Original Article

Iodine Status

Evaluation of Impact of Dietary Pattern on Iodine and Thyroid Status of Adolescent Girls in Lahore

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ABSTRACT

Objective: Study was designed to determine, inter alia, the impact of dietary pattern on the iodine status of adolescent girls' population in City District, Lahore.

Study Design: Cross-sectional study.

Place and Duration of Study: The study was conducted in the Department of Nutrition & Dietetics, Institute of Public Health, Lahore from 21st March to 02nd June, 2009.

Subjects and Methods: It was a community based study conducted in the 66 public and private girls secondary schools situated within urban and rural areas of Capital City District, Lahore. The study population comprised adolescent school girls of age group 11-16 years in 09 administrative towns of Lahore. Multistage sampling technique was used. In first stage, 75 schools in Lahore were selected by simple random sampling. In second stage, 10 girls students of 11-16 years age from each school were selected by using the table of random number. 660 subjects were recruited for the study and urine samples were collected for urinalysis. In third stage, 01 girl student out of 10 from each school was randomly selected and her venous blood taken for TSH estimation. Data was collected through interview on predesigned and pretested questionnaire. Chi-squared, Fisher's exact and ANOVA tests were employed to determine the association between different variables. P-value <0.05 was considered significant except in case of impact of food items and goiter, where P value ≤ 0.10 (10%) was considered significant.

Results: Of sample population (n=660), 78.6% (519) had goiter of grade-0, whereas 8.8% (58) respondents having goiter of grade 01A, 01B and 02 were found with lower UI level [iodine deficiency goiter] and 12.25% (81) had goiter of grade 01A, 01B and 02 with optimal UI level. [physiological goiter]. The figure of 8.8% vis-à-vis <05% recommended by WHO signified public health problem. Sea foods and dairy products showed a significant relationship with mean UI level, whereas no relationship between mean UI level –and- meat, cabbage, cauliflower, salad leaves, spinach, turnips, fruits and eggs could be ascertained. No relationship between sea foods, cauliflower, salad leaves, turnips, spinach, fruits, yogurt, cereals & eggs –and– goiter could be ascertained. However, meat, milk, butter and cabbage exhibited significant association with goiter. Percentage of UI deficient subjects using non-iodized salt was higher (60%) as compared to those (31%) with optimal UI level using the same. Contrary to that, the percentage of UI sufficient subjects using iodized salt (44%) was higher than those with deficient urinary iodine level (07%). Statistical analysis $P <0.001$ confirmed definite impact of iodized salt on urinary iodine level.

Conclusion: The goiter rate of 8.8% in the adolescent girls of Lahore with lower urinary iodine level invites the attention of policy makers and enforcing agencies. The findings of the studies were not in consonance with WHO, UNICEF, ICCIDD's criteria for monitoring progress towards the goal of ID elimination as public health problem and call for strict implementation of iodine fortification and supplementation programs in Lahore for the purpose of halting and reversing the upward trends of ID/ IDD.

Key Words: Adolescent Goitrogens, Goiter Grade, Goiter Rate, Iodine Deficiency Disorders, Iodized Salt, TSH Level, Urinary Iodine Level.

INTRODUCTION

Iodine is a trace element present in the human body in minute amounts [15-20mg in adults]. It is present in soil and water and is essential for the synthesis of thyroid hormones namely tetra-iodothyronine also called thyroxin (T4) and tri-iodothyronine (T3), which in turn are needed for the regulation of metabolic activities of all cells throughout life. They are also required for normal growth especially of brain, which occurs from fetal life to the end of third postnatal year[1,2]. The effects of iodine deficiency on growth and development are now denoted by the term iodine deficiency disorders (IDD)[3].

Adolescence is defined as a period of transition between childhood and adulthood (10-19 years of age) and occupies a crucial position in the life of human beings. The adolescents constitute about 20% of the total population of the world. Adolescence is characterized by an exceptionally rapid rate of growth[4]. As for physical growth during adolescence, a peak is reached, after which deceleration begins[5].

