

Appraisal of Iodine Status and Goiter Rate in Adolescent School Girls of City District Lahore

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ABSTRACT

Aim: To appraise the iodine status & goiter rate of adolescent girls' population in City District, Lahore.

Study design: It was a community based study, conducted through cross-sectional approach.

Place and duration of study: The study was conducted from 21st March to 02nd June, 2009 in 66 public and private girls secondary schools situated within urban and rural areas of Capital City District, Lahore.

Subjects and methods: 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. Clinical examination of thyroid glands of sample population was carried out according to WHO's classification. Chi-square and ANOVA tests were employed to determine the relationship between thyroid size and UI and TSH levels. P-value <0.05 was considered significant.

Results: Of sample population (n=660), 78.6% (519) had goiter of grade-0, whereas 21.10% (139) revealed goiter of grade 01A, 01B & 02, showing goiter rate of 21.10%. On further analysis, **8.8%** (58) respondents having goiter of grade 01A, 01B and 02 were found with lower UI level [iodine deficiency goiter]. 12.25% (81) respondents had goiter of grade 01A, 01B and 02 with optimal UI level. 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 <0.01) confirmed a strong inverse association between the size of thyroid gland and 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.

Keywords: Adolescent, Goiter Grade, Goiter Rate, Iodine Deficiency Disorders, TSH Level

INTRODUCTION

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% (1.2 billion) of the total population of the world. Adolescence is characterized by an exceptionally rapid rate of growth¹. As for physical growth during adolescence, a peak is reached, after which deceleration begins².

Hidden hunger is a term used to denote the condition of nearly two (02) billion people – almost a third of the world's population – mostly concentrated in developing countries, who are at the risk of deficiency in micronutrients such as iodine, iron and /

or Vitamin-A³. Iodine Deficiency Disorders (IDD) and Vitamin-A Deficiency (VAD) are two of the three major micronutrient deficiencies affecting large magnitude of populations in the world⁴. WHO believes that hidden hunger can be eliminated by interventions such as dietary diversification, food fortification and pharmaceutical supplementation³.

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^{5,6}. RDA for iodine is 150 µg for males and females over 12 years age, with an additional 25 and 50µg recommended during

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pregnancy and lactation respectively⁷. The effects of iodine deficiency on growth and development are now denoted by the term iodine deficiency disorders (IDD)⁴. Assessment of nutritional iodide status of a population in an area or region is of two types: clinical and biochemical⁸. 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^{8,9}.

On a world scale, WHO has estimated that IDD was a significant problem in 130 out of 191 countries assessed, whereas it has been eliminated in remaining 61 countries. Out of total world population, 1.57 billion people (28.9%), who lived in iodine deficient environments (or were at risk of IDD), 0.66 billion were actually affected with goiter –and– almost 50% of goiter problem is found in Asia^{6,10}. According to WHO estimates, globally nearly 740 million (0.74 billion) people in 2005 as against 655 million (0.66 billion) in 1994 were suffering from goiter. It shows that IDD problem is at an increase. China and India have come to regard their entire population at the risk of IDD^{10,11}. Goiter is present in almost all sub mountainous regions in various countries in the world, there being 200 million cases in the world [6, 10, 12]. 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)¹².

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 is 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 economy¹³. The goiter belt of northern areas of Pakistan (Baltistan, Sakardu, Gilgit, Malakand and Hazara division of NWFP, the state of AJK and northern part of Punjab) is one of world's most severely endemic areas¹², where the goiter rates in school children and women are as high as 80-90%. A small survey from country's capital Islamabad found a 40% goiter rate among school children and 50% goiter rate among adult women living just outside Islamabad. It is believed that some 50 million people are clinically or sub-clinically affected with iodine deficiency in Pakistan¹⁴. According to Prof. Glen Maberly of PAMM (program against micronutrient malnutrition), today Pakistan is one of the severely

affected countries in the world as far as ID is concerned. Micronutrient survey of PMRC has confirmed it¹⁵.

METHODOLOGY

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 as follows:

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.

Data was collected through interview on predesigned and pretested questionnaire. Clinical examination of thyroid gland of sample population was carried out according to the following WHO's classification of goiter:

Grade 0 – No palpable or visible goiter

Grade 1 – Palpable goiter

A – Goiter detectable only on palpation.

B – Goiter palpable or visible with neck extended.

Grade 2 – Goiter visible with neck in normal position

Grade 3 – Large goiter visible from a distance^{8,9,16}.

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 the age group, UI level and thyroid size

of the respondents. Frequency distribution and percentages were calculated and findings tabulated. Chi squared test and, where applicable ANOVA test was employed to determine the relationship between thyroid size, UI level and TSH. P value <0.05 was considered significant.

