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Nutrient Adequacy Among Pregnant Women With Altered Iodine Status

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ORIGINAL STUDY

Nutrient Adequacy among Pregnant Women with Altered Iodine Status

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Abstract

Background: **Pregnant women, are one of the most vulnerable groups for iodine deficiency. Alteration in the nutritional status during pregnancy can have a significant impact on maternofoetal health outcomes. Evidence relating to macro and micronutrient requirements, their deficiency its risks, and consequences still remain a gap of knowledge.**

Objectives: **The aim of this study was to assess the nutrient intake of pregnant women with altered iodine status in the Mysuru region.**

Methods: **A hospital-based cross-sectional study was conducted and random spot urine samples ($n = 110$) were collected to determine Urinary iodine concentration (UIC). Three-day 24hr recall and FFQ were collected to assess the nutrient intake. Adequacy percent and ratio was calculated for both macro and micronutrients and ANOVA was employed to find the significance among different groups.**

Results: **Intake of both macro and micronutrients were insufficient in UIC<150 μg/L and UIC>500 μg/L groups except for carbohydrate. A significant difference ($p < 0.05$) was observed for fiber, folic acid, vitamin A, thiamine, vitamin B6, zinc, and magnesium. The commonly consumed iodine-rich foods were dairy products. The intake of milk among iodine insufficient women was less compare to normal and excess. Frequency of milk consumed was daily, while other iodine rich foods like meat, fish, egg, groundnuts, spinach and potato was 3-5 times in a week.**

Conclusion: **To conclude iodine deficiency and excess still exists. The nutrient intake was not optimum among all the study groups which is essential for synthesis and absorption of iodine. Therefore, efforts are still needed to avoid the nutrient deficiency and inturn deficiency of iodine and excess.**

Keywords: Iodine insufficiency, Macro and micro-nutrients, Pregnant women, Nutrient adequacy

1. Introduction

For the synthesis of thyroid hormones iodine is a key component. It influence the brain development in foetus and neonates therefore being crucial during pregnancy and early life. Deficiency of Iodine leads to a spectrum of disorders, viz. IDD, including cretinism, increased pregnancy loss and infant mortality, intellectual impairments, growth retardation, and thyroid dysfunction with or without goiter [1]. Conversely, even mild deficiency of iodine during pregnancy can result in satisfactory outcomes, impairing child's cognition, intelligence quotient (IQ), and school performances [2]. Many factors influence the supply of thyroid hormones to brain, which includes poor quality diet, use of non-iodized salt, limiting the absorption of iodine and rendering the mineral unavailable for the use by the body [3]. Also, factors like deficiency of iron, vitamin A, selenium, protein-energy malnutrition and parasitic infestations can adversely affect the uptake and utilization of iodine [4]. The requirement of energy and protein increases during pregnancy to maintain the maternal homeostasis by supporting

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the growth of the foetus. Balanced supplementation of energy and protein may increase birth weight, however high protein intake might adversely affect the foetal growth [5]. Micronutrients like folic acid, calcium can improve pregnancy outcome by preventing neural tube defect and hypertension disorder of pregnancy respectively [6,7]. Sufficient iron supply is essential for effective synthesis of thyroid hormone after supplementation of iodide. Selenium is an essential trace element that play an important role in regulating thyroid function [8]. Since thyroid hormone plays an important role in the regulation of total body metabolism, nutritional factors may strongly alter the regulation, supply, and disposal of this thermogenic hormone. The thyroid economy is affected by most important dietary changes incudes total caloric intake and supply of iodine [9]. The presence of these factors may cause the deficiency of iodine to persist affecting children's intellectual development.

Based on our literature survey and to the best of our knowledge, this is the first study of its kind in Karnataka, India, to assess the intake of nutrients among pregnant women with altered iodine status.

2. Methods

2.1. Study design

A hospital based cross-sectional was conducted in Mysuru district of Karnataka, Southern India, from January–December 2019 based on convenient sampling with the inclusion criteria of pregnant women with altered iodine status aged between 18 and 40 years in the first trimester. Subjects who had personal history of thyroid disease; who were on thyroid-related medications; those with other metabolic disorders and who were not willing to participate were excluded from the study.

