ORIGINAL REPORT

# The Prevalence of Iodine Deficiency Disorder in Two Different Populations in Northern Province of Iran: A Comparison Using Different Indicators Recommended by WHO

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**Abstract-** Comparison of the prevalence of Iodine Deficiency Disorder (IDD) in neonates and school children using two different WHO indicators. From 2006 to 2010, 119701 newborns were screened by measurement of serum TSH level by heel prick. Neonates who had blood TSH ≥ 5 mIU/l were recalled for more evaluation. In the same period of time, urine iodine was measured in 1200 school-aged children. The severity of IDD was classified using WHO, UNICEF, ICCIDD criteria. Between 2006 and 2010 a total of 138832 neonates were screened in Guilan province and the total recall rate (neonates with TSH level ≥ 5 mIU/l) was 1.8 %. The incidence rate of Congenital Hypothyroidism (CH) was 1/625. The median urine iodine level in school-aged children was 200-299 µg/l. Considering the WHO, UNICEF, ICCIDD criteria, Guilan province would be classified as a none-IDD endemic area. However, health care systems should pay attention to the iodine excess and the risk of iodine induced hyperthyroidism in this population.

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**Keywords**: Iodine deficiency disorder (IDD); Neonatal TSH; Urine iodine; WHO criteria

## Introduction

Iodine deficiency is the most common cause of preventable brain damage in newborn infants. Recent reports of the World Health Organization show iodine deficiency to be a worldwide health problem. Iodine is a key element in the synthesis of thyroid hormones and as a consequence, severe iodine deficiency results in hypothyroidism, goiter, and cretinism (1). Globally, it is estimated that 2 billion individuals have an insufficient iodine intake, and South Asia and sub-Saharan Africa are particularly affected. However, about 50% of Europe remains mildly iodine deficient, and iodine intake in other industrialized countries, including the United States and Australia, have decreased in recent years. Iodine deficiency during pregnancy and infancy may impair growth and neurodevelopment of the offspring and increase infant mortality rate respectively. Deficiency during childhood reduces somatic growth and cognitive and motor functions (2,3).

Universal Salt Iodization (USI) is the recommended strategy for Iodine Deficiency Disorder (IDD) control, and the lowest prevalence of iodine deficiency is found in the United States (10.1%), where the proportion of households consuming iodized salt is the highest in the world (90%). Surprisingly, the highest prevalence of iodine deficiency is in Europe (59.9%), where the proportion of households consuming iodized salt is the lowest (27%), and most countries have weak or nonexistent national programs (4).

Assessing the severity of IDD and monitoring the progress of salt iodization programs are cornerstones of a control strategy. Four methods are generally recommended for assessment of iodine nutrition: urinary iodine concentration (UI), the goiter rate (GR), serum thyroid stimulating hormone (TSH), and serum thyroglobulin (Tg). These indicators are complementary, in that urinary iodine is a sensitive indicator of recent iodine intake (days) and Tg shows an intermediate response (weeks to months), whereas changes in the

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goiter rate reflect long-term iodine nutrition (months to years) (5).

The principal indicator of IDD in a population is the median UI, because it is highly sensitive to recent changes in iodine intake (6-7). A second indicator is thyroid volume (TV) as reflected by the GR. Although in endemic areas, thyroid size decreases in response to increase in iodine intake, TV and GR may not return to normal for months or years after correction of iodine deficiency (8). During this period, GR is a poor indicator because it reflects a population's history of iodine nutrition but not the present iodine status, and will be inconsistent with measurements of urinary iodine.

The newborn thyroid has limited iodine stores, and even mild IDD during pregnancy will compromise neonatal thyroid secretion of T4 causing increased pituitary TSH secretion. It follows that an elevated TSH in the neonate is a sensitive indicator of an inadequate supply of thyroid hormone to the developing brain. This principle underpins the application of newborn TSH screening as an indicator of maternal and hence population iodine nutrition. Although neonatal TSH screening may be a powerful and underused tool in monitoring iodine nutrition in mothers and babies, according to WHO recommendation, it should not be used as the sole indicator for monitoring IDD control programs in a geographical area (9,10).

In Iran, salt iodization has been implemented since 1992 and health statistics show iodized salt usage in more than 95% households. National screening for congenital hypothyroidism (CH) is carried out since 2006 in Iran. The aim of this study was to compare the prevalence of iodine deficiency between school-aged children and neonates using different indicators recommended by WHO.

## Materials and Methods

We used recorded data in Guilan health center. All neonates born from 2006 to 2010 in this northern province of Iran were screened for CH and those who had a TSH level ≥5 mIU/l were recalled for more evaluation. Screening was performed by TSH measurement via a filter paper blood spot that was carried out 3-5 days after birth. At the same time, urine samples of 1200 school-aged children (aged 8 to 12 years) were examined by biochemical analysis for iodine. These children included 120 clusters that were selected by using random multi cluster sampling from different schools in Guilan. WHO recommendation, the United Nations Children's Fund (UNICEF) and the International Council for the Control of Iodine Deficiency Disorder (ICCIDD) were used for classification in terms of the severity of IDD as shown in table 1 (5).

**Laboratory and method**

TSH level was measured by immunoradiometric assay (IRMA) (Xit Immunotech, Belgium) in filter papering and iodine was measured by by digestion method based on a modification of Sandell-Kolthoff reaction with intra-assay CV of 1.2% and inter-assay CV of 2.2%).

## Results

In five years, from 2006 to 2010, a total of 138832 neonates were screened in Guilan province and the total recall rate (neonates with TSH level ≥ 5mIU/l) was 1.8% (Table 2). In this period 222 cases of congenital hypothyroidism were diagnosed with an overall incidence rate of 1/625. These results are summarized in table 2.

