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Significance of Improving Iodine Nutrition by Oral Intake of Iodinated Oil and Iodinated Salt in Women of Reproductive Age in Southern Xinjiang, China

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Abstract

Objective: In severe endemic area of IDD at southern fringe of Tarim Basin, investigation was carried out to know the situation of iodine nutrition improvement by oral intake of iodinated oil in women of reproductive age for 3 years from 2007 to 2009, in order to prevent neonate cretinism and intelligence disability of children from occurrence.

Methods: In 4 counties of Kashi Prefecture and 3 counties of Kizilsu Kirgiz Prefecture of southern Xinjiang, China, women of 4 kinds (getting marriage certificate, procreation certificate, within 3 month-pregnancy, in lactation) were implemented iodine supplementary measure of taking iodinated oil. Out of 74 536 women of volunteers, each took 400 mg for twice a year (200 mg in April for the first half year and 200 mg in October for the second half year). Then, 1,533 samples of urine were collected randomly to conduct analysis of urine iodine. Meanwhile, 2,742 child volunteers were taken B-ultrasound examination on thyroid enlargement and their urinary samples were collected for analysis of urine iodine. Results: Iodized salt were delivered freely to poverty households by governmental subsidy in Xinjiang. After 2 years, goiter rate of children decreased to be 4.2% in 2009 from 18.5% in 2007. There was statistical significance between 2007 and 2009 (chi square, $P<0.05$), and urine iodine of children increased 47 percentage points. Urine iodine of women of reproductive age improved from 75.3 μg/L in 2007 to 316.68 μg/L in 2009 by taking iodinated oil orally. There was statistical difference in urine iodine of women in different counties before and after supplementary iodine (t test, $P<0.05$). Investigation on children within 3-year-old born after supplementary iodine in 2007 showed there was no new occurrence of endemic cretinism through emergent iodine supplement in women of reproductive age by taking iodinated oil for successive 3 years.

Conclusions: Measure of taking iodinated oil orally in women of reproductive age in southern Xinjiang is effective for preventing neonate cretinism and intelligence disability of children from occurrence.

Keywords: Women; Reproductive age; Iodinated oil; Iodine nutrition; Southern Xinjiang; China

Introduction

In China, Xinjiang is a minority autonomous region where nationalities live in compact communities and multiple religions coexist, including Uygur, Han, Kazak, Hui, Mongolia and so on. Xinjiang is located in the northwestern part of China and Eurasian Continental inland. Unique physical geography and climate result in extreme shortage of iodine resources in the external environment. Generally, iodine content is 1-4 μg/L in water and 10 μg/kg in soil. Xinjiang is a severe area of iodine deficiency with prevalence and severe damage of iodine deficiency disease (IDD). Endemic cretinism and intelligence disability of children caused by iodine deficiency are common in Xinjiang. IDD in Xinjiang not only severely affects people's constitution and intelligence of all nationalities, but also restricts improvement of population quality, economic development and social progress. In order to prevent endemic cretinism in children from occurrence induced by iodine deficiency in southern Xinjiang, measure of oral intake of iodinated oil by women of reproductive age was developed in Kashi and Kizilsu Kirgiz Prefecture without reaching the stage goal of IDD elimination in southern Xinjiang in 2007 successively for 3 years, according to "Emergent Iodine Supplement Program for IDD Control by Oral Intake of Iodinated Oil in Women of Reproductive Age" formulated by Ministry of Health of China, aiming at prevention of endemic cretinism, intelligence disability and improvement of iodine nutrition.

Materials and Methods

In the light of "Emergent Iodine Supplement Program for IDD Control by Oral Intake of Iodinated Oil in Women of Reproductive Age" formulated by Ministry of Health of China, emergent iodine supplement with oral intake of iodinated oil was developed focally in high risk areas of IDD in Kashi and Kizilsu Kirgiz Prefecture. In the investigated areas, it is effective for preventing children cretinism resulted from mother's iodine deficiency by way of intake of iodized salt and taking iodinated oil orally twice a year in women.

Investigation content

Examination in children of 8 to 10 years old

Out of the focal counties, 2,742 children of 8 to 10 years old from 7 counties were selected randomly to take B-ultrasound examination on goiter (the selected children related to the families to somehow).

Investigation on iodized salt by entering into household

In each county (district, city), 4 townships were sampled randomly according to direction of the west, east, north, south and the middle. Out of them, 2 townships (streets, towns) were sampled randomly in the west, east, north and south, while 1 township (town) was sampled randomly in the middle. In each township (town), 4 administrative villages (residents' committees) were sampled randomly. Out of the 4 villages, 2 were selected in location of township government and its neighborhood, and the other 2 in districts with high rate of non-iodized salt or the villages with distance over 5 km to the township government. In each administrative village (residents' committee), 8 households were sampled.

Out of 74,536 women of 18-45 years old who took in iodinated oil orally with voluntary participation, urinary samples of 1,533 women of reproductive age (getting marriage certificate, procreation certificate, within 3 month-pregnancy, in lactation) were collected to detect for urine iodine.

