Major success stories in the global fight against IDD: Iran and China

With an estimated population of 71.4 million, Iran is the most populous country in the Middle East and North African Region, and the 16th most populous in the world. With an estimated population of 1.3 billion, including 86 million children under 5 years of age, China is the most populous country in the world, and China's current process of "modernization" is of a speed, scale and scope probably unprecedented in human history. The following reports, prepared by Chen Zupei, ICCIDD Regional Coordinator, China and Eastern Asia region, and Fereidoun Azizi, ICCIDD Regional Coordinator, Middle Eastern Region, highlight how sustained elimination of IDD was achieved in these countries.

Sustained elimination of iodine deficiency in the Islamic Republic of Iran: an update

Fereidoun Azizi and Parvin Mirmiran Shaheed Beheshti University of Medical Sciences; Robabeh Sheikholesham Ministry of Health & Medical Education, Tehran, I.R. Iran

Historically, IDD was endemic in many areas of Iran. The first epidemiological assessment of goiter, conducted in 1969, found iodine deficiency was common in most cities and in the rural regions at the foot of the Alborz and Zagross mountains, with the prevalence of goiter ranging from 10 to 60% in the provinces (1). However, no long-term preventive measures were taken. In 1983-84, after a gap of 15 years, Azizi et al. reported that populations of Shahriar (2), Tehran (3) and the south-central province of Kohkolyeh-BoyerAhmad (4) had low median urinary iodine (UI) excretion and hyperendemic goiter. Subsequently, severe IDD was found in many villages located in the north of Tehran city (5,6).

In 1995, thyroid status and neurologic, psychometric and auditory functions were reported by Azizi et al (5) in presumably normal schoolchildren, aged 6 to 16 years from three iodine deficient areas in Iran. This study demonstrated that mild to moderate growth retardation and neurological, auditory and psychomotor impairments were present in apparently normal subjects residing in areas of iodine deficiency (5). In a subsequent study of schoolchildren from three areas with different degrees of iodine deficiency, the results indicated alteration in psychomotor development may occur in children with moderate iodine deficiency despite normal physical growth (6).
Before iodine supplementation, median UI in all provinces was <100 μg/L, and was even 20 μg/L in many regions (Table 1).

Table 1: Median urinary iodine concentration in selected endemic and hyperendemic regions in Iran before iodized salt distribution.

<table>
<thead>
<tr>
<th>Location</th>
<th>Province</th>
<th>Urinary Iodine (μg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kigha</td>
<td>Tehran (rural)</td>
<td>20±11</td>
</tr>
<tr>
<td>Randan</td>
<td>Tehran (rural)</td>
<td>12±5</td>
</tr>
<tr>
<td>Zagoon</td>
<td>Tehran (rural)</td>
<td>18±10</td>
</tr>
<tr>
<td>Keshar</td>
<td>Tehran (rural)</td>
<td>19±10</td>
</tr>
<tr>
<td>Tehran City</td>
<td>Tehran (urban)</td>
<td>39±19</td>
</tr>
<tr>
<td>Shahriar</td>
<td>Tehran (rural &amp; urban)</td>
<td>71±39</td>
</tr>
<tr>
<td>Hanna</td>
<td>Esfahan (rural)</td>
<td>40±21</td>
</tr>
<tr>
<td>Yasuj</td>
<td>Boyer-Ahmand (rural)</td>
<td>34±39</td>
</tr>
<tr>
<td>Doruhun</td>
<td>Boyer-Ahmand (rural)</td>
<td>24±17</td>
</tr>
</tbody>
</table>

These findings prompted the Ministry of Health and Medical Education to form the Iranian National Committee for Control of IDD (INCCIDD) in 1988, including government, media, industry and academic partners. Since 1989, IDD has been a health priority in the country. The INCCIDD prepared a national plan with detailed objectives and strategies for IDD control. Salt iodization began in 1990. The production, distribution and consumption of iodized salt increased only gradually, with a national survey in 1993 showing <50% of households were consuming iodized salt. INCCIDD then announced universal salt iodization (USI) and all salt factories were obliged by law to produce only iodized salt for household use. Also, an enhanced and vigorous system of evaluation and monitoring was applied.

