Original Article

Status of iodine nutrition in pregnant and lactating women in national capital district, Papua New Guinea

Victor J Temple PhD[1], Benjamin Haindapa BMedSci[1], Robert Turare PhD[1], Andrew Masta PhD[1], Apeawusu B Amoa FRCPG [2] and Paulus Ripa MMed [3]

[1] *Division of Basic Medical Sciences, School of Medicine and Health Sciences, University of Papua New Guinea*
[2] *Division of Obstetrics and Gynaecology and Port Moresby General Hospital*
[3] *Division of Clinical Sciences, School of Medicine and Health Sciences, University of Papua New Guinea,*

Urinary Iodine excretion is a useful and important indicator of the iodine status of a population. This study attempts to determine the urinary iodine concentration of non-pregnant, pregnant and lactating women, resident in the National Capital District of Papua New Guinea, so as to evaluate their status of iodine nutrition. The study population was made up of 56 non-pregnant, 40 lactating and 212 pregnant women. Of the 212 pregnant women, 14 were in the first, 64 in the second, and 134 in the third Trimester of pregnancy. Casual urine samples were collected and analysed for urinary iodine by Sandell-Kolthoff reaction. The median urinary iodine concentration for the non-pregnant, lactating and pregnant women was 163.0ug/L, 134.0ug/L and 180.0ug/L, respectively. Median urinary iodine for the first, second and third trimesters were 165.0ug/L, 221.5ug/L and 178.0ug/L, respectively. The 20th percentile urinary iodine values were higher than 50ug/L for all the groups. This indicates adequate intake of dietary iodine and optimal status of iodine nutrition amongst women in the various groups. Mild to severe status of iodine nutrition was found in 30.4% of non-pregnant, 35.0% of lactating, 22.2% of pregnant women, 28.5% of women in the first, 18.8% in the second, and 23.1% in the third trimester of pregnancy. To achieve optimal iodine nutrition in pregnant and lactating women, an increase in their intake of dietary iodine is recommended.

Key Words: urinary iodine, pregnancy, lactation, trimesters, non-pregnant, Papua New Guinea

Introduction

Urinary Iodine (UI) excretion is a useful and important indicator of the iodine status of a population.[1-,3] The UI values obtained can be conveniently expressed either as a range with a median, or as proportions, using a series of cut-off points to indicate the severity of iodine deficiency.[1,3]

Iodine deficiency in women of childbearing age can cause infertility and also set the stage for miscarriage, abortion or stillbirth during pregnancy.[1] Maternal iodine deficiency during pregnancy and lactation can severely compromise the thyroid status of the fetus and neonate.[4,5] Mild iodine deficiency during the first and second trimesters of pregnancy can cause subclinical fetal hypothyroidism, with subtle negative effects on neurodevelopment; the effect is more pronounced in cases of moderate to severe iodine deficiency.[5,6]

According to recent reports[4,7-9] there is growing evidence that iodine deficiency may be reappearing in some countries, where it was previously under control. This underscores the need to evaluate the iodine status of children, pregnant women, lactating women and women of childbearing age in populations that have been at risk in the past. Universal salt iodization (USI), a policy of iodising all salt used in households, catering, food processing and agriculture, is the internationally agreed strategy for the control of iodine deficiency.[1,2] The implementation of the USI policy in Papua New Guinea (PNG) commenced in June 1995, when the Government of PNG amended the "Pure Food Act". This amendment promul-gated the PNG Salt Legislation, which effectively put a ban on the importation and sale of non-iodised salt in PNG.[10,11]

According to the PNG salt legislation, all salt in PNG should be iodised with potassium iodate (KIO_3) and the iodine content in all salt should not be less than 30ppm (30 mg of iodine per kilogram of salt).[10] Estimated daily per capita salt consumption in PNG was not indicated in the legislation. The Consumer Affairs Council (CAC) was mandated to monitor and implement the salt legislation, promote the use of iodised salt, and take violators of the legislation to task.[11] A CAC report in early 1996[11] stated that the lack of effective transport system and relative inaccessibility of many areas, because of the mountainous topography, constituted a major obstacle to the the effective distribution of iodised salt around the country. Thus, iodised salt is not regularly available in most