RESULTS

The study was designed to address the public health problem of iodine deficiency among adolescent girls in Lahore by using three indicators: *clinical examination of neck* for determining the size of thyroid gland, hence assess the goiter rate – *urinary iodine (UI) analysis* to assess the iodine status and *TSH estimation* for cross checking of UI level & determining as to whether there exists some relationship among these three variables or not? It was perhaps the first of its kind in district Lahore to assess the iodine status of adolescent school girls by using these three indicators. In most of the studies in Pakistan including Lahore, only one or rarely two indicators have been used.

As illustrated in Table-1, on the basis of the size of thyroid gland, the sample population (n=660) was divided into 05 groups as per WHO's criteria. 519 (78.6%) respondents were found with goiter of grade-0 (normal), whereas 139 (21.1%) had goiter of grade-01A, 01B and 02 and 02(0.3%) of grade-03. As regards urinary iodine status, 523(79.1%) respondents showed optimal UI level, whereas 137(20.8%) were found with lower UI level.

On further analysis, as highlighted in Table-1, the number of respondents (in group II, III & IV) having grade-01A, 01B & 02 goiter with lower urinary iodine level (iodine deficiency goiter) has been calculated as 58 (8.8%) – *whereas*– those with same goiter grade and optimal urinary iodine level came at 81(12.25%). TGR of 8.8% vis-à-vis 05% recommended by WHO signified public health problem. P value <0.01 showed a strong inverse relationship between the size of thyroid gland and urinary iodine level i.e. greater the mean urinary iodine level, lesser the size of thyroid glands in a population.

Table-2 shows a cross-examination of mean urinary iodine level of respondents in each of five groups according to the size of thyroid gland. Mean UI level in 21.10% (139) respondents with goiter of grade-01A, 01B and 02 was 92 µg/L i.e. lower UI level, *whereas* the same in **78.60% (519)**

respondents with goiter of **grade-0** came at **143 µg/L** i.e. optimal UI level. Furthermore, statistical analysis (P value <0.01) again showed that there existed an inverse relationship between the size of thyroid gland and mean urinary iodine level.

In this study, the mean, median, mode and standard deviation for urinary iodine level have been computed as 135 µg/L, 125µg/L (optimal), 200 µg/L and 53.06 respectively, while the 10th, 50th and 90th percentiles of distribution have been worked out at 64 µg/L, 125µg/L and 200µg/L respectively. However, it is worth mentioning that the mean UI level of 21.10% (139) respondents with goiter of grade 01A, 01B & 02 has been computed as 92µg/L (lower).

Specific and sole objective of TSH estimation (n=64) was to cross-check UI level on one hand – and– establish an association between UI and TSH levels and goiter grade on the other hand. As shown in Table-3, 64 respondents were divided into 04 groups. Out of the sample of 64, whose blood samples were analyzed for TSH, 71.87% (46) respondents (in group-I & III) were found with optimal UI level, while 28.12% (18) respondents (in group-II & IV) with lower UI level. As regards their TSH levels, 82.81% (53) respondents (in group-I & IV) showed optimal level, whereas 17.19% (11) respondents (in group-II & III) had higher TSH level. On further analysis, as depicted in Table-3, the percentage of respondents with optimal UI level and optimal TSH level has been worked out at 70.31% (45) and that of those with lower UI level and higher TSH level at 15.63% (10). Statistical analysis (P<0.01) reflected highly significant relationship between UI and TSH levels.

Out of 64 respondents, 01 was not considered due to goiter grade-03 –*whereas*– remaining 63 were distributed into 04 groups according to goiter grade, UI level and TSH level as shown in Table 4:

The contents of Table-4 show that 77.77% (60.31%+17.46%) respondents showed a significant relationship (P <0.01) between UI level, TSH level and goiter grade. 12.69% respondents exhibited no relationship between UI level (lower), TSH level (optimal) and goiter grade (0), may be due to lesser dietary iodine intake on previous day, because >90% iodine is excreted in the urine within 24 hours. 9.52% respondents also revealed no relationship between UI level (optimal), TSH level (optimal) and goiter grade (>0).

Table 1

Group	Thyroid status		Urinary iodide status		P Value [Chi-Squared]
	Goiter Grade	Frequency with percentages (n=660)	Optimal UI level	Lower UI level	
I	Grade-0	519(78.60%)	441 (66.81%)	78(11.81%)	<0.01 [Significant]
II	Grade-1A	93(14.10%)	063 (09.54%)	30(04.54%)	
III	Grade-1B	33(05.00%)	012 (01.81%)	21(03.18%)	
IV	Grade-2	13(02.00%)	006 (00.90%)	07(01.06%)	
V	Grade-3	02(00.30%)	001 (00.01%)	01(00.15%)	
Total	05	660(100)	523 (79.07%)	137(20.74%)	