Also, the TSH level measurements are summarized in table 3. In the same period of time, 1200 school-aged children were evaluated for iodine deficiency by measurement of urine iodine (Table 4).

**Table 1.** WHO, UNICEF and ICCIDD criteria for classifying IDD.

| IDD State / Population Data | Non-IDD Endemic Area | Mild IDD | Moderate IDD | Severe IDD |
|---|---|---|---|---|
| Median Urine Iodine (μg/l) in School Children | >100 | 50-99 | 20-49 | <20 |
| Percentage of Neonatal TSH ≥ 5 mIU/l | < 3 | 3-20 | 20-40 | > 40 |

**Table 2.** Results of Screening for Congenital Hypothyroidism in Guilan (2006-2010).

| Year | Number of births | Number of screened neonates | | | Recall rate (%) | Number of congenital hypothyroidism | Incidence rate |
|---|---|---|---|---|---|---|---|
| | | Total (%) | Female | Male | | | |
| 2006 | 21921 | 9251 (42.2) | 4545 | 4706 | 1.7 | 18 | 1/514 |
| 2007 | 28728 | 23529 (81.9) | 11466 | 12063 | 1.4 | 30 | 1/784 |
| 2008 | 28689 | 27427 (95.6) | 13233 | 14194 | 2.1 | 65 | 1/422 |
| 2009 | 29511 | 29511 (100) | 14228 | 15283 | 1.8 | 63 | 1/468 |
| 2010 | 29983 | 29983 (100) | 15265 | 14718 | 1.9 | 46 | 1/652 |
| Total | 138832 | 119701 (86.2) | 58737 | 60964 | 1.8 | 222 | 1/625 |

**Table 3.** Serum TSH levels among recalled neonates.

| Year \ Level of TSH (mIU/l) | ≥ 5 (%) | Total Recall Population 5-9.9 (%) | 10-19.9 (%) | >20 (%) |
|---|---|---|---|---|
| 2006 | 1.7 | 90.8 | 4.8 | 4.4 |
| 2007 | 1.4 | 88 | 8.8 | 3.2 |
| 2008 | 2.1 | 88.9 | 8.9 | 2.2 |
| 2009 | 1.8 | 88.6 | 6.1 | 5.3 |
| 2010 | 1.9 | 90.6 | 5.8 | 3.5 |

**Table 4.** Results of urine iodine level in school-aged children.

| Year | Number of school-aged children | Median of urine iodine (µg/l) |
|---|---|---|
| 2006 | 240 | 270.2 |
| 2007 | 240 | 200.4 |
| 2008 | 240 | 200.1 |
| 2009 | 240 | 200 |
| 2010 | 240 | 200.2 |

**Table 5.** Epidemiologic criteria by WHO for assessing iodine nutrition based on median urinary iodine concentration in school-aged children.

| Median urinary iodine (µg/l) | Iodine Intake | Iodine nutrition |
|---|---|---|
| < 20 | Insufficient | Severe iodine deficiency |
| 20-49 | Insufficient | Moderate iodine deficiency |
| 50-99 | Insufficient | Mild iodine deficiency |
| 100-199 | Adequate | Optimal |
| 200-299 | More than adequate | Risk of iodine induced hyperthyroidism within 5-10 yrs following introduction of iodized salt in susceptible groups |
| >300 | Excessive | Risk of adverse health consequences (iodine-induced hyperthyroidism, autoimmune thyroid disease) |

## Discussion

In the present study we compared the prevalence of IDD by application of two different methods as indicators of IDD in two different populations: serum TSH level in newborns and urine iodine level in school children.

Based on WHO criteria, considering both the TSH level in neonates and the urine iodine level in school children, Guilan would be classified as non-IDD endemic area.

Between 2006 and 2010, the incidence of congenital hypothyroidism in Guilan province was 1/625 (Table 2). This is comparable with other studies such as reported incidence of 1/1300 in the Netherlands (11) and 1/1800 in Thailand (12) and Lebanon (13). Interestingly, other studies show different incidence rates in Iran such as 1/357 in Isfahan by Hashemipour *et al.* (14) and 1/1465 in Shiraz by Karamizadeh *et al.* (15).

Hashemipour *et al*. believed that these different incidence rates in Iran may be related to dissimilarity between the screening methods, environmental, genetic and immunologic factors. Results of our study in Guilan, showing a higher incidence of CH and the IDD non-endemic state, can strongly preclude iodine deficiency as a responsible factor for CH.

In 2002, Copeland *et al.* in the United States, Guatemala and Bangladesh reported that elevated TSH level may be partially attributed to use of beta iodine containing antiseptics prior to birth and recommended the cautious interpretation of TSH results in newborns for assessment of IDD when iodine containing antiseptic are used during birth process (16). However, in our study the use of beta iodine did not have any effect on the neonatal TSH levels. It may be because the use of heel stick TSH sampling or judicious use of beta iodine. Therefore we recommend the use of heel stick TSH collection in evaluation of neonatal IDD.

It is surprising that Guilan province is a non-IDD endemic area and on the other hand, considering the level of urine iodine level in school-aged children, Guilan is at risk for iodine induced hyperthyroidism within 5-10 yrs of introducing iodized salt (Table 5). Therefore we recommend that health care worries be more oriented on the iodine excess rather than the iodine deficiency in this area. In conclusion, although more studies are required to confirm our conclusion, we recommend heel prick tests as a cost effective alternative for monitoring iodine levels.

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