2.2. Setting and selection of participants

Data was collected from pregnant women in 1st trimester from three different hospitals. One hundred ten (n = 110) subjects were enrolled for the study and UIC was analysed using random urine sample [10]. Based on the UIC the subjects were grouped into four viz. iodine insufficient (<150 μg/L), adequate (150–249 μg/L), above requirement (250–499 μg/L) and iodine excess (>500 μg/L). The data on dietary intake was elicited using 24hr recall and iodine rich foods using food frequency questionnaire.

2.3. Tools

Dietary component consists of the assessment of food or nutrient intake which provides information on the current food consumption. Dietary intakes were recorded using 24 h recall method for three non-consecutive days (2 week day and one weekend) and was converted into a quantity of raw food consumed and the nutritive values of the foods consumed were calculated using Indian food composition database by NIN, India. The food frequency questionnaire (FFQ) was used to measure the consumption pattern of different foods rich in iodine on daily, weekly, monthly or occasional basis by the pregnant women. Standardized measuring cups and visual guides were shown to the subjects in order to accurately measure the portion size of the foods.

Evaluation of daily nutrient intakes or food measurements which is an important tool of dietary assessment component not only provides information on the daily food consumption patterns but also renders a strong basis for the direct measurement of growth. The records of foods consumed were analysed using Diet Cal software (developed by Kaur 2015; Profound Tech Solutions, New Delhi) to calculate nutrient intake and an individual report was generated for each subject.

Diet Cal software is a tool for dietary assessment and planning of commonly consumed foods and is based on Indian Data (National Institute of Nutrition, Indian Council of Medical Research). It has an editable central repository of nutrients and their measure units, editable central repository of food items classified by food groups and their nutritive values and also had the facility to create custom recipes and allowed calculation of nutritive values of set of food items and recipes. The software also had an option of addition of foods into the database in which local food recipes could be added and can be estimated for the nutrients (macro, micro and calorie content). The adequacy of diets can be assessed using several analytical approaches such as cut-off method, which estimates the percentage of the population having usual intakes below a given value; and probability method, which assesses the percentage of the population whose usual intakes are below their individual requirements [11]. Recommended Dietary Allowances cut-off method [12] was used to assess the prevalence of adequacy or deficiency of nutrient intakes.

The macronutrient and micronutrient adequacy were evaluated for each nutrient with the RDA/RDI values derived for each subject. The percent nutrient adequacy (PNA) was calculated for each nutrient compared to RDA/RDI values derived for each subject and expressed as a percentage. The equation for deriving PNA is as follows:

PNA: actual nutrient intake (AI)/Recommended dietary intake x 100.

The nutrient adequacy was also evaluated by deriving nutrient adequacy ratio (NAR), which is a ratio of an individual's intake per day to the RDA of that nutrient based on age and gender. A NAR ration ≤ 0.66 was considered to be inadequate, 0.66–1.0 as fairly adequate and $\geq$ one as an adequate level of intake [13]. The formula used to derive NAR is as follows:

Nutrient adequacy ratio (NAR): Actual intake of a particular nutrient per day/RDA or RDI of the nutrient per day.

2.4. Statistical methods

Statistical analysis was performed using the statistic software package (SPSS, 16.0, International Business Machines, USA). Frequency and percent was calculated for descriptive data. ANOVA was used to compare the nutrient intake among different UIC groups.

2.5. Ethical clearance

Written informed consent was obtained from all participants. Besides, the study protocol was approved by Institutional Human Ethics Committee (IHEC-UOM NO. 156/Ph.D/2017–18).

3. Results

3.1. General characteristics of the study population

The average age of the study population is around 24 years. Majority (38.2%) of the study subjects had UIC <150 μg/L. More than adequate and iodine excess pregnant women were also observed in the study (Table 1).

3.2. Dietary information

Table 2, shows the comparision of mean nutrient intake of pregnant women's grouped based on different iodine status with the local recommended dietary allowences (RDAs). The gap in nutrients consumption across all the groups ranged from 6.09% to 24.7%, lowest energy consumption was recorded in the pregnant women with UIC >500 μg/L. The carbohydrate and fat intake increased in all the groups ranging from 17.5% to 43% and 58.78%–100.89% respectively. Intake of protein ranged from 5.11% to 26.1% compared to RDA. The adequacy of fiber was less among all the groups and the gap was found to be high (55.03%) among UIC 250–499 μg/L.

