

# Iodine status in vulnerable groups of Linxia Hui Autonomous Prefecture, China

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**Abstract.** To assess iodine status in vulnerable groups of Linxia Hui Autonomous Prefecture, China. We selected 5 villages in the east, south, west, north and center of 8 counties of Linxia Hui Autonomous Prefecture randomly. In each village, one primary school was identified and 80 students aged 8-10 years were randomly selected. At the same time, 20 pregnant women, 20 lactating women, 20 women of childbearing age and 20 young children (0-3 years) were randomly selected via existing township health center lists. The iodine content of household salt and drinking water and the urine in four population subsets (except school-aged children) was measured. The thyroids were examined in school-aged children. The iodine content in most household drinking water (90.2%) was less than 10 $\mu$ g/L. The percentage of households using adequately iodized salt was 83.2% and percentage of households using non-iodized salt was as high as 15%. The median urinary iodine concentration (UIC) of pregnant and lactating women, and women of child-bearing age was 89, 85 and 90 $\mu$ g/L, respectively, indicating an iodine deficiency. The median UIC of 0-3 year old babies was 107 $\mu$ g/L. The goiter rates of school-aged children were 10.6% by ultrasound and 9.9% by palpation. Low median UIC and high goiter rates were observed most frequently in counties with higher non-iodized salt and higher percentage of minority nationalities. Iodine deficiency has been a significant public health problem in Linxia Hui Autonomous Prefecture and still exists. Iodine supplement is needed to ensure adequate iodine nutrition for at-risk groups.

Key words: Iodine deficiency, iodized salt, goiter, urine iodine concentration

## 1. Introduction

Iodine deficiency (ID) has multiple adverse effects on growth and development in humans and is collectively termed the iodine deficiency disorders (IDD) (1). IDD was a significant public health problem in China (2). Universal salt iodization (USI), which is defined as all salt for human and animal consumption are iodized to the adequate levels, is the main strategy to control iodine deficiency worldwide and is recommended by WHO (3). Since 1995, China has implemented a policy of universal salt iodization (USI) in which it has been mandatory for all edible salt to be iodized according to national standards. China has achieved the goal of eliminating IDD nationally (4), but there were seven provinces primarily in the west, where IDD still was a public health problem, especially in remote, poor

and minority regions (5). Urinary iodine excretion is a good marker of very recent dietary iodine intake. The criteria for assessing iodine status provided by WHO is that in children and non-pregnant women, median urinary iodine concentrations of between 100 $\mu$ g/L and 299 $\mu$ g/L define a population which has no iodine deficiency and during pregnancy, median urinary iodine concentrations of between 150 $\mu$ g/L and 249 $\mu$ g/L define a population which has no iodine deficiency. For lactating women and children <2 years of age a median urinary iodine concentration of 100 $\mu$ g/L can be used to define adequate iodine intake (1). Public health policies to prevent iodine deficiency have been successful and iodine prophylaxis, mainly through salt iodination, proved an inexpensive and effective measure. In areas where neglect in iodine-prophylaxis enforcement caused its discontinuation, there has been a resulting of increase in the prevalence of IDD.

### Study area

Linxia Hui Autonomous Prefecture is situated at the juncture of the Loess Plateau and the Qinghai Tibet Plateau in northwest China. More than ten ethnic groups including Hui, Han, Tibet,

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Dongxiang, Tu, Yugu, Baoan, Mongolia and Sala have inhabited in Linxia Hui Autonomous Prefectures for generations. Among its total population of 1.932 million, the minority population makes up 57.1%. Hui nationality is the largest in all the minority nationalities, while the Yugu, Dongxiang and Baoan are unique nationalities. Directly under its jurisdiction, Linxia Hui Autonomous Prefectures have eight counties (cities). Guanghe, Dongxiang and Jishishan counties have a higher percentage of minority nationalities. The economy in Linxia Hui Autonomous Prefectures is very poor and the illiteracy rate in some villages is more than 60%.

## 2. Materials and method

During May to September 2006, we selected 5 villages in the east, south, west, north and center of each county of Linxia Hui Autonomous Prefecture randomly. In each village, one primary school was identified and 80 students aged 8-10 years were randomly selected. At the same time, 20 pregnant women, 20 lactating women, 20 women of childbearing age and 20 young children (0-3 years) were randomly selected via existing township health center lists. Plastic bottles with screw caps were provided to women for the urine samples and urine samples of young children (0-3 years) were collected using pediatric urine bags. Casual urine samples were collected from women of child-bearing age (20-40 years), pregnant women, lactating women and young children (0-3 years) tightly sealed in bottles and refrigerated at 4°C until laboratory for analysis. Salt samples were collected from a subset of women included in the study. Two samples of drinking water were collected for analysis from different sources (central drinking water supply and non-central drinking water supply) in each selected village.