The IDD prevention program in Iran (7,8)

Under the National IDD Elimination Committee, a subcommittee for production and distribution related to USI activities:

- Developed training material and conducted the required training for salt producers, laboratory and health care workers.

Measures taken for USI monitoring include:

At production level:
- **Factories**
  - Daily sampling of iodized salt from 8-10 lines, to assess the level of iodine with titration and registration in the logbook.

Food Safety Department
- Inspection of iodized salt factories including:
  - Appropriate manufacturing
  - Labeling
  - Potassium iodate packages
  - Storage of iodized salt
  - Laboratory log books
  - Random sampling of iodized salt from factories and dispatch to the provincial food laboratory

Food and Drug Laboratory
- Recording the results on special iodized salt assessment forms (ISAF) and sending these to national level officials through the provincial IDD committee

- Assuring capability of the salt factory technician to perform titration and their retraining if necessary

At distribution level (urban areas)

By the environmental health specialists:
- Sampling of existing salt in the market every three months by environmental health workers and analysis at the Food Laboratory;
- Recording the results on the ISAF by the provincial food laboratories and its relaying to national level officials through the provincial IDD committee;
- Inspection of iodized salt at all sites where food is provided (restaurants, hospitals, day care centers, and canteens) with rapid test kits
- If tests show lack of iodine in the salt, importance of iodized salt is stressed and source of the defective salt is traced
- Results of this testing is relayed to the national level

Nutrition Department
- Computer data entry of all ISAFs from the provinces
- Half-yearly reports generated and feedback provided (IDD committees, salt producers, Food Inspection Department, National Food Laboratory, Environmental Health Dept)
- Same procedures followed as with the market salt and feedback sent to related bodies

Integrated activities in rural areas
- Testing of salt with rapid test kits and education about importance of iodized salt provided by the Behvarz at the Health House. Testing is done in:
  - Local shops
  - All households (once a year)
  - Schools (every 6 months)
- Results of statistics of iodized salt utilization in households registered on special stickers on the Vital

Horoscope
Health technicians supervise Behvarz activities using a checklist

Rural checklists include:
- Is iodized salt available in the rural market?
- Has the Behvarz put the sticker of the iodized salt on the Vital Horoscope of the village?
- Have the schoolchildren been taught about the benefits of iodized salt?
- Are village shopkeepers aware of the reason why they should sell exclusively iodized salt?

National labs, quality assurance
- Bi-annually, the National Food Laboratory sends blind samples of iodized salt to provincial food labs to ensure precision of their tests.
- Necessary training provided to laboratories with low performance ratings
- Surveys are done to monitor USI
- Questions on IDD are integrated into other public health surveys
- Iodized salt utilization among households in rural and urban areas is surveyed
- Each year, UI is measured in 240 schoolchildren (8-10 yrs) in each province

The 2nd National Survey in 1996

In 1996, the second national survey was conducted 7 years after the initiation of iodized salt production, and 2 years after the implementation of the new law for mandatory consumption of iodized salt in households (9). The total number of 8-10 y-old children surveyed was 36178 of which 2917 had urinai iodine assessments. Approximately half of the schoolchildren in each province were from rural regions. In 16 of 26 provinces, the total goiter rate was more than 40% in boys and over 50% in girls. However, the majority of schoolchildren had small, grade 1 goiters. There was no significant difference in goiter prevalence between boys and girls or schoolchildren of rural and urban regions. In all 2917 schoolchildren, median urinary iodine excretion was 205 μg/L. Over 85% of children had UI >100 μg/L. respectively. Median UI was 175 μg/L. This study demonstrated the adequacy of iodine intake in the majority of families residing in Tehran.

Before introduction of iodized salt in Iran, visible goiter and impaired mental development were common among rural children

In the 1996 survey, the prevalence of goiter was still high in many provinces. However, the study was performed when the majority of people had used iodized salt only for 2 years, and the majority of 8 to 10 year old children had lived most of their lives without adequate iodine supplementation. This is consistent with studies showing that thyroid size in children exposed to iodine deficiency in the first years of their lives may not regress completely following consumption of iodized salt (10).