Similarly the micro-nutrient inadequacy was observed in all the groups. The gap for calcium ranged from 46.95% to 61.23%, least being in UIC <150 μg/L group. Iron intake in comparison to RDA standard varied across all the groups, ranging from 38.05% to 46.93%. The highest gap of 69.68% was observed in UIC <150 μg/L group for folic acid. Similar trend was observed for selenium (23.25%) intake.

The deficiency of nutrients among pregnant women has shown as gap in the Table 2. The gap in the intake of vitamin A was ranged from 26.16% to 46% with an overall highest gap of 46% in UIC <150 μg/L group. The gap for thiamin ranged from 52.46% to 73.71% among all the groups compared to RDA. The gap for vitamin B12 and B6 was found to be 47.74%–62.8% and 19.65%–46.64% respectively. The highest gap for vitamin C was observed in UIC >500 μg/L (31.3%) followed by UIC <150 μg/L (22.13%), UIC 250–499 μg/L (21.09%), and UIC 150–249 μg/L (18.37%). Zinc, a trace element necessary for a healthy immune system. Deficiency and inadequate zinc consumption through diet or supplementation may be susceptible to disease, illness, and increased infection risk. The highest gap of 55.13% for zinc was observed in UIC <150 μg/L group. The highest (58.76%) gap for magnesium was observed in UIC <150 μg/L, followed by UIC 250–499 μg/L (34.06%), UIC >500 μg/L (23.66%), and UIC 150–249 μg/L (15.58%) group.

3.3. Nutrient adequacy ratio

The nutrient adequacy ratio is as shown in Table 3. Majority of the nutrients were found to be inadequate (≤ 0.66) viz. fibre, calcium, iron, folic acid, vitamin A, thiamine, B12, B6, Zinc and magnesium while other nutrients like carbohydrates and fat were found to be adequate (≥ 1).

It was observed that between the groups energy was found to be fairly adequate (0.66–1), protein intake in iodine insufficiency and excess subjects waere fairly adequate. Calcium was adequate in pregnant women with iodine adequacy. Selenium,

Table 1. General charecteristics of pregnant women.

Variables	Frequency (F)	Percentage (%)
Age (mean ± SD)	23.87	3.91
UIC <150 μg/L	42	38.2
UIC 150–249 μg/L	26	23.6
UIC 250–499 μg/L	34	30.9
UIC >500 μg/L	8	7.3

Table 2. Nutrient intake its adequacy percent and GAP as percent of RDA among different UIC groups

Nutrients	RDI	UIC <150 µg/L			UIC 150–249 µg/L			UIC 250–499 µg/L			UIC >500 µg/L		
		Daily Intake	Adequacy %	GAP as % of RDA	Daily Intake	Adequacy %	GAP as % of RDA	Daily Intake	Adequacy %	GAP as % of RDA	Daily Intake	Adequacy %	GAP as % of RDA
Energy (Kcal)	2010	1694.84 (521.9)	84.32	−15.68	1913.73 (486.68)	93.91	−6.09	1725.87 (420.70)	85.9	−14.1	1513.11 (622.92)	75.3	−24.7
Carbohydrates (g)	175	230.79 (58.60)	131.8	31.8	250.26 (59.29)	143	43	238.64 (60.12)	136.4	36.4	205.66 (80.69)	117.5	17.5
Proteins (g)	63	54.26 (22.14)	86.13	−13.87	59.79 (21.95)	94.89	−5.11	56.51 (20.47)	89.69	−10.31	46.56 (26.84)	73.90	−26.1
Fat (g)	30	55.65 (30.07)	185.51	85.51	58.12 (56.82)	200.89	100.89	54.34 (20.99)	181.12	81.12	47.64 (37.51)	158.78	58.78
Fibre (g)	40	22.11 (10.82)	55.28	−44.72	26.36 (10.97)	65.99	−34.01	17.99 (9.51)	44.97	−55.03	29.87 (17.01)	74.67	−25.33
Calcium (mg)	1000	387.74 (258.48)	38.77	−61.23	465.51 (192.78)	46.55	−53.45	435.34 (231.88)	43.53	−56.47	530.47 (610.97)	53.05	−46.95
Iron (mg)	40	21.23 (5.71)	53.07	−46.93	24.78 (4.73)	61.95	−38.05	23.49 (5.72)	58.74	−41.26	21.93 (7.21)	54.83	−45.17
Folic acid (µg)	570	172.84 (63.7)	30.32	−69.68	350.95 (125.08)	61.57	−38.43	234.91 (288.54)	41.21	−58.79	309.65 (323.88)	54.33	−45.67
Selenium (µg)	40	30.69 (19.74)	76.75	−23.25	32.61 (13.25)	81.53	−18.47	32.33 (29.79)	80.83	−19.17	31.12 (8.33)	77.8	−22.2
Vitamin A (µg)	900	486.02 (246.66)	54.00	−46	664.65 (233.37)	73.84	−26.16	501.01 (156.51)	55.67	−44.33	629.74 (220.47)	69.97	−30.03
Thaimine (mg)	1.6	0.50 (0.28)	30.81	−69.19	0.76 (0.24)	47.54	−52.46	0.42 (0.26)	26.29	−73.71	0.48 (0.22)	30.37	−69.63
Vitamin B12 (µg)	2.7	1.00 (0.70)	37.20	−62.8	1.41 (0.94)	52.26	−47.74	1.10 (0.46)	40.76	−59.24	1.36 (0.46)	50.33	−49.67
Vitamin B6 (mg)	23	12.27 (4.97)	53.36	−46.64	18.48 (2.39)	80.35	−19.65	17.64 (4.15)	76.71	−23.29	16.89 (2.67)	73.46	−26.54
Zinc (mg)	14.5	6.51 (3.10)	44.87	−55.13	9.48 (4.86)	65.38	−34.62	8.76 (4.29)	60.6	−39.4	7.85 (3.44)	54.16	−45.84
Vitamin C (mg)	65	50.61 (13.38)	77.87	−22.13	53.06 (8.15)	81.63	−18.37	51.29 (10.42)	78.91	−21.09	44.66 (14.72)	68.70	−31.3
Magnesium	385	158.76 (147.03)	41.24	−58.76	328.89 (188.87)	84.42	−15.58	253.86 (166.94)	65.94	−34.06	293.91 (311.88)	76.34	−23.66