Correspondence address: Dr Victor J Temple, Division of Basic Medical Sciences, School of Medicine and Health Sciences, University of Papua New Guinea, P. O. Box 5623, Boroko, NCD, Papua New Guinea
Tel: + 675 – 3262657; + 675 – 6858324; Fax: + 675 – 3243827
Email: templevj@upng.ac.pg
Accepted 22 February 2006

remote areas of Papua New Guinea. Data on the implementation of the salt legislation are scanty.[9,13] Recent reports indicate that although the per capita consumption of salt is low, adequately iodised salt is available in over 90 per cent of households and retail shops in Lae city[12] and in the Hella Region of Southern Highlands Provinces, PNG.[9] There is little information on the impact of the salt iodisation programme on susceptible groups, such as school-age children and pregnant women in PNG.[8,9] No published data are available on the status of iodine nutrition of non-pregnant and lactating women in PNG. The aim of this study was to assess the status of iodine nutrition of non-pregnant, pregnant and lactating women resident in the National Capital District (NCD), PNG.

Subjects and methods

The NCD, with a population of about 250 000, is the incorporated area around Port Moresby, the capital of PNG.[13] Port Moresby General Hospital (PMGH) is the major general, specialist and reference hospital in NCD and PNG. It also serves as the teaching hospital for the School of Medicine and Health Sciences (SMHS).

The population for this cross-sectional study consisted of healthy 265 pregnant and 54 lactating women resident in NCD and attending antenatal and pediatric clinics respectively at the PMGH. The lactating group was made up of women who have been breastfeeding for less than eight weeks. Seventy age-matched non-pregnant women were recruited from staff and students in PMGH and SMHS. Only staff and students residing in NCD were included in the study. All women with previous history of thyroid disease or medications that affect thyroid status, including those with systemic illness, were excluded from the study. This constituted about 2.0% of all the women that participated in the study.

Informed consent was obtained from each participant recruited to the study before collecting 5 to 10 ml casual urine sample in wide-mouth screw-capped plastic bottles.[1] Urine samples were stored frozen at about –20^{o}C until required for analysis. Urinary iodine analysis was carried out in the Micronutrient laboratory in the Division of Basic Medical Sciences, SMHS UPNG, using the spectrophotometric method of Sandell-Kolthoff reaction, after digesting the urine with Ammonium Persulfate in a water bath at 100^{o}C.[1] The sensitivity (10.0 – 12.50ug/L) and percentage recovery (95 ± 10 percent) of the UI assay were frequently used to assess the performance characteristics of the assay method.

External quality control assessment of the analytical procedure was carried out by, The Centers for Disease Control and Prevention (CDC) Atlanta Georgia USA EQUIP program and by the Iodine Reference Laboratory for Asia Pacific Region Institute of Clinical Pathology and Medical Research (ICPMR), Westmead Hospital, NSW Australia. Statistical analysis of data was carried out using SPSS-PC software (version 10). ANOVA was used to compare differences in urinary iodine excretion between different groups, with the Scheffe test used for post-hoc analysis. A P value <0.05 was considered as significant.

Ethical clearance and approval for the study were obtained from the SMHS Ethics and Research Grant Committee. In addition, permission for the study was obtained from the appropriate authorities in PMGH. The iodine status of women in the various groups was determined using the recommended WHO/UNICEF/ICCIDD criteria. [1-3]

Results

A total of 56 non-pregnant (response rate: 80 per cent), 212 pregnant (response rate: 80 per cent) and 40 lactating (response rate: 75 per cent) women participated in the study. Table 1 shows the mean age and UI values for the three groups of women. The median UI concentrations for the non-pregnant, lactating and pregnant groups of women are 163.0ug/L, 134.0ug/L and 180.0ug/L, respectively. The 20th Percentile value for each of the groups was greater than 50ug/L. In comparing the UI concentrations between women in the non-pregnant, pregnant and lactating groups, there was a significant difference between the UI concentrations of women in the pregnant and lactating groups (P<0.05). There was, however, no significant difference between UI concentrations of women in the non-pregnant and pregnant groups, and neither was there any significant difference between the lactating and non-pregnant groups.