A study to assess iodine status in Tehran in 1996 (11) was done in 1146 families comprising 5140 subjects of all ages in the twenty districts of the city. Thyroid size was examined by palpation and graded according to the WHO classification. In 163 families, thyroid size was determined by ultrasonography and UI was measured. Percentages of grades 1 and 2 goiter were 44 and 44% in females and 49 and 33% in males, respectively. Median UI was 175 μg/L. This study demonstrated the adequacy of iodine intake in the majority of families residing in Tehran.

The 3rd National Survey in 2001

The third national survey was conducted in 2001. More than 33000 schoolchildren were examined from all 28 provinces by inspection and palpation methods for goiter, and more than 3300 urine samples were collected. Ultrasound was used to measure thyroid size of 7-10 yr Tehranian children.

The total goiter rate was 9.8%. The total goiter rate in Ilam, Chahar Mahal Bakhhtiari, Hamadan, Khoozestan, Zanjan, Semnan, Sistan Baloochestan, Fars, Qom, Kordestan, Kerman, Kermanshah, Golestan and Gilan was >10%. The prevalence of goiter grade 2 in 22 provinces was <5% and in 6 other provinces (Boosheehr, Chahar Mahal Bakhhtiari, Sistan Baloochestan, Qom, Kordestan, Kermanshah) the goiter rate was <10%. These rates were significantly lower than the corre-
Median UI (range) and 95% CI were 165 (18-410) and 183-190 µg/L, respectively. UI values <100, 100-199, and ≥200 µg/L were present in 19.7%, 45.7%, and 34.7% of children, respectively. Frequency distribution of low (mild, moderate, and severe) and adequate iodine intakes in various provinces according to their median UI levels are shown in Table 2. Median UI concentrations increased significantly in most provinces, compared to 1996.

Use of iodized salt (1994 to 2004)

National surveys in 1996, 1998, 2000 and 2004 have shown that more than 95% of the households were consuming iodized salt (9) (Fig 3). The results of the survey done in the year 2000 showed that 94.5% in urban and 91.8% in rural areas were consuming iodized salt.

The impact of iodine prophylaxis in severely iodine deficient Iranian schoolchildren

In villages in Northwest Tehran in 1989, before iodized salt was introduced, iodine deficiency was severe. Ten years afterwards, there were significant decreases in the goiter rate, and urinary iodine increased (Table 3). In 1989, many of schoolchildren were hypothyroid. For example, the prevalence of serum TSH between 5 and 10 µU/ml was 30% in Kiga and 22% in Randan, and the prevalence ≥10 µU/ml was 40% in Kiga and 24% in Keshar, respectively. In sharp contrast, in 1999, no child had a TSH ≥5.0 µU/ml (12).
Impact on child intelligence

Comparison of the intelligence quotient (IQ) in 1989 and 1999 in four villages is shown in Table 4. An increase in IQ was found in 3 of 4 villages; the greatest increase was 10 points in Randan.

Based on results of the national monitoring programs in 1996 and 2001, it was concluded that Iran has an optimal and sustainable program for control of IDD, including meeting the following programmatic indicators:

■ An effective and functional national body (IDD Nation Committee), responsible to the government for the elimination of IDD, has been active since 1989. This multidisciplinary council includes the relevant fields of nutrition, medicine, industry and education etc.
■ Political commitment to universal salt iodization and the elimination of IDD was made in 1989 and is sustainable.
■ A responsible executive officer has been appointed for the IDD control programme, since 1990.
■ Universal salt iodization has been legalized since 1992. The Ministry of Industry has announced that salt factories should produce only iodized salt for household use.
■ I.R. Iran has been committed to assessment and reassessment of progress made in the elimination of IDD, with access to laboratories able to provide data on salt and urinary iodine.
■ Public education programs and social mobilization on the importance of IDD and the consumption of iodized salt have been vigorously followed in the last 11 years. These programs have been integrated into the health network, with full participation of Behvaz (rural health workers) in education and monitoring.