UIC-Urinary Iodine Concentration, RDA-Recommended Dietary Allowance.

vitamin B6 and vitamin C was fairly adequate among all the groups.

3.4. Mean nutrient intake

The mean nutrient adequacy percentage of pregnant women in different UIC groups is as shown in Table 4. Significant ($P < 0.01$) difference was observed between the group for nutrients like fibre, folic acid, vitamin A, thiamine, vitamin B6, zinc, and magnesium.

3.5. Food frequency-iodine rich foods

Figure 1, depicts the frequency of average intake of iodine rich foods and beverages of the study population. The consumption of iodine rich grains and legummes, fruits and vegetables, nuts and oil seeds, meat, fish and egg was found to be less compare to dairy products which were consumed on daily basis (Fig. 1).

It was observed that legumes like field beans (54.5%) was consumed 1−2 times and 9.1% 3-5times in a week. Similar trend was observed with peas and cowpea. Consumption of potato was higher (13.6%) on daily basis compared to that of cabbage, cauliflower and tapioca. Similarly consumption of banana (27.27%) and pomogranate (22.73%) was higher on daily basis than other fruits. Additionally dates (23.64%), almond (18.18%), and raisins (22.73%) consumption was higher among the pregnant women on daily basis. Furthermore, consumption of dairy products was higher in the pregnant women (89.09% once/day, and 10.91% more than 2 times a week). Consumption of egg (43.64%) was seen daily in the boiled and omlet form, 45.46% consumed 1−2 times in a week and 89.09% consumed 3−5 times a week. The pregnant women ate meat in the form of chicken (50.91%), mutton (14.55%) and beef (40%) 3−5 times in a week. Fish consumption, as an essential source of iodine, was low in the study population (23.64%, 3-5times in a week), and 9.1% of pregnant women never ate fish. When compared between the groups, the consumption of milk was less in those with UIC <150 µg/L when compare to other groups.

4. Discussion

The current study is first of its kind carried out in the Mysuru region, which aimed in assessing the nutrient intake among pregnant women with altered iodine status. Our previous studies have shown the existence of iodine insufficiency and also excess among vulnerable pregnant women [14,15].

Table 3. Nutrient adequacy ratio of pregnant women with altered UIC.