Table 1. Mean age and Urinary Iodine values in non-pregnant, lactating and pregnant women

Parameters	Non-pregnant (n = 56)	Lactating (n = 40)	Pregnant (n = 212)
Mean age yrs (± SD)	25.0 ± 5.6	25.8 ± 3.6	26.4 ± 5.1
Median (ug/L)	163.0	134.0	180.0
Mean (ug/L)	176.6	138.2	188.7
Range	286.0	304.0	304.0
SD	96.0	78.2	96.7
95% CI (ug/L)	150.9–202.3	113.2 – 163.2	175.6–201.8
20th Percentile (ug/L)	82.0	57.6	90.0
Per cent of women with UI ≥ 100ug/L	69.6	65.0	77.8
Per cent of women with UI < 50ug/L	7.2	17.5	6.6
Per cent of women with UI ≥150ug/L	53.6	40.0	61.3

Further analysis of the UI data (Table 2), indicates mild to moderate status of iodine nutrition in 30.4 per cent of non-pregnant, 32.5 per cent of lactating and 19.4 per cent of pregnant women. In addition, 7.2 per cent of non-pregnant, 17.5 per cent of lactating, and 6.6 per cent of pregnant women, have UI concentration less than 50.0ug/L. This indicates severe status of iodine nutrition, especially in the lactating and pregnant groups.

The 212 pregnant women were grouped according to their trimester of pregnancy. Women in the first trimester

Table 2. Distribution (Percent) of non-pregnant, lactating and pregnant women according to range of UI concentration and status of iodine nutrition

Range of UI conc. (ug/L)	Status of Iodine Nutrition[1,3]	Non-pregnant	Lactating	Pregnant
		Distribution (per cent)		
< 20	Severe	0	2.5	2.8
20 – 49	Moderate	7.2	15.0	3.8
50 – 99	Mild	23.2	17.5	15.6
100 – 199	Optimal	28.6	42.5	33.5
200 - 299	Risk of IIH	19.6	17.5	23.6
≥ 300	Risk IIH	21.4	5.0	20.8

of pregnancy accounted for about 75 per cent of the non-response rate in the pregnant group. In most of the cases, the women needed to obtain approval from their spouses. The mean age and UI values for the women in the first, second and third trimester of pregnancy are shown in Table 3. The median UI concentrations (165.0ug/L, 221.5ug/L and 178.0ug/L) for the First, Second and Third Trimesters, respectively, are greater than 100ug/L, and the 20th Percentile values are greater than 50ug/L. There were no statistically significant differences in the UI concentrations among the three trimesters of pregnancy,

Table 3. Mean age and Urinary Iodine values of pregnant women in first, second and third trimester of pregnancy

	Trimester of pregnancy		
Parameters	*First* (n = 14)	Second (n = 64)	Third (n = 134)
Mean age yrs (± SD)	25.6 ± 4.6	26.8 ± 5.4	26.3 ± 5.1
Median (ug/L)	165.0	221.5	178.0
Mean (ug/L)	181.5	204.9	181.7
Range	304.0	294.0	304.0
SD	104.1	98.6	94.9
95% CI	121.4 – 241.6	180.3 – 229.5	165.5 – 197.9
20th Percentile (ug/L)	74.4	107.0	90.0
Per cent of women with UI ≥ 100ug/L	71.4	81.3	76.9
Per cent of women with UI < 50ug/L	7.1	6.3	6.7
Per cent of women with UI ≥ 150ug/L	71.4	64.1	59.0

Table 4. Distribution (per cent) of pregnant women in the various trimesters according to range of UI concentration and status of iodine nutrition

		Trimester of pregnancy		
Range of UI conc (ug/L)	Status of Iodine Nutrition[1,3]	First	Second	Third
		Distribution (per cent)		
< 20	Severe	7.1	0	3.7
20 – 49	Moderate	0	6.3	3.0
50 – 99	Mild	21.4	12.5	16.4
100 – 199	Optimal	28.6	26.6	37.3
200 – 299	Risk of IIH	21.4	28.1	21.6
> 300	Risk IIH	21.4	26.6	17.9

and also between the non-pregnant group and each of the three trimesters of pregnancy. However, the UI concentration in the lactating group was significantly lower (P<0.05) than the UI concentration in the second trimester of pregnancy.

The distribution (per cent) of pregnant women in the various trimesters according to range of UI concentrations and status of iodine nutrition is presented in Table 4. For women in the first, second and third trimesters of pregnancy, 28.5%, 18.8% and 23.1% respectively, have mild to severe status of iodine nutrition.