<table>
<thead>
<tr>
<th>Classification by Median UIC (µg/L)</th>
<th>Provinces</th>
<th>UIC values (µg/L)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt;20</td>
</tr>
<tr>
<td>100-149</td>
<td>West Azarbaijan, Isfahan, Boushehr, Khurasan, Semnan, Golestan (n = 719)</td>
<td>0</td>
</tr>
<tr>
<td>150-199</td>
<td>East Azarbaijan, Ardebil, Ilam, Tehran, Charmahal, Khousstan, Zanjan, Sistan, Ghom, Kordestan, Kerman, Kermanshah, Kohkiloyeh, Guilan, Lorestan, Mazandaran, Markazi, Hormozgan, Hamedan, Yazd (n = 2370)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>&lt;200</td>
<td>Fars, Ghazvin (n = 240)</td>
<td>0</td>
</tr>
</tbody>
</table>

* Numbers indicate percentages.

Table 3: Total goiter rate and median urinary iodine in schoolchildren of villages before (1989) and 10 years after iodine supplementation (1999)

<table>
<thead>
<tr>
<th>Village</th>
<th>Goiter rate (%)</th>
<th>Median urinary iodine (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1989 All children</td>
<td>1999 11-16 years old</td>
</tr>
<tr>
<td>Kiga</td>
<td>100</td>
<td>64</td>
</tr>
<tr>
<td>Keshar</td>
<td>99</td>
<td>52</td>
</tr>
<tr>
<td>Sangan</td>
<td>99</td>
<td>52</td>
</tr>
<tr>
<td>Randan</td>
<td>100</td>
<td>61</td>
</tr>
<tr>
<td>Zagoon</td>
<td>100</td>
<td>54</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>57</td>
</tr>
</tbody>
</table>

Table 4: Comparison of mean and the frequency of IQ in schoolchildren of villages before (1989) and 10 years after iodine supplementation (1999)

<table>
<thead>
<tr>
<th>Location</th>
<th>Year</th>
<th>mean±SD</th>
<th>Q &gt;100</th>
<th>90-100</th>
<th>70-90</th>
<th>&gt;70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kiga</td>
<td>1999</td>
<td>95±11</td>
<td>36</td>
<td>29</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1989</td>
<td>89±11</td>
<td>20</td>
<td>25</td>
<td>40</td>
<td>15</td>
</tr>
<tr>
<td>Keshar</td>
<td>1999</td>
<td>101±12</td>
<td>38</td>
<td>35</td>
<td>27</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1989</td>
<td>96±9</td>
<td>24</td>
<td>53</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Randan</td>
<td>1999</td>
<td>99±9</td>
<td>50</td>
<td>43</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1989</td>
<td>89±15</td>
<td>17</td>
<td>36</td>
<td>38</td>
<td>9</td>
</tr>
<tr>
<td>Zagoon</td>
<td>1999</td>
<td>105±11</td>
<td>57</td>
<td>43</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>1989</td>
<td>102±11</td>
<td>45</td>
<td>33</td>
<td>22</td>
<td>0</td>
</tr>
</tbody>
</table>
- Regular data on salt iodine at factory (daily), retail (monthly) and household levels (yearly) are collected in each province and analyzed by the National Committee.
- Regular laboratory data on urinary iodine in school-aged children with appropriate sampling for higher risk areas in each province on a yearly basis and nationally once every 5 years.
- Cooperation from the salt industry in maintenance of quality control is excellent, supervised by the IDD executive officer.
- Database with recording of results and regular monitoring procedures, particularly for salt iodine and urinary iodine is available in the Ministry of Health (MOH). Neonatal TSH has been measured in Tehran in 1989 and 1997–1999, and indicates a significant decrease in transient hypothyrotropinemia and recall rate.

According to these criteria, I.R. Iran has achieved sustainable IDD control since 1996, as recognized by WHO-EMRO in the year 2000 (13). Monitoring of the IDD control programme is planned every 5 years. Commenting on Iran’s accomplishments in the control of IDD, Dr. Azizi stated (14), “they should remind us that USI, although achieved in the majority of countries where iodine deficiency is a major public health problem, is not sufficient by itself to eliminate IDD. The main objective should focus on suitable effective and sustainable iodine nutrition rather than on IDD control. Greater attention needs to be paid to the development of an efficient, sustainable and operating monitoring system in each country.”