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Status of iodine-deficiency disorders as estimated by neonatal cord serum thyrotropin in Lahore, Pakistan

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Abstract

Cord serum thyrotropin (CST) was estimated in the blood of 1295 neonates randomly selected of 25 000 live births from various hospitals of Lahore, Pakistan, during the period of 1998-2002. Data obtained were used to assess the degree of iodine-deficiency disorder (IDD) in the local population. In iodine-sufficient areas, the percentage of neonates with CST value of >10 mIU/L is less than 3%. A frequency of 3% to 19.9% indicates mild IDD. Frequencies of 20% to 39.9% and >40% indicate moderate and severe IDD, respectively. Results indicated that on average, 13.5% of the neonates had a CST level >10 mIU/L, which indicate the existence of a mild degree of IDD. Statistically, there was no difference in the percentage of neonates with this level of CST for the 5-year study. It was observed that iodized salt has not been widely accepted despite the lack of difference in the price of iodized and noniodized salt.

Keywords: Iodine deficiency; Pakistan; Iodized salt

1. Introduction

Iodine deficiency is a well-recognized public health problem in developing countries. The clinical and subclinical manifestations of iodine deficiency are collectively called iodine-deficiency disorders (IDD), which include goiter, hypothyroidism, mental retardation, reproductive impairment, and decreased child survival [1]. Optimal iodine nutrition is

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necessary to fully realize the human intellectual capabilities in a community. Iodine deficiency is the single most common cause of preventable mental retardation and brain damage in the fetus and is the major cause of intellectual deficit worldwide [2]. Available data indicate that 2.2 billion people (38% of the world's population) in 130 countries of world are at risk for IDD [3]. Prevalence of goiter and biochemical indicators, such as urinary iodine excretion, serum thyroid hormones, and thyroglobulin, can determine iodine status of a community [4,5]. However, neonatal cord serum thyrotropin (CST) has also been used in many studies as a useful indicator for assessing IDD at a population level [2,6,7]. Elevated CST in the neonates indicates insufficient supply of thyroid hormones to the developing fetus resulting from the iodine deficiency [6]. It is the only indicator that allows prediction of possible impairment of mental development at a population level.

Pakistan is considered one of the severely iodine-deficient countries. About 70% of the population was estimated to be at risk for IDD in 1993 [8,9]. The overall prevalence of cretinism is reported around 3% [10], and it is claimed that 40% of adult women are deficient in iodine. The northern areas are one of the first known areas endemic for iodine deficiency [9-11]. However, most of the big cities and towns of Pakistan are located in the Indus Plain [12], which have not been extensively investigated for the magnitude of IDD. An example is the city of Lahore, which is the second largest city of Pakistan with a population of 5 million people. Although goiter is not endemic and severe iodine deficiency is not prevalent in Lahore, the extent of IDD is still not known.

The elimination of IDD by the year 2000 was one of the goals adopted by government leaders at the 1990 World Summit for Children. Fortification of salt with iodine has been recognized as the most effective and cost-efficient strategy to achieve that goal [3]. Under a resolution of the SAARC summit at Colombo, the government of Pakistan had showed its commitment to eliminate the IDD by the year 2000 by introducing the iodized salt throughout the country by the end of 1995. The Iodized Salt Support Facility was established in 1994 to encourage, support, promote, and sustain the universal access to iodized salt [13]. It is expected that after a decade of iodized salt introduction in the local markets, the problem should no longer be serious, at least, in urban areas where public health awareness is comparatively better than in rural areas. The present study was planned to investigate the effect of iodized salt and the current state of IDD in Lahore. For this purpose, we have analyzed the CST data collected from local hospitals during 1998-2002. The results of this study are described and discussed herein.

2. Materials and methods

2.1. Selection of study samples

From July 1998 to March 2002, 1295 cord blood samples out of 25 000 live births were randomly collected immediately after delivery, from Lady Aitchison Hospital, Lady Willingdon Hospital, and Government Mian Munshi Hospital, Lahore.