Discussion

In the present study, the median UI concentrations for the non-pregnant, lactating and pregnant groups of women are higher than the recommended minimum adequate UI concentration of 100ug/L. In addition, less than 20 per cent of women in each group have UI concentration below 50ug/L. This, according to the WHO/ UNICEF/ ICCIDD criteria,[1-3] indicates adequate dietary iodine intake and an optimal status of iodine nutrition. There is, however, prevalence of mild to severe status of iodine nutrition in a significant number of women in these groups, indicating inadequate intake of dietary iodine.

The median UI concentration (180.0ug/L) for pregnant women obtained in the present study is lower than the 231.0ug/L obtained for pregnant women in Lae PNG.[8] Mild to severe status of iodine nutrition was reported in 15 per cent of pregnant women in Lae[8] compared to 22.2 per cent in the present study. These differences might be due to a number of factors, including diversity in cultural habits that results in low consumption of iodised salt by pregnant women in NCD compared to those in Lae.[8,12] The goitrogen content in the staple foods consumed in NCD might also be higher. The differences might also be due to apparent lack of awareness of the need for pregnant women to consume adequate amounts of iodine to improve their thyroid function, which is vital for early development of the brain and other tissues in their foetus and neonates.[1,6] In NCD, there is a popular belief that high intake of salt is associated with high blood pressure and increased risk of heart disease and stroke.

The relatively low UI concentration in the lactating group of women, compared to the women in the pregnant and the second trimester groups, may be due to the loss of iodide in breast milk during lactation. The source of iodine for neonatal thyroid hormone formation is mainly from maternal milk.[1,3]

Although the median UI concentrations obtained during the first, second and third trimesters indicate optimal status of iodine nutrition according to the current WHO/UNICEF/ICCIDD criteria[1,3], yet mild to severe status of iodine nutrition is prevalent in the groups. Our results clearly indicate inadequate consumption of dietary iodine by some of the pregnant and lactating women in the NCD. This is of concern, because of the association between iodine deficiency and the potential risk of irreversible damage to the foetus and neonate.[1,3] Thus, it is necessary to regularly evaluate and monitor the implementation of the USI strategy in the region.

According to the current WHO/UNICEF/ICCIDD[1,3] criteria, the recommended indictor of an adequate dietary

intake of iodine and optimal status of iodine nutrition in a population is when the median UI concentration in the general population is between 100 to 199ug/L. Currently, there are no WHO/UNICEF/ICCIDD recommendations for the range of UI concentration that indicates optimal iodine nutrition in pregnant and lactating women.[14] However, since maternal iodine requirement is higher than normal during pregnancy and lactation,[14,15] scientific opinion increasingly suggests that the median UI concentration of 100ug/L used as benchmark for optimal status of iodine nutrition in the general population may have to be raised during pregnancy and lactation.[14,16] Delenge[14] has recently proposed a range of 150 to 230ug/L for the median UI concentration to indicate optimal iodine nutrition during pregnancy and lactation.

In our present study the percentages of women in the lactating and pregnant groups with UI concentration ≥ 150ug/L are presented in Tables 1 and 3. Further analysis of our results indicates a suboptimal level of iodine nutrition in about 60 per cent of lactating, and between 30 to 40 per cent of pregnant women.

In order to achieve optimal iodine nutrition in pregnant and lactating women, an increase in their intake of dietary iodine is recommended. This can be achieved by conducting intensive education and awareness campaign in the population on the need for pregnant and lactating women to consume adequate amounts of iodised salt. However, because of local dietary customs that are characterised by low intake of salt, other sources of iodine can be suggested. In the short term, these women can be advised to include seafood, such as seaweeds, kelp, nori, fish and shellfish in their diet once or twice a week. In addition, pregnant and lactating women in particular can be given multivitamin supplements that include appropriate amounts of iodine and other trace elements. In the long term, iodine can be added to the water supply. Water, adequately iodised with potassium iodide or potassium iodate, can provide adequate iodine for nutrition.[1,17] Such a program exists in Mexico, Chile and other parts of the world.[17] Other vehicles such as soy source, vegetable oil, milk, bread, candy, tea and sugar can be used to deliver adequate amount of iodine to the general population.[17,18] Some brands of powdered milk sold in NCD are enriched with iodine, but their retail price - is relatively higher than the non-iodised brands. It should be emphasised that supplementation programmes must be accompanied by effective monitoring of urinary iodine, so as to ensure proper adjustment of iodine intake.