Nutrients	UIC <150 μg/L	UIC 150–249 μg/L	UIC 250–499 μg/L	UIC >500 μg/L
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Energy (Kcal)	0.84 ± 0.26	0.94 ± 0.24	0.86 ± 0.21	0.76 ± 0.31
Carbohydrates (g)	1.32 ± 0.34	1.49 ± 0.34	1.36 ± 0.34	1.18 ± 0.46
Proteins (g)	0.99 ± 0.40	1.09 ± 0.40	1.03 ± 0.37	0.85 ± 0.49
Fat (g)	1.86 ± 1.00	2.01 ± 0.89	1.81 ± 0.70	1.59 ± 1.25
Fibre (g)	**0.55 ± 0.27**	**0.66 ± 0.27**	**0.45 ± 0.24**	0.75 ± 0.43
Calcium (mg)	**0.39 ± 0.26**	5.12 ± 0.19	**0.44 ± 0.23**	**0.53 ± 0.61**
Iron (mg)	**0.53 ± 0.14**	**0.62 ± 0.12**	**0.59 ± 0.14**	**0.55 ± 0.18**
Folic acid (μg)	**0.30 ± 0.11**	**0.62 ± 0.22**	**0.41 ± 0.51**	**0.54 ± 0.57**
Selenium (μg)	0.78 ± 0.49	0.96 ± 0.33	0.88 ± 0.54	0.80 ± 0.21
Vitamin A (μg)	**0.54 ± 0.27**	0.74 ± 0.56	**0.56 ± 0.17**	0.70 ± 0.25
Thaimine (mg)	**0.31 ± 0.17**	**0.48 ± 0.15**	**0.27 ± 0.16**	**0.30 ± 0.14**
Vitamin B12 (μg)	**0.37 ± 0.26**	**0.51 ± 0.34**	**0.40 ± 0.17**	**0.49 ± 0.17**
Vitamin B6 (mg)	**0.53 ± 0.22**	0.89 ± 0.10	0.77 ± 0.18	0.74 ± 0.12
Zinc (mg)	**0.45 ± 0.21**	**0.65 ± 0.34**	**0.61 ± 0.30**	**0.54 ± 0.24**
Vitamin C (mg)	0.78 ± 0.21	0.81 ± 0.17	0.79 ± 0.20	0.73 ± 0.28
Magnesium	**0.41 ± 0.38**	0.85 ± 0.49	**0.66 ± 0.43**	0.84 ± 0.81

UIC-Urinary Iodine Concentration.

Table 4. Mean nutrient adequacy percent of pregnant women with altered UIC.

Nutrients	UIC <150 μg/L	UIC 150–249 μg/L	UIC 250–499 μg/L	UIC >500 μg/L	*P* value
Energy (Kcal)	84.32	93.91	85.9	75.3	0.222
Carbohydrates (g)	131.88	149.38	136.36	117.52	0.091
Proteins (g)	86.13	94.89	89.69	73.90	0.448
Fat (g)	185.51	200.89	181.12	158.78	0.668
Fibre (g)	55.28	65.99	44.97	74.67	0.007*
Calcium (mg)	38.77	46.55	43.53	53.05	0.475
Iron (mg)	53.07	61.95	58.74	54.83	0.072
Folic acid (μg)	30.32	61.57	41.21	54.33	0.004*
Selenium (μg)	76.75	81.53	80.83	77.8	0.390
Vitamin A (μg)	54.00	73.84	55.67	69.97	0.005*
Thaimine (mg)	30.81	47.54	26.29	30.37	0.000*
Vitamin B12 (μg)	37.20	52.26	40.76	50.33	0.095
Vitamin B6 (mg)	53.36	80.35	76.71	73.46	0.000*
Zinc (mg)	44.87	65.38	60.6	54.16	0.016*
Vitamin C (mg)	77.87	81.63	78.91	68.70	0.333
Magnesium	41.24	84.42	65.94	76.34	0.002*

UIC-Urinary Iodine Concentration, * Statistically significant $P < 0.01$.

Calcium could be goitrogenic when consumed excessively in the diet. Intake of 2 g calcium per day, was in fact associated with decreased iodide clearance by the thyroid. Additionally, calcium reduces the absorption of thyroxine [6,7].

Very little iron during pregnancy may lead to anemia causing fatigue and increased infection risk. Generally, iron helps RBCs deliver oxygen to fetus. Iron intake in comparison to RDA standard varied across all the groups, ranging from 38.05% to 46.93%. The deficiency of iron leads to reduced cGPx activity in numerous rat tissues [16], and also T4 and T3 disposal rates were decreased [17]. Impaired efficiency of synthesis of thyroid hormones in iron-deficient goitrous children and adults has been reported, demonstrating that sufficient iron supply is essential for effective synthesis of thyroid hormone after supplementation of iodide [18].