Four milliliters of cord blood from placental side was obtained after ligation of the cord in a disposable syringe and stored in refrigerator. The serum was separated by low-speed centrifugation (2000*g*) for 5 minutes at room temperature. Serum samples were stored at $-20°C$ until analysis.

Table 1
Prevalence of IDD (%) in a sample with CST level >10 mIU/L

Degree of IDD	Percentage
Nonexistent	≤3
Mild	3-19.9
Moderate	20-39.9
Severe	>40

χ^2 test was applied to compare the percentages of sample with CST higher than 10 mIU/L between successive years.

2.2. Analytical procedure

Estimation of thyrotropin was carried out using commercial kits of Amerlex-M (Amersham, UK) and North Eastern Thames Regional Immunoassay (St Bartholomew's Hospital, London, UK). CST was measured by highly sensitive immunoradiometric assay, which used coated tubes. There was a reaction of thyrotropin present in the sample with a monoclonal mouse antibody coupled to the tube and ^{125}I-radiolabeled polyclonal antibody. This assay was highly sensitive even at a very low concentration of CST (detection limit 0.05 mIU/L). Measurement of radioactivity, fitting of the standard curve, and analysis of samples was carried out using a computerized gamma counter (Cap-RIA 16, CAPINTEC Inc, Pittsburgh, PA, USA). Assay reliability was determined by the use of commercially derived control sera of low, medium, and high thyrotropin concentrations, which were included in every run. All assays were carried out in duplicate, and samples showing more than 10% cumulative variation (CV) were reanalyzed.

The analysis of CST levels distribution for each study year (1998-2002) was carried out using SPSS software on a personal computer. The degree of IDD was assessed according to the classification given in Table 1 [2,6]. This table is derived from the fact that in iodine-sufficient areas, the percentages of babies with CST value >10 mIU/L (equal to a whole blood value of 5 mIU/L) is less than 3%. A frequency of 3% to 19.9% indicates mild IDD. Frequencies of 20% to 39.9% and >40% indicate moderate and severe IDD, respectively [6,7].

Table 2
Yearly distribution and CST levels in 1295 cord blood samples

Year	No. of samples	Samples with CST concentration range of		
		<5.0 mIU/L	5.1-10.0 mIU/L	>10.0 mIU/L
1998	212	112 (52.8)	72 (34.0)	28 (13.2)
1999	283	144 (50.8)	95 (33.6)	44 (15.6)
2000	290	155 (53.4)	101 (34.9)	34 (11.7)
2001	257	164 (63.8)	61 (23.7)	32 (12.5)
2002	253	110 (43.5)	105 (41.5)	38 (15.0)
1998-2002	1295	685 (53.0)	434 (33.5)	176 (13.5)

Figures in parentheses represent the percentage of the sample.

3. Results

A year-wise detail of the samples and the number of neonates having CST levels <5.0, between 5.0 and 10.0, and >10.0 mIU/L has been summarized in Table 2.

Overall, 685 (53%) neonates had CST levels <5.0 mIU/L, 434 (33.5%) had CST value between 5.0 and 10.0 mIU/L, and 176 (13.5%) neonates had CST value >10 mIU/L. χ^2 test showed that during the study period (1998-2002), the difference between the percentage of samples above 10.0 mIU/L was nonsignificant.

The descriptive statistics of the entire sample (1998-2002) indicated that CST levels were positively skewed, with coefficient of skewness of 1.1. Mean $\pm$ SD and median value for CST level was 6.2 $\pm$ 6.7 and 4.9 mIU/L, respectively, with a range of 0.05 to 150 mIU/L. The 95th and 5th percentiles had a value of 14.6 and 1.3 mIU/L, respectively.