Our results indicate that about 20 per cent of women in the non-pregnant and pregnant groups are at risk of developing iodine-induced hyperthyroidism (IIH). Some individuals can tolerate relatively high intake of iodine without any obvious adverse effect.[1,14,17] However, excessive intake of iodine (over 1000.0ug per day) can be potentially harmful to susceptible individuals.[1,14,16,17] Thus, the possibility of IIH and related complications further strengthens the need for USI programme planners and implementers to include effective monitoring of urinary iodine concentration in women and children as part of the salt iodization programme in NCD.

Universal salt iodization is the approved strategy for achieving optimal iodine nutrition in PNG.[10] However, since the implementation of the Salt Legislation in June 1995, no comprehensive analysis of the status of the salt iodization programme in PNG has been carried out after the report of the CAC in early 1996.[11] Analysis of data from various parts of the country indicates that the status of the salt iodization programme can be characterized as "existent but needing strengthening".[8,9,12,18] According to WHO/UNICEF/ICCIDD,[1,18] the recommended action needed to improve such programmes includes periodically reviewing the programme, to ensure that its tempo is maintained. In addition, to eliminate iodine deficiency permanently, iodization of salt and its distribution should become an integral part of the salt production, importation and distribution system that will run on its own momentum after an initial period of support and monitoring.[1,18]

In order to sustain and improve on the current status of the salt iodization programme, especially in NCD, social mobilization, effective education for and communication with all relevant target groups including policy makers is urgently needed. In addition, continuous monitoring of iodine content in salt at the retail shops and households and the urinary iodine levels in the vulnerable groups (such as pregnant, lactating and non-pregnant women of childbearing age, neonates and school-age children) should be mandatory.

Conclusion

Our results indicate that although iodine deficiency is not a significant public health problem among pregnant and lactating women in NCD, a sizable number of these women have mild to severe status of iodine nutrition. There is therefore an urgent need to assess the implementation of the USI policy and the salt consumption pattern, especially among pregnant and lactating women in NCD. Aggressive advocacy of appropriate and adequate use of iodised salt for the elimination of iodine deficiency must be carried out at all levels in the various communities in NCD, including at antenatal and well-baby clinics in PMGH.

Acknowledgement

We thank Professor John Vince, who is the Professor of Child Health, Dr. Adulf Saweri who is the Head of Clinical Sciences, Professor Lance Hill, Ms Philomena Sengu and Sam Grant for their support during this project. We also thank Professor Francois Delange of ICCIDD for his invaluable support. We thank the School of Medicine and Health Sciences (SMHS) Research Grant Committee for the funding of the project. We also thank all the Nurses, Pregnant and Lactating mothers at the O&G and Pediatric Wards at PMGH, and all the Staff and Students at SMHS and PMGH.

References

1. WHO, UNICEF, ICCIDD. Assessment of IDD and monitoring their elimination: A guide for programme mangers, 2nd Edition. WHO/NHD/01.1, 2001
2. WHO. Iodine deficiency. WHO Executive Board 103rd Session, Provisional Agenda item 8. EB103/27, Nov. 1998; 1 – 3.
3. Delange F, de Benoist B, Burgi H, & the ICCIDD working group Determining median urinary iodine concentration that indicates adequate iodine intake at population level. Bulletin of the WHO 2002; 80 (8): 633 – 636.