Worldwide, the oceans are the primary stores and source of iodine. Ocean water contains 50µg iodine per liter and most iodide naturally present in our diets comes from oceans. As the ocean mist blows on to nearby land, the iodide becomes part of soil. Plants and vegetables that grow in that soil accumulate the iodide. The iodine content of rainwater and atmosphere diminishes as the distance from the coast increases. The melting of glaciers leaches away most of the iodine of soil beneath. Consequently, the soils longest covered by glaciers during quaternary era are the lowest in iodine.[6,7,8].

Sea foods (fish and salt), cod liver oil are the best sources of iodine, but it also occurs in small quantities in milk, meat, vegetables and cereals. About 90% of iodine comes from foods eaten and the rest is from drinking water. The iodine content of the soil determines its supply to human beings. Severe iodine deficiency [ID] will impair thyroid function resulting in lower metabolic rate, growth retardation and brain damage.[1]

Assessment of nutritional iodide status of a population in an area or region is of two types: clinical and biochemical[9]. Clinical assessment involves the examination of thyroid gland according to WHO's classification of goiter. Biochemical assessment involves measurement of urinary iodide (UI) excretion –and– determination of blood TSH levels[9,10].

In South Asia, 410 million i.e. 25.1% of regional population (06% of total global populations) at risk lives in the areas of IDD. In the South Asian countries, the females are affected with goiter more than males. In the SAARC countries the goiter prevalence is 47% (Bangladesh), 10% (India), 10% (Pakistan), 24% (Maldives), 19% (Sri Lanka) and 55% (Nepal)[11]. In Pakistan, several studies reveal that as high as 68% of school age children are suffering from goiter (all grades). There is sufficient evidence suggesting that --non-endemic areas are also at the risk of IDD. In Pakistan, over 70% of population was estimated to be at the risk of IDD in 1998. Presently, it is estimated that 50% of the population is at the risk of IDD with grave consequences on the national economy[12]. The goiter belt of northern areas of Pakistan (Baltistan, Sakardu, Gilgit, Malak and and Hazara division of NWFP, the state of AJK and northern part of Punjab) is one of world's most severely endemic areas[11], where the goiter rates in school children and women are as high as 80-90%. It is believed that some 50 million people are clinically or sub-clinically affected with iodine deficiency in Pakistan[13].

MATERIALS AND METHODS

It was a community based cross sectional study, which was conducted from 21st March to 02nd June 2009 in 66 public and private girls secondary schools situated within the urban and rural areas of Capital City District Lahore. The study population comprised adolescent school girls of age group 11-16 years in nine (09) administrative towns of capital city district Lahore. As such, an adolescent school girl of age 11-16 years was the sampling unit of the study. Multi stage sampling technique was used. In first stage, out of total 1533 girls' schools in Lahore, 75 were selected by simple random sampling. But only 66 schools could be visited. Of the remaining 09 schools, 03 had been closed, 02 were non-existent and administration of 04 schools denied entry, despite permission granted earlier. In second stage, 10 girl students of 11-16 years age from each school were selected by using table of random number. As such 660 subjects were recruited for the study –and– in toto, 660 urine samples were collected in sterile sampling plastic bottles till the last day of study. In third stage, one (01) girl student out of ten (10) sampled from each school was randomly selected and her venous blood (03ml) taken in 05ml disposable syringe for TSH estimation. Two (02) blood samples were destroyed due to the breakage of syringes during transportation, leaving behind 64 samples. Clinical examination of thyroid gland of sample population was carried out according to the WHO's classification of goiter. Data was collected through interview on predesigned and pretested questionnaire. History of food intake was reduced to writing on the questionnaire with frequency (never, daily, weekly, fortnightly or monthly) for each item selected for the purpose of study and taken or not taken by the respondents.