4. Discussion

Results of the present study indicated that for the last 5 years, on an average, 13.5% neonates in Lahore had CST levels above 10 mIU/L. This indicated the existence of a mild degree of IDD. Although such a state of iodine nutrition is sufficient to meet the usual needs of thyroid hormone in adults, it may prove inadequate to meet extra requirements of iodine at the time of thyroidal stress, such as pregnancy [14,15], lactation, and neonatal and pubertal growth [16,17]. Recent studies have shown that even mild to moderate iodine deficiency may result in increased pregnancy loss, increased perinatal and neonate mortality, neonatal hypothyrotropinemia, neonatal hypothyroidism, growth retardation, and intellectual disability in children [2,3]. It may impose tremendous developmental costs because of a loss of up to 15 IQ points [3]. Data indicate that children entering school age with even milder form of iodine deficiency have low IQ and show a poorer school performance [18].

To assess the IDD in neonates, in 1994, UNICEF and the Pakistan Medical Association jointly conducted a study in 4 major cities of Pakistan (ie, Islamabad, Lahore, Karachi, and Quetta). This study was based on the results of CST level from 884 neonates born in different hospitals. The results indicated that on average, 72% and, in Lahore alone, 81% of neonates were deficient in iodine [13,19]. This study is frequently cited [8,10,13]. It is the basis of all regional and international IDD data about Pakistan [9,11] and indicates that severe iodine deficiency is prevalent in Lahore. However, the cutoff level used in this study has not been documented [8,10,13,19]. Even if the cutoff value of 5 mIU/L is believed, the percentage of neonates with IDD is double that of our data. The citation of a higher percentage of iodine-deficient neonates has perhaps helped to convince the public and the medical community for the need of salt iodination at that time. However, the results of the present study are suggestive that mild iodine deficiency is persisting for the last 5 years, because a nonsignificant change has been observed in the percentage of neonates having a CST level above 10 mIU/L. In the light of the results of the present study, it may be postulated that a mild degree of IDD has been prevalent in Lahore, and although available at the same price as noniodized salt, iodized salt prophylaxis was not widely accepted in big cities of Pakistan.

Our conclusion that severe iodine deficiency is not prevalent in Lahore is in agreement with 2 recently conducted surveys in the city about iodine intake in women. Fatima [20] reported that among nonpregnant women of reproductive age, only 7% were severely deficient in iodine (ie, urinary iodine excretion below 50 μg/L). Similarly, Fareeha [21], in another study, reported that 20% of the pregnant women during their first trimester of pregnancy in Lahore had urinary iodine excretion below 50 μg/L.

The consumption of iodized salt in Pakistan received good response initially but declined shortly because of many factors. Among them, the most important was the lack of data to determine the level of iodine intake in different areas. Hence, the gravity of the problem could not elicit appropriate attention from the concerned authorities. Another obstacle was the propaganda launched by religious orthodox that the use of iodized salt reduces the procreation capabilities and that it is a part of the government's family planning policy. It is estimated that 30% of households in Pakistan consumed iodized salt by 2001 [11]. We also have recently surveyed 336 outpatient women, mostly pregnant, at the Department of Obstetrics and Gynecology of one of the hospitals regarding the household use of iodized salt. It was observed that only 114 women (34%) were taking iodized salt. A similar investigation from Faisalabad (a neighboring urban area) reported that only 6% of pregnant women were taking iodized salt [22]. These figures are not impressive as compared with other regional countries [9]. Because of the lack of health education, a majority of the public had little knowledge about iodine nutrition. It is imperative that the medical community should not only dispel the misinformation about the use of iodized salt but also strengthen the ongoing iodine supplementation program.

In the light of present study, it may be concluded that although the dietary iodine intake of the Lahore population is borderline sufficient, it is inadequate to meet the extra requirements at times of thyroidal stress, such as pregnancy, lactation, and neonatal and pubertal growth. An iodine supplementation program should be aimed at increasing iodine intake to a level at which IDD can be avoided but not to a level higher than the requirement. This goal can only be achieved if the magnitude of the IDD is precisely known in different areas of the country.

References

[1] Dunn JT. What happens to our iodine? J Clin Endocrinol Metab 1998;83(10):3398-400.

