon states and solar salt are easily available from salt factories and local market.

The median urinary iodine concentration was 105 $\mu\text{g/L}$ that was lower than the recommended minimum adequate urinary iodine concentration (UIC) of 150 - 250 $\mu\text{g/L}$. Among 144 pregnant women, 73.6% of pregnant women had urinary iodine level less than 150 $\mu\text{g/L}$. Data from National Nutrition Centre, Department of Health, Myanmar showed that median urinary iodine excretion among pregnant was 205 $\mu\text{g/L}$ (2004) and percentage of with median urinary

excretion below 100 µg/L was 22.3% [7]. In this study median urinary excretion below 100 µg/L was 45.1%. The median urinary iodine concentration from this study is similar with the median urinary iodine concentration of Thai pregnant women that is 108 µg/L (11 - 558 µg/L) in 2009 [8]. In this study, the median urinary concentration of pregnant women in 1st, 2nd and 3rd trimesters was 110 µg/L, 105 µg/L and 90 µg/L respectively. There is no difference in median urinary iodine concentration between trimesters ($P = 0.4$). These finding is consistent with results of Thai pregnant women.

The mean urinary iodine level did not differ between pregnant women who consumed iodized salt and those consumed non-iodized salt ($P = 0.336$). All of the pregnant women consumed salt daily. There is no relationship between sea products and urinary iodine level. The most likely explanation may be the lower iodine contents of foods consumed by pregnant women. Our study also found that the iodine content of salt samples were lower than the permissible level of iodine in iodized salt, *i.e.*, 30 - 40 ppm even in iodized salt. This may be another explanation of low urinary iodine level. In our study, we could not analyze the iodine contents of foods consumed by pregnant women in this area. However, iodine contents of marine and sea water fish, other sea products were measured in 1996 [9]. In this study, iodine contents of fresh water fish, sea water fish and prawn were 4.3 to 33.6 µg/100g, 10.4 to 122.96 µg/100g and 78.14 to 282.48 µg/100g respectively. Mean iodine content of squid and crab were 21.68 ± 3.09 µg/100g and 14.24 ± 2.57 µg/100g. Iodine content of dried sea fish was 39.43 to 541.54 µg/100g. There were high iodine contents in fermented fish paste from Rakhine ($558. \pm 13.08$ µg/100g), Myeik (415.0 ± 11.51 µg/100g), Pathein (399.0 ± 10.02 µg/100g). However, iodine contents of sea foods from Mon state did not analyzed in this study. Therefore, iodine contents of these foods cannot represent the iodine contents of food in Mon state. The iodine content in plants and animal is determined by the environment in which they grow. According to Lunde *et al.* (1930), the fishing locality had a considerable influence. These differences might depend upon the lower iodine of the plankton. Soil erosion can cause low iodine contents in the soil as well in foods.

In Myanmar, source of iodine from foods were only from iodized salt and sea foods. Universal salt iodization is only one food fortification programme in Myanmar. In Thailand, Salt, Fish Sauce, Soy Sauce and Cooking Brine are fortified with iodine. Edible salt and salt for food processing must have iodine content between 20 - 40 parts per million, whereas fish sauce, soy sauce and cooking brine must have iodine content between 2 - 3 parts per million.

6. Conclusion and Recommendations

In conclusion, the median UIC indicated that iodine deficiency in pregnant women in coastal area of Mon state. Therefore, there is needed to improve the current status of salt iodization programme and continue monitoring of iodine content in salt at factories, retail shop and household levels. Monitoring of the urinary iodine concentration among vulnerable groups such as children, preg-

nant women and lactation mothers should be done. Nationwide surveillance of the iodine nutritional status of these vulnerable groups should be done.

7. Limitation of the Study

This study was conducted only in one township in Mon State therefore the urinary iodine level of this study cannot represent the pregnant women living in Coastal area of Myanmar. It would have been useful to include nonpregnant as control group to help ascertain whether lower UI concentrations during pregnancy could be attributed to pregnancy itself or to dietary intake of this population.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Zimmermann, M.B., Jooste, P.L. and Pandav, C. (2008) Iodine Deficiency Disorders. *Lancet*, **372**, 1251-1262. [https://doi.org/10.1016/S0140-6736\(08\)61005-3](https://doi.org/10.1016/S0140-6736(08)61005-3)
- [2] WHO, ICCIDD, UNICEF (2007) Assessment of the Iodine Deficiency Disorders and Monitoring Their Elimination. 3rd Edition.
- [3] UNICEF (2008) A Review of the Status of Salt Production and Salt Iodisation in the Union of Myanmar.
- [4] Ministry of Health, Myanmar (2011) Health in Myanmar 2011.
- [5] Dunn, J.T. (1993) Methods for Measuring Iodine in Urine. International Council for Control of Iodine Deficiency Disorder, 18-23.
- [6] Hetzel, B.S., Dunn, J.T., Stanbury, J.B., *et al.* (1987) The Prevention and Control of Iodine Deficiency Disorders. Elsevier, Amsterdam.
- [7] National Nutrition Centre, Department of Health, Ministry of Health Sports, Union Republic of Myanmar (2004) Unpublished Report.
- [8] Gowachirapant, S., Winichagoon, P., Wyss, L., Tong, B., Baumgartner, J., Melse-Boonstra A. and Zimmermann, M.B. (2009) Urinary Iodine Concentrations Indicate Iodine Deficiency in Pregnant Thai Women but Iodine Sufficiency in Their School-Aged Children. *The Journal of Nutrition*, **139**, 1169-1172. <https://doi.org/10.3945/jn.108.100438>
- [9] Thiri, M.O. (1996) Comparison of Iodine Content in Fresh and Sea Water Fish and Crustaceans. Thesis, University of Yangon, Yangon.