Reference Values: Goiter Grade >0 = Grade 1 A, 1 B & 2 [$\geq 5\%$ signifies public health problems]
 Optimal UI Range =>100-200 $\mu\text{g/L}$ [$>200 \mu\text{g/L}$ = >adequate, not excess]
 Optimal TSH Range = 0.20-4.00 mIU/L [standard value adopted by INMOL]

Table 2

Group	Goiter Grade	Frequency %age (n=660)	Mean UI Level [$\mu\text{g/L}$]	St. Deviation	P Value [ANOVA]
I	Grade 0	519 (78.60%)	143	47.6	< 0.01 [Significant]
II	Grade 1A	93 (14.10%)	123	52.6	
III	Grade 1B	33 (05.00%)	076	72.6	
IV	Grade 2	13 (02.00%)	078	76.8	
V	Grade 3	02 (00.30%)	100	141.4	

Table 3:

Group	UI level	TSH Level	Frequency %age (n=64)	P Value [Chi squared]
I	Optimal	Optimal	45 (70.31%)	< 0.01 [significant]
II	Lower	Higher	10 (15.63%)	
III	Optimal	Higher	01 (01.56%)	
IV	Lower	Optimal	08 (12.50%)	

Table 4

Group	Goiter Grade	UI level	TSH Level	Frequency %age (n=63)	P Value [ANOVA]
I	Grade-0	Optimal	Optimal	38 (60.31%)	<0.01 [significant]
II	Grade->0	Lower	Higher	11 (17.46%)	
III	Grade-0	Lower	Optimal	08 (12.69%)	
IV	Grade->0	Optimal	Optimal	06 (09.52%)	

DISCUSSION

Goiter, also called stuma i.e. an enlarged thyroid, is the most visible consequence of iodine deficiency. The process begins as an adaptation in which the thyroid is more active in its attempts to make enough thyroid hormones for the body's needs because of the limited supply of raw iodine, much as a muscle gets bigger when it has to do more work⁹. When iodine levels are low, the concentration of thyroid hormones in the pituitary gland stimulates the release of TSH, which can then be detected in blood. Thus, whole blood TSH levels directly reflect the availability and adequacy of thyroid hormones⁸. If the adaptation by the thyroid gland is successful and the iodine deficiency is not too severe, the person may escape with only an enlarged thyroid and no other apparent damage from iodine deficiency occurs⁹. Iodine deficiency goiter is more common in females, especially during puberty (adolescence), pregnancy and lactation¹².

Assessment of nutritional iodide status of a population in an area or region is of two types: clinical and biochemical⁸. Clinical assessment involves the examination of thyroid gland according to WHO's classification of goiter. Total goiter rate (TGR) i.e., goiter of grades 01A, 01B and 02 of 5% or more in school-age children signifies presence of a public health problem [9]. Biochemical assessment involves measurement of urinary iodide (UI) excretion –and–determination of blood TSH levels through immunoradiometric assay⁸. Most of the iodine (>90%) that is absorbed is excreted in the urine, therefore, urinary iodine (morning samples) is a useful marker of previous day's dietary iodine intake. Plus, since urinary iodine values from populations are not usually normally distributed, therefore, median values rather than the mean should be used^{8,9}.

Out of sample population of 660 adolescent schoolgirls, 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. Because of skewed distribution of urinary iodine concentrations, WHO, UNICEF & ICCIDD recommend the use of median values of urinary iodine concentration to determine as to whether there exists / does not exist a public health problem in the sampled population. Median value of lower than 100 µg/L in adults and school children suggests that there is public health problem^{8,9,10}. Median urinary iodine level of study population i.e. adolescent schoolgirls was 125µg/L, which falls within the ambit of optimal range [>100 µg/L–200 µg/L], -But- on the other hand, the prevalence of urinary iodine deficiency (lower UI levels) has been worked out as 20.8% [137]. Since, besides UI estimation, two other indicators i.e., clinical examination of neck for thyroid gland and TSH levels have also been used in this study, therefore, these two indicators were also taken into consideration besides valuing median values.

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^{9,16}. 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 < 0.01) confirmed a strong inverse association between the size of thyroid gland and urinary iodine level.

In community surveys, median urinary iodine concentrations are preferred mode of determining the existence or non-existent of a public health problem in the sampled population due to skewed distribution of urinary iodine concentrations. It may be a valid recommendation if one indicator only i.e., UI level is used. If other indicator (s) like goiter grading is carried out and / or TSH levels are estimated, then UI

level, TSH level and goiter grade are taken together for the purpose of reaching some conclusion.

In Pakistan, the goiter rate is above 10%. According to the target set for IDD control at SAARC convention, the goiter rate should not exceed 05% by the year 2000 in Southeast Asian countries¹². But in the year 2009, as stated above, 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.

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