[2] Kung JW, Lao TT, Chau MT, Tam SCF, Low LCK, Kung AWC. Mild iodine deficiency and thyroid disorders in Hong Kong. Hong Kong Med J 2001;7(4):414-20.

[3] Dunn JT, Delange F. Damaged reproduction: the most important consequence of iodine deficiency. J Clin Endocrinol Metab 2001;86(6):2360-3.

[4] WHO/UNICEF/ICCIDD. Indicators for assessing iodine deficiency disorders and their control through salt iodization. Geneva: WHO; 1994 [WHO/NUT/94.6].

[5] Pardede LVH, Hardjowasito W, Gross R, Dillon DHS, Totoprajogo OS, Yosoprawoto M, et al. Urinary iodine excretion is the most appropriate outcome indicator for iodine deficiency at field conditions at district level. J Nutr 1998;128(7):1122-6.

[6] Delange F. Screening for congenital hypothyroidism used as an indicator of the degree of iodine deficiency and of its control. Thyroid 1998;8(12):1185-92.

[7] Costante G, Grasso L, Ludovico O, Marasco MF, Nocera M, Schifino E, et al. The statistical analysis of neonatal TSH results from congenital hypothyroidism screening programs provides a useful tool for the characterization of moderate iodine deficiency regions. J Endocrinol Invest 1997;20(5):251-6.

[8] Ghayur S, Siddiqui S, Alam MM, Shaukat A, Khan FA. Spectrum of iodine deficiency in school children of Rawalpindi. Pak Armed Forces Med J 2001;51(1):27-32.

[9] WHO/UNICEF/ICCIDD Coordinating Office ME and EMR. In: Azizi F, editor. Iodine deficiency disorders in the Middle East and Eastern Mediterranean region: Pakistan. Assessment, monitoring and evaluation of Iodine deficiency disorders in the Middle East and Eastern Mediterranean region. Tehran: Endocrine Research Centre of Shaheed Beheshti, University of Medical Sciences; 2002. p. 30.
[10] Kazi AQ, Qureshi MM. A critical analysis of nutritional studies in Pakistan (1956-1985) Part II: malnutrition mortality and related deficiencies. Pak J Med Res 1998;37(3):132-43.
[11] ICCIDD Database. IDD prevalence and control program data: Pakistan; 2002 [www.iccidd.org].
[12] Akhtar R. The land and the people. Pakistan year book. 17th ed. Karachi: East & West Publishing Company; 1989. p. 4-5.
[13] UNICEF. Punjab: socio-economic profile. A better future for children and women in Pakistan (a brochure). Lahore: UNICEF Punjab; 1995. p. 14.
[14] Glinoer D. The regulation of thyroid function in pregnancy: pathways of endocrine adaptation from physiology to pathology. Endocr Rev 1997;18:404-33.
[15] Glinoer D. The thyroid in pregnancy: a European perspective. Thyroid Today 1995;18(2):1-11.
[16] Glinoer D. Maternal and fetal impact of chronic iodine deficiency. Clin Obstet Gynecol 1997;40(1):102-16.
[17] Kung AW, Chan LW, Low LC, Robinson JD. Existence of iodine deficiency in Hong Kong—a coastal city in southern China. Eur J Clin Nutr 1996;50(8):569-72.
[18] Delange F. Disorders due to iodine deficiency. Acta Clin Belg 1990;45(6):394-411.
[19] Anonymous. Iodine deficiency: a national problem. Medical Spectrum 16(21-22), November 1995. IDD Newsletter 1996;12(2):14.
[20] Fatima G. Iodine intake and thyroid parameters in women of childbearing age. M.Sc. Thesis. Lahore, Pakistan: Institute of Chemistry, University of the Punjab; 2002.
[21] Fareeha R. Iodine intake and thyroid parameters in pregnant women during first trimester. M.Sc. Thesis. Lahore, Pakistan: Institute of Chemistry, University of the Punjab; 2002.
[22] Saeed M, Yaqub M, Roohi M, Ashraf M. Prophylactic use of iodized salt in pregnancy. Professional 2000;7(1):66-9.