By health education and propaganda of IDD, the women of reproductive age in the 4 counties of Kashi and 3 counties of Kizilsu Kirgiz Prefecture knew advantage of oral intake of iodinated oil for preventing neonate cretinism and intelligence disability, and accepted iodine supplement by oral intake of iodinated oil willingly. School children of 8-10 years old were voluntary to be collected urinary samples for detecting urine iodine and take thyroid examination.

Detection method

Determination of iodine in salt

Iodine content in edible salt was detected according to direct titration method GB/T13025-1999 [1].

Measurement of thyroid of children by B-ultrasound

In accordance with the normal value of thyroid volume of children and adolescents GB/T16398-1996 [1].

Determination of urine iodine

According to arsenic and cerium catalysis spectrophotometric determination (WS/T107-2006) [1].

Statistical analysis

EPIINFO database Ed3.32 was taken with statistical software.

Results

Iodine in salt

Before free delivery of iodinated salt to poverty families by Xinjiang government in 2007, 2,028 samples of edible salt of inhabitants in 7 counties in Kashi and Kizilsu Kirgiz Prefecture were collected by entering their households. Intake rate was 52.1% of qualified iodinated in inhabitants and 47.9% of non-iodinated salt. In 2009, 2,028 samples of edible salt of inhabitants were collected in the areas mentioned above, and intake rate was 87.9% of qualified iodinated in inhabitants and 12.1% of non-iodinated salt. They were improved 35.8 percentage points compared with those in 2007. There was statistical difference before and after delivery of iodinated salt (t test, $P<0.05$) (Table 1).

The edible rate of qualified iodized salt was 52.1% in 2007. There was a difference by 38 percentage point from the national standard of iodized salt for the stage goal of IDD elimination >90%. The edible rate of qualified iodized salt was 87.9% in 2009. There was a difference by 2 percentage point from the national standard of iodized salt for the stage goal of IDD elimination >90%.

Group	Samples	Median before delivery mg/kg	Qualified rate %	Samples	Median after delivery mg/kg	Qualified rate %
A	288	30.7	49.3	288	32.0	85.8
B	288	30.7	42.5	288	32.1	87.9
C	288	30.8	69.1	288	33.4	85.1
D	288	30.7	59.1	288	27.2	92.4
E	288	30.6	43.8	288	36.2	87.2
F	288	30.8	52.1	288	31.0	96.9
G	300	30.8	81.3	300	34.4	96.7
Total	2028	30.7	52.1	2028	32.1	87.9

Table 1: Comparison of free delivery of iodized salt in 7 counties in Kashi and Kizilsu Kirgiz Prefecture

Goiter rate

In 2007, Xinjiang government delivered iodized salt freely in southern Xinjiang. 4,639 children of 8-10 years old in 7 counties in Kashi and Kizilsu Kirgiz Prefecture were taken examination by B-ultrasound before the delivery. After delivery of iodized salt for 2 years in 2009, the volume of thyroid of 763 children was measured by B ultrasound, with the goiter of 18.5%. There was big difference from the national standard for the stage goal of IDD elimination ≥5%.

Group	Cases	Goiter No. before delivery	Goiter rate (%)	Cases	Goiter No. after delivery	Goiter rate (%)
A	561	107	19.1	240	10	4.2
B	607	19	3.2	240	10	4.2
C	996	198	19.9	240	7	2.9
D	610	125	20.5	240	10	4.2
E	604	112	18.5	240	14	5.8
F	647	98	15.2	240	6	2.5
G	614	104	16.9	241	7	2.9
Total	4639	763	18.5	1681	64	4.2

Table 2: Comparison of goiter rate of children of 8-10 years old before and after free delivery of iodized salt

1,681 children were examined by B-ultrasound, with goiter rate of 4.2% (Table 2). The goiter rate of children decreased 14 percentage points after 2 years. There was statistical significance in the goiter rate of children before and after taking iodized salt (χ^2 test, $P<0.05$).

Analysis of urine iodine of children and women

Before taking iodinated oil in women of reproductive age in 2007, 1,113 urinary samples of women of reproductive age were collected in 7 counties in Kashi and Kizilsu Kirgiz Prefecture to detect urine iodine. The median of urine iodine was 75.3 μg/L. There were 588 women with urine iodine less than standard 100 μg/L, accounting for 52.8%. After taking iodinated oil for 2 years (to 2009), 420 urinary samples were collected with median of urine iodine of 316.7 μg/L (Table 3). There were 37 women with urine iodine less than 100 μg/L, occupied 8.8%. After taking iodinated oil, urine iodine of the women improved 44 percentage points compared with that before iodine supplement. It had statistical difference in urine iodine between pre- and post-iodine supplement by oral intake of iodinated oil (t test, $P<0.05$). Urine iodine of the women was 93.0% in 2009, reaching the standard of 100 μg/L. Taking iodinated oil orally improved the female nutrition level obviously. In the investigated areas, it is effective for preventing children cretinism resulted from mother's iodine deficiency by way of intake of iodized salt and taking iodinated oil orally twice a year in women.