4. Brander L, Buess Als, H, Haldimann F, Harder M, Hangi, Herrmann W U, Lauber K, Niederer U, Zarcher T, Burgi U, Gerber H. Urinary iodine concentration during pregnancy in an area of unstable dietary iodine intake in Switzerland. J Endocrinol Invest 2003; 26 (5): 389 – 396.
5. Kibirige MS, Hutchison S, Owen CJ, Delves HT. Prevalence of maternal dietary iodine insufficiency in the North East of England: Implications for the Fetus. Arch Dis Child Fetal Neonatal Ed 2004; 89: F436 – 439.
6. Hetzel BS. Iodine deficiency and fetal brain damage. N Engl J Med 1994; 331: (6) 1770 – 1771.
7. Guttikonda K, Travers CA, Lewis PR, Boyages S. Iodine deficiency in urban primary school children: A cross-sectional analysis. Med J Aust 2003; 179 (7): 346 – 348.
8. Amoa B, Rubiang L, Iodine status of pregnant women in Lae. Asia Pac J Clin Nutr 2000; 9 (1): 33 – 35.
9. Temple VJ, Mapira P, Adeniyi KO, Sims P. Iodine deficiency in Papua New Guinea (Sub-clinical iodine deficiency and salt iodization in the highlands of Papua New Guinea). J Public Health 2005; 27 (1): 45 – 48.
10. Barter P. Pure Food Act, amendment of Pure Food Standards. Papua New Guinea Govt. National Gazette. Port Moresby 1995; G 47.
11. Government of PNG, UNICEF. Children, women and families in PNG: A situation analysis. Port Moresby; October 1996; APO Production Unit Inc.
12. Amoa B, Pikire T, Tine P. Iodine content in salt in Lae city of Papua New Guinea. Asia Pac J Clin Nutr 1998; 7 (2): 128 – 130.
13. National Health Plan 2001-2010, Health Vision 2010, Provincial and District Health Profiles. Vol. 3 Part 2; 1st edn. Port Moresby: Papua New Guinea Ministry of Health, August 2000; 38 – 44.
14. Delange F. Optimal iodine nutrition during pregnancy, lactation and the neonatal period. Int J Endocrinol Metab 2004; 2: 1 – 12.
15. Delange F. Iodine deficiency as a cause of brain damage. Postgrad Med J 2001; 77: 217 – 220.
16. Thomson CD. Dietary recommendations of iodine around the world, IDD Newsletter 2002; 18 (3): 38-42.
17. Dunn JT. Nutrient composition for fortified complementary foods: Iodine should be routinely added to complementary foods. J Nutr 2003; 133: 3008S – 3010S.
18. Vankatesh Manner MG, Dunn JT. Salt iodisation for the elimination of iodine deficiency. ICCIDD, Netherlands 1995; 79 – 81.

Status of iodine nutrition in pregnant and lactating women in national capital district, Papua New Guinea

Victor J Temple PhD[1], Benjamin Haindapa BMedSci[1], Robert Turare PhD[1], Andrew Masta PhD[1], Apeawusu B Amoa FRCPG [2] and Paulus Ripa MMed [3]

[1] *Division of Basic Medical Sciences, School of Medicine and Health Sciences, University of Papua New Guinea*
[2] *Division of Obstetrics and Gynaecology and Port Moresby General Hospital*
[3]*Division of Clinical Sciences, School of Medicine and Health Sciences, University of Papua New Guinea,*

巴布亞新幾內亞首都地區孕婦及哺乳婦女碘的營養狀況

尿液中碘的排出量是評估族群碘營養狀況有用且重要的指標。此研究測量居住在巴布亞新幾內亞首都的未懷孕者、孕婦及哺乳婦女尿液中碘的濃度，以此評估她們碘的營養狀況。此研究族群包括了56名未懷孕者、40名哺乳婦女及212名孕婦。這212名孕婦中有14名是懷孕第一期、64名是懷孕第二期及134名懷孕第三期。收集研究對象尿液，以Sandell-Kolthoff反應分析尿中碘濃度。未懷孕者、哺乳婦女及孕婦尿中碘濃度的中位數分別為163.0ug/L、134.0ug/L及180.0ug/L。懷孕者第一期、第二期及第三期的尿中碘濃度中位數分別為165.0ug/L、221.5ug/L及178.0ug/L。而各組的尿液碘之20百分位濃度均超過50ug/L以上，指出不同組別的婦女均能從飲食中攝取到足夠的碘，而碘的營養狀態均達到理想的狀態。碘營養狀況由輕微至嚴重缺乏的情形分別為未懷孕者30.4%、哺乳婦女35.0%、孕婦22.2%、懷孕第一期28.5%、懷孕第二期18.8%及懷孕第三期23.1%。本研究建議懷孕及哺乳的婦女增加飲食中碘的攝取使碘的營養狀況達到理想狀態。

關鍵字：尿液碘、懷孕、哺乳、孕期、未懷孕者、巴布亞新幾內亞。