The laboratory of Nutrition & Dietetics Department of Institute of Public Health, Lahore was used for urinary iodine analysis. Blood samples of 64 respondents were got analyzed by immunoradiometric assay for TSH estimation from INMOL, Lahore. TSH estimation was used to cross check UI level and ascertain relationship between UI & TSH levels. The sample population was distributed according to, inter alia, the age group, UI level, thyroid size and dietary pattern of the respondents. Frequency distribution and percentages were calculated and findings tabulated. Chi squared test, Fisher's exact test and, where applicable ANOVA test was employed to determine the association between different variables. P-value <0.05 was considered significant except in case of impact of food items and goiter, where P value ≤ 0.10 (10%) was considered significant.

RESULTS

Out of sample population of 660, 523 (79.1%) showed optimal urinary iodine concentration, whereas 137 (20.8%) were found with lower urinary iodine level. Thus the prevalence of iodine deficiency was 20.8% in the study population. According to WHO, UNICEF & ICCIDD's criteria, total goiter rate (goiter of grade 01A, 01B & 02) of 5% or more in school-age children signifies the presence of a public health problem[10,14]. In this study, out of sample population of 660, 519

(78.6%) respondents were found with goiter grade-0 (normal), whereas 139 (21.15%) revealed goiter of grade 01A, 01B & 02, showing goiter rate of 21.15%. On further analysis, the number of respondent adolescent school girls having goiter of grade 01A, 01B & 02 with lower UI level [iodine deficiency goiter] has been calculated as 58 (8.8%) –whereas– the number of respondents with goiter of grade 01A, 01B & 02 and optimal UI level came at 81 (12.25%). The presence of goiter with optimal UI level may be due to puberty (physiological goiter) or some pathological reason (s) other than iodine deficiency. The figure of 8.8% as against <05% recommended by WHO signified public health problem. Statistical analysis (P value < 0.05) confirmed a strong inverse association between the size of thyroid gland and urinary iodine level.

Table-1: Impact of Various Food Items on Mean Urinary Iodine Level [ANOVA, Confidential Limit = 0.95]

Food Items	Food Frequency	Frequency Distribution	Mean UI Level [µg/L]	Standard Deviation	P Value [ANOVA Test]
Fish	Never	185	122	57	P = <0.01
	Daily	003	153	81	
	Weekly / Monthly	472	140	51	
Prawns	Never	597	133	54	P = <0.01
	Daily	002	170	42	
	Weekly / Monthly	061	155	48	
Meat	Never	028	123	58	P = 0.13
	Daily	190	141	53	
	Weekly / Monthly	442	134	54	
Milk	Never	073	115	54	P = <0.01
	Daily	345	141	52	
	Weekly / Monthly	242	133	54	
Cabbage	Never	222	137	52	P = 0.73
	Daily	056	139	53	
	Weekly / Monthly	382	134	55	
Cauliflower	Never	076	132	52	P = 0.44
	Daily	007	159	63	
	Weekly / Monthly	577	136	54	
Salad leaves	Never	053	133	54	P = 0.14
	Daily	314	140	52	
	Weekly / Monthly	293	131	55	
Spinach	Never	072	128	55	P = 0.13
	Daily	006	171	42	
	Weekly / Monthly	582	136	53	
Turnips	Never	061	136	54	P = 0.47
	Daily	075	142	51	
	Weekly / Monthly	524	134	54	
Fruits	Never	001	108	00	P = 0.11
	Daily	388	139	52	
	Weekly / Monthly	271	103	56	
Butter	Never	073	117	55	P = <0.01
	Daily	281	141	33	
	Weekly / Monthly	306	134	53	
Yogurt	Never	073	115	54	P = <0.01
	Daily	345	141	52	
	Weekly / Monthly	242	133	54	
Eggs	Never	066	125	55	P = 0.23
	Daily	200	138	54	
	Weekly / Monthly	394	136	53	
Cereals	Never	000	000	00	xxx
	Daily	660	135	54	
	Weekly / Monthly	000	000	00	

Reference Value: Optimal UI Range = >100-200 µg/L [>200 µg/L = >adequate, not excess]