The study was approved by the local institutional ethics committee. The study was explained to the women and parents of children and oral consents were obtained.

### 2.1. Measurement

The content in urinary samples was measured by ammonium persulfate oxidation method (6). Iodine was measured in water after appropriate digestion (7,8). Iodine content in salt was measured by liberating iodine from salt and titrating the iodine with sodium thiosulphate using starch as an external indicator (9). Based on WHO's recommendation and the specific conditions in China, the national standard for salt iodization is  $35\pm 15$  mg/kg at all levels from production to households. To consolidate the sustainable elimination of IDD, availability and

consumption of adequately iodized salt ( $35\pm 15$ ppm iodine) must be guaranteed. The coverage of adequately iodized salt at the household level should be more than 90% (10). Thyroid volumes of the children were measured by ultrasound using a portable ultrasound machine (LOGIQ  $\alpha 50$ ) with a 7.5MHz 6-cm linear transducer. All ultrasound measurements were performed by one sonographer (C.J.E) with the students placed in supine position with the neck fully extended. The volume of each thyroid lobe (cm) was calculated using the following formula: volume of each lobe = length $\times$ width $\times$ thickness $\times 0.479$ . Goiter was defined as >97th percentile of thyroid volume by age using national reference values for iodine sufficient Chinese children, in which the cut-off values are 4.5ml for age 8yr, 5.0ml for 9yr, and 6.0ml for 10yr (11). At the same time goiter was assessed by palpation, using the classification system of ICCIDD/UNICEF/WHO (grade 0, no goiter; grade 1, thyroid palpable but not visible; and grade 2, thyroid visible with neck in normal position) (1). When in doubt, the immediate lower grade was recorded. The intra- and inter-observer variation was controlled by repeated training and random examinations of goiter grades by another author.

### 2.2. Statistical analysis

Results were analyzed by SPSS (version 10.0). Values for iodine concentration in urine and drinking water are reported as medians. Non-parametric analyses (Kruskal-Wallis test) were used for comparisons among groups.

## 3. Results

### 3.1. Iodine in household water

The median iodine content of 51 household drinking waters was  $2.54\mu\text{g/L}$  (1.05-15.67). Household drinking water  $<10\mu\text{g/L}$  was found in 90.2% of households.

### 3.2. Iodine in household salt

A total of 1269 household salt samples were collected. The percentage of adequately iodized salt was >95% in all 8 counties. The percentage of households using adequately iodized salt was 83.2%. Only 3 of 8 counties had reached the standards of using adequately iodized salt over 90% which were Kangle (98%), Linxiashi (99%) and Yongjin (97%). The percentage of households using non-iodized salt was 15% in all counties. The percentage of household consuming non-iodized salt above 15% were found in Guanghe (50%), Jishishan (36%), Dongxiang (22%), Linxiashan (19%) and Hezheng (17%).

3.3. Urinary iodine concentration

A total of 778 pregnant women, 824 lactating women, 998 women of child-bearing age (20-40 years) and 1056 young children (0-3 years) were selected in the study. The median UIC of pregnant and lactating women, and women of child-bearing age was 89, 85 and 90µg/L respectively (Table 1) and the percentage of UIC <50µg/L was 31%, 32% and 30% respectively which indicated iodine deficiency existing in all group women investigated. The median of urine iodine of 0-3 year old children was 107µg/L, with 24% had a UIC <50µg/L. The medians for pregnant, lactating women and women of child-bearing age in all counties were <100µg/L.

3.4. Goiter

A total of 3518 children' thyroid were examined by ultrasound and palpation. The goiter rate was 10.6% by ultrasound and 9.9% by palpation in all counties. The goiter rate by ultrasound in 5 of 8 counties did not reach the elimination criterion of children' prevalence of goiter less than 5% (12), particularly the goiter rate was respectively 31.5%, 13.8% and 13.9% in

Guanghe, Dongxiang and Jishishan counties. The goiter rate did not reach the national IDD elimination criterion in all counties. The higher goiter rates were found mostly in those counties with a poorer economy and higher non-iodized salt coverage (Table 2).

4. Discussion

The most common cause of iodine deficiency is inadequate iodine in the diet resulting from a lack of this element in the soil. It often coexists with poverty and remoteness, where foods from the outside world are out of reach of local people. Poverty and malnutrition are among the contributing factors to the etiology of iodine deficiency. Natural iodine deficiency extensively exists in Linxia Hui Autonomous Prefecture. Iodine deficiency in the environment can not be changed in a short period of time, so IDD prevention and control mainly rely on increasing iodine intake by fortification or supplementation. USI is the most efficient strategy for IDD elimination. USI was carried out in 1995 in China (13).