Selenium is an essential trace element that play an important role in regulating thyroid function. Deficiency of selenium increases the sensitivity of the thyroid gland to necrosis caused by iodide overload in iodine-deficient thyroid glands. Supplementation of selenium during pregnancy and in the postpartum period reduced inflammatory activity of thyroid and the incidence of hypothyroidism [19].

Minerals like vitamin A, and B complex also help in maintenance of normal thyroid functions. Vitamin B1, B5 is needed with an overactive thyroid.

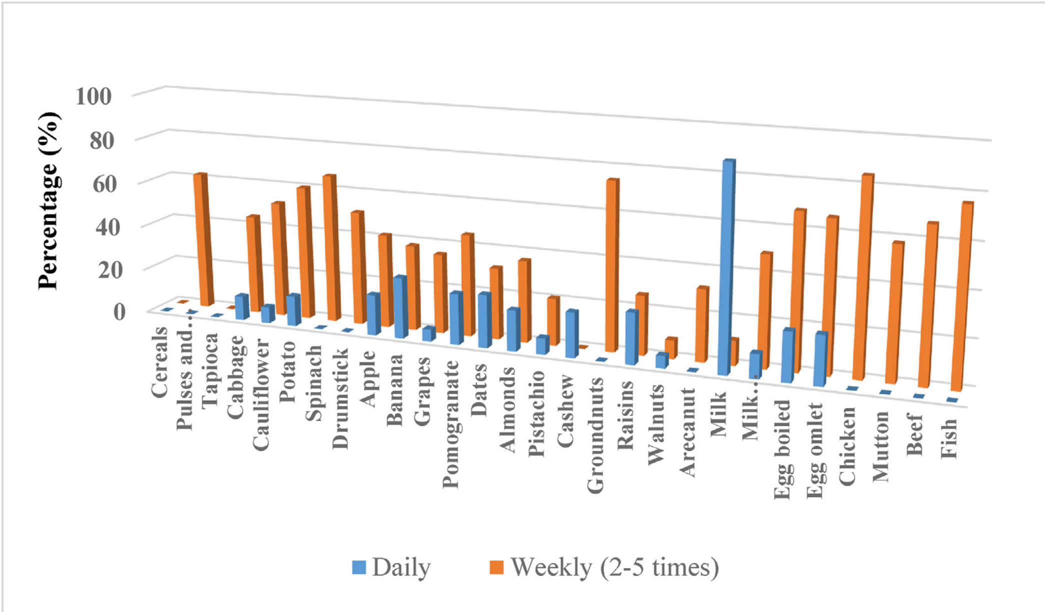

Fig. 1. Frequency intake of iodine rich foods.

It has been found to help with the perception of hyperthyroid symptoms and normalization of the basal metabolic rate. Also B12 deficiency is associated with hyperthyroidism due to increased turnover during hyperthyroidism [20]. Deficiency of vitamin A increases TSH, thyroglobulin and size of goiter in severely iodine deficient individuals, reducing the risk of hypothyroidism; on the other hand, iodine efficacy is improved by the association of vitamin A supplementation to iodized salt. This effect may be related to vitamin A-mediated suppression of TSH-β gene [21]. Selenium being an important constitute of enzymes involved in the regulation of thyroid hormone and also protecting the thyroid from the attack of free radicals as in autoimmune thyroid disease. Therefore, due to this reason diet must warrant an adequate intake of this micronutrient along with iron, and vitamin A.

5. Conclusion

Overall our results indicate that the intake of nutrients among all the groups was fairly adequate and inadequate except for carbohydrates and fats which is evident by the food pattern consumption in southern India, staple being rice. Nutrients like selenium, zinc and vitamin A which plays an important role in production of thyroid hormones and subsequent thyroid health was found to be inadequate. Therefore, adequate nutrient intake of both macro and micronutrients such as iron, vitamin A, selenium and zinc is warranted. Women who excluded milk and dairy products from their diets as observed in iodine insufficient subjects may be at risk of iodine deficiency and may possibly have an increased risk of thyroid dysfunction with non-optimal developmental status in children. Therefore the current study results underline the importance of nutrient implementing actions to improve iodine nutrition among pregnant women in current region.

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Conflict of interest

There are no conflicts of interest.

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