Table No.2. Impact of Various Food Items on Size of Thyroid Gland [Chi-Squared & Fisher's Exact Test Confidence Limit = 0.90 (90%)]

Food Items	Food Frequency	Frequency Distribution	Thyroid Status		P Value / Level of Significance
			Grade 0	Grade 1 A+B & 2	
Fish	Never Daily/Weekly/Monthly	185 475	140 379	45 96	P = 0.25 [Insignificant]
Prawns	Never Daily/Weekly/Monthly	597 063	468 051	129 012	P = 0.64 [Insignificant]
Meat	Never Daily/Weekly/Monthly	028 632	501 018	131 010	P = 0.06 [Significant]
Milk	Never Daily/Weekly/Monthly	073 587	467 052	120 021	P = 0.10 [Significant]
Cabbage	Never Daily/Weekly/Monthly	222 438	335 184	103 038	P = 0.06 [Significant]
Cauliflower	Never Daily/Weekly/Monthly	076 584	455 064	129 012	P = 0.21 [Insignificant]
Salad leaves	Never Daily/Weekly/Monthly	053 607	476 043	131 010	P = 0.44 [Insignificant]
Spinach	Never Daily/Weekly/Monthly	072 588	464 055	124 017	P = 0.62 [Insignificant]
Turnips	Never Daily/Weekly/Monthly	061 599	471 048	128 013	P = 0.99 [Insignificant]
Fruits	Never Daily/Weekly/Monthly	001 659	518 001	141 000	P = 0.79 [Insignificant]
Butter	Never Daily/Weekly/Monthly	073 587	283 236	065 076	P = 0.07 [Significant]
Yogurt	Never Daily/Weekly/Monthly	073 587	465 054	122 019	P = 0.30 [Insignificant]
Eggs	Never Daily/Weekly/Monthly	066 594	471 048	123 018	P = 0.22 [Insignificant]
Cereals	Never Daily/Weekly/Monthly	000 660	000 520	000 140	xxx

Reference Value: Goiter Grade >0 = Grade 1 A, 1 B & 2 [≥5% signifies public health problems]

Table No.3: Comparisons with regard to use of salt

Group	Type of Salt Used	Frequency with %ages	UI Status of Respondents			Mean UI Level (µg /L)	P Value [ANOVA]
			Optimal UI Level	Lower UI Level	P Value [Chi Squared]		
I	Iodized	237 (35.90%)	228 (44%)	09 (07%)	<0.001 [significant]	158	<0.01 [significant]
II	Non Iodized	249 (37.79%)	166 (31%)	83 (60%)		117	
III	Not Known	174 (26.40%)	129 (25%)	45 (33%)		131	
Total	03	660 (100%)	523 (100%)	137 (100%)		xxx	

1. **In order to determine the impact of various food items consumed by the respondents on their urinary iodine level**, the respondents were trifurcated according to the food frequency as illustrated in Table-1: Group-I Included those respondents having never consumed the food items mentioned in Table 1. Group-II Consisted of those respondents having consumed the food items daily –and- Group-III was of those respondents, who took the tabulated food weekly/ fortnightly / monthly.

Table-1 depicts the food items, frequency distribution of respondents in each of three groups [I, II, III], their mean urinary levels (µg/L) standard deviation and level of significance. Sea foods [fish & prawns] and dairy products [milk, yogurt & butter] showed a significant and strong relationship with mean urinary iodine level (P<0.05).

2. In order to determine the impact of various food items consumed by the respondents on the size of their thyroid gland, the respondents were bifurcated as illustrated in Table-2: *Group-I* Included those respondents having never consumed the food items mentioned in the Table –and– *Group-II* (a merger of groups II & III depicted at Table-1) Consisted of those respondents having consumed the food items daily, weekly and monthly.