Table 1. Urinary iodine status of vulnerable groups of people living in linxia hui autonomous prefecture, China, 2006

County	Women of Childbearing age			Pregnant Women			Lactating Women			Young Children		
	n	Median (µg/L)	UIC<50 µg/L(%)	n	Median (µg/L)	UIC<50 µg/L(%)	n	Median (µg/L)	UIC<50 µg/L(%)	n	Median (µg/L)	UIC<50 µg/L(%)
Guanghe	102	47	54	97	48	60	92	46	54	87	140	31
Kangle	99	152	15	97	147	17	107	145	19	155	150	12
Hezheng	77	127	29	78	130	30	80	100	29	98	136	21
Dongxiang	229	64	40	90	79	37	127	65	44	224	67	40
Jishishan	68	126	15	77	115	14	64	97	8	73	93	27
Linxiagian	165	103	29	146	128	28	155	76	37	169	104	26
Linxiashi	98	114	15	93	83	25	99	92	27	134	115	10
Yongjin	100	91	22	100	78	34	100	91	30	116	105	18
All	938	90	30	778	89	31	824	85	32	1056	107	24

Table 2. Goiter status in children aged 8-10 years in linxia hui autonomous prefecture, China, 2006

County	n	by ultrasound			by palpation		
		sample with goiter	TGR (%)	95% CI (%)	sample with goiter	TGR (%)	95% CI (%)
Guanghe	400	128	32	27.5-36.5	60	15	11.5-18.5
Kangle	408	18	4	3.4-4.6	32	8	5.4-10.6
Hezheng	403	26	7	4.5-9.5	42	10	7.1-12.9
Dongxiang	412	57	14	10.6-17.4	64	16	12.5-19.5
Jishishan	381	64	14	10.5-17.5	45	10	7.0-13.0
Linxiagian	630	31	5	3.3-6.7	56	9	6.8-11.2
Linxiashi	401	13	3	1.3-4.7	33	8	5.3-10.7
Yongjin	403	29	7	4.5-9.5	18	5	2.9-7.1
All	3438	364	11	10.0-12.0	350	10	9.0-11.0

Because of limited funding, the dispersed population, inadequate transport, non-iodized raw salt cheap and accessed easily, the exchanging of salt for grain in some communities and the habit of eating raw-salt in local areas, salt iodization was a difficult strategy to sustain as a strategy to prevent IDD. After ten years of USI, the percentage of households using adequately iodized salt was 83% in Linxia Hui Autonomous Prefecture, but only 48% in Guanghe County. The percentage of households using adequately iodized salt was lower than 90% of Chinese. The strategy of USI has not been effective in 5 of 8 counties. Mild iodine deficiency could prevent children from attaining their full intellectual potential (14). In order to protect the intelligence of those at risk, pregnant, lactating women and infants less than two years old are the targeted in iodine deficiency disorders (IDD) prevention and control (15). The median UIC is the best indicator to use in population surveys to assess the iodine nutrition of pregnant and lactating women, and of young children. The median UIC of all women in this study was lower than 100 $\mu$ g/L, and lower than 50 $\mu$ g/L in Guanghe. The UIC medians of three groups of women were lower than that of children 0-3 years, probably because children 0-3 years mainly obtain iodine from the breast milk or complementary feeding. According to the criteria for assessing iodine status provided by WHO, inadequate iodine nutrition existed in local women who are the most vulnerable to iodine deficiency. The median UIC of children was lower than 100 $\mu$ g/L in Dongxiang and Jishishan. The total goiter rate was 10.6% by ultrasound and 9.9% by palpation. The low UIC and high goiter rate were found more frequently in counties with higher non-iodized salt and higher percentage of minority nationalities.

Iodine deficiency has been a significant public health problem in Linxia Hui autonomous prefecture. USI remains the key strategy to eliminate IDD in Linxia Hui autonomous prefecture. We recommend:

- 1) Monitoring of both iodized salt and iodine nutrition of pregnant and lactating women as well as young children are important to ensure that an optimal state of iodine nutrition is reached and then sustained.
- 2) Pregnant and lactating women should be encouraged to obtain additional iodine from other source, such as iodized oil or iodine supplement.
- 3) Increased health education should be encouraged as this plays an important role in IDD control and prevention.

- 4) Government subsidies for iodized salt and improved distribution services are needed.

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