Table-2 depicts the food items, food frequency, frequency distribution of respondents in each of two groups I & II (group-II & III at Table-1 joined together as group-II), the size of their thyroid gland (grade) and level of significance. No relationship between sea food [fish & prawns], cauliflower, salad leaves, turnips, spinach, fruits, yogurt and eggs and goiter could be ascertained (P>0.1) –whereas– remaining tabulated food items, meat, milk, cabbage and butter exhibited significant association with goiter ($P \leq 0.01$).

Criteria for monitoring progress towards the goal of ID elimination as public health problem established by WHO / UNICEF / ICCIDD include both process and impact indicators: i.e. the proportion of households consuming effectively iodized salt should be **>90%,** less than 20% of population should have urinary iodine **<50µg/L** and the prevalence of enlarged thyroid by palpation

(1A & 1B only) or ultrasound should be below **5%**. A cut off for neonatal TSH was agreed that 97% of newborns should have <5mU/L of whole blood[7].

Table No.4: Comparison showing recommended comparison with findings from study

Process & Impact Indicators	Recommended Criteria	Findings from Study
Proportion of population using Iodized Salt	**>90%**	**49.0%**
Population with UI level <50µg/L	**<20%**	**07.0%**
Goiter Rate by Palpation [grade 1 A+1B]	**<05%**	**07.7%**

According to this criteria, the comparison presented in Table-4 shows that the population (07%) with UI level <50µg/L was in accordance with the recommended criterion (<20%) –whereas- the figures relating to the proportion of study population using iodized salt (49%) was for less (nearly half) than the standard value (>90%) and goiter rate (07.7%) vis-à-vis recommended value (05%) are discouraging –and– call for strict implementation of iodine fortification and supplementation programs in Lahore.

DISCUSSION

Delimitation to the impact of goitrogenic food on thyroid status in study sample. Goitrogens are the substances, which, when taken in larger amounts interfere with the utilization of iodine by the thyroid gland and lead to the development of goiter. Table-3 depicts five (05) commonly used goitrogenic food items [cabbage, cauliflower, salad leaves, spinach & turnips] in Pakistan, consumed by study population. Only one such food item i.e. cabbage could exhibit its impact on thyroid gland [P value = 0.06]. Furthermore, meat, milk & butter, which are not goiterogenic, also revealed relationship with goiter [P value = <0.1]. This paradoxus may be attributed to the factors like under / over estimated and wrongly reported food frequency record, non-intake of larger amounts of goiterogenic food –or– negligible amounts of goiterogen in cooked food, as the latter gets destroyed on cooking.[6,2,11,15].

Statistical analysis (P <0.001) shows that there is a definite impact of iodized salt on urinary iodine level. As depicted in Table-4, the percentage (44%) of subjects with lower urinary iodine using iodized salt was higher (six times) than those (07%) with lower urinary iodine level. Contrary to that, the percentage (60%) of subjects with lower urinary iodine using non-iodized salt was higher (double) as compared to those (31%) with optimal urinary iodine level using the same. The mean UI level of group-I using iodized salt was higher (158µg/L) than those in group II, using non-iodized salt (117µg/L) and in group-III having no knowledge about the type of salt they and their families were using (131µg/L). Statistical analysis (P <0.01) confirmed the same.

Effective management of Iodine Deficiency (ID) / Iodine Deficiency Disorders (IDD) cannot be separated from their prevention. Iodine deficiency is not just an individual problem, it is a community problem and needs to be tackled as such. Not only in Lahore, but in other districts of Pakistan, the disturbed parameters, particularly higher goiter rate, call for halting and reversal of upward trends of ID / IDD through effective prevention and management, which will require an integrated approach involving actions by all segments of society: government, voluntary and private sectors, as well as commitment to action by individuals and communities.

CONCLUSION

The goiter rate of 8.8% in the adolescent girls of Lahore with lower urinary iodine level invites the attention of policy makers and enforcing agencies. The findings of the studies were not in consonance with WHO, UNICEF, ICCIDD's criteria for monitoring progress towards the goal of ID elimination as public health problem and call for strict implementation of iodine fortification and supplementation programs in Lahore for the purpose of halting and reversing the upward trends of ID/ IDD.

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