In 2007, urinary samples of 1,061 children were collected to detect for urine iodine, with the median of 91.2 μg/L. 655 cases were under lower limit of the standard 100 μg/L, accounting for 61.7%. In 2009, 1,681 samples of the women were gathered to test for iodine content in urine, with the median of 257.9 μg/L. There were 246 cases lower than the lower limit of the standard 100 μg/L, occupied 14.6% (Table 3). After free delivery of iodized salt for 2 years, urine iodine of the children improved 47 percentage points, with statistical significance (t test, $P<0.05$).

Group	Women of reproductive				Children			
	Before taking iodinated oil		After taking iodinated oil		Before taking iodized salt		After taking iodized salt	
	Cases	Median (μg/L)	Cases	Median (μg/L)	Cases	Median (μg/L)	Cases	Median (μg/L)
A	165	54.0	49	160.0	160	91.2	240	206.2
B	180	75.3	60	201.9	108	68.8	240	273.7
C	229	159.5	60	384.6	171	259.6	240	257.9
D	173	50.1	58	316.7	149	58.3	240	289.0
E	122	64.1	63	351.7	161	61.7	240	287.0
F	179	103.2	61	396.2	152	101.5	240	213.8
G	65	111.4	69	194.1	160	237.0	241	208.6
Total	1113	75.3	420	316.7	1061	91.2	1681	257.9

Table 3: Urine iodine of women of reproductive age before and after taking iodinated oil orally in southern Xinjiang (μg/L)

Discussion

Iodized salt and goiter rate of children

In the investigated areas, goiter rate of children of 8 to 10 years old was 18.5% in Kashi and Kizilsu Kirgiz Prefecture. There was a big difference from national standard for stage goal of eliminating IDD ≧5%. In 2009, the goiter rate decreased to 4.2%, which reached the national standard. There were many relevant factors of influencing goiter rate of children, such as severe iodine deficiency in external environment in the areas, residents' food habits for long term, and restriction of straggly local economy and culture, that made the goiter rate high. In this investigation, intake rate of qualified iodized salt in residents was 52.1% in 2007 and goiter rate of the children was 18.5%. The result showed that 47% of the children didn't get iodine supplement. Combining with goiter result, it confirmed that goiter of children took long time for disappearance after spreading iodized salt. Because there was individual difference, local salt resource (non-iodized salt), and the children didn't get iodine supplement in embryo stage. Even if there was other iodine supplement preparation or sufficient supplement of iodized salt, and thyroid function of the children recovered to be normal, regression of the thyroid should take 3 to 5 years. The spread rate of iodized salt is low in poor and remote areas of Xinjiang in China. So intake amount of iodized salt is few. Iodized concentration in salt shall be regulated or increased, so as to effectively improve iodine deficiency situation in local residents, maintain physiologic equilibrium of iodine in human body and finally eliminating endemic goiter.

Intake of qualified iodized salt in residents and urine iodine of children

In this investigation, intake rate of non-iodized salt (local salt) was 47.9% in residents in 2007 and 61.7% of the children's urine iodine was under 100 μg/L, while in 2009, those were 12.1% and 14.6%, respectively. The results indicated that qualified rate of iodized salt closely related to goiter of children. From 2007 to 2009, the investigated intake rate of qualified iodized salt in residents basically coincided with urine iodine of children. That also showed there were about 50% of the investigated families without intake of iodized salt and taking unqualified iodized salt. The family members didn't get iodine supplement or iodine deficiency of the body didn't improve. It is confirmed that endemic goiter shall occur when intake amount of iodine is 40-80 μg/L for one person per day, but no endemic cretinism is prevalent [2]. Intake amount of iodine for one person per day less than 50 μg/L is the starting point of prevalence of endemic goiter. But in some areas with iodine over normal limit, there is prevalence of endemic goiter.

Oral intake of iodinated oil and iodine nutrition of women of reproductive age

Women of reproductive are key target crowds for IDD control. Their iodine nutrition level directly influence fetal iodine nutrition and brain development. Professional researchers confirms that median of urine iodine of pregnant women shall be 250-300 μg/L. In this investigation, urine iodine of women of reproductive age is obviously lower in 2007 than in 2009. There is significant difference between the two years. In October 2007, control measure of oral intake of iodinated oil was implemented in women of reproductive age. In 2009, the measures had been executed continuously for 3 years, and their urine iodine increased from 91.2 μg/L to 257.9 μg/L. It was improved 2.8 times. The investigative results are in accordance with that in the domestic and overseas. The actually curative effect on controlling neonate cretinism and intelligence disability relates to the dosage, usage and intake time of oral intake of iodinated oil. It is confirmed by practice for many years that effect of iodine supplement by oral intake of iodinated oil and maintaining time in human body are best by taking small dose for many times. Therefore, iodine nutrition is due to

absorption and application of iodine in human body that is affected by many factors. According to special geographical and geological environment and living habit of minority in southern Xinjiang, [3] reasonably comprehensive measure of iodine supplement shall be taken for evaluation by combining with thyroid function. Normal value of urine iodine of all crowds in the area and incisor point value of inducing goiter and endemic cretinism shall be calculated for reasonable iodine supplement. And it shall be considered that iodine metabolism in human body is influences by some factors of geography, food habits and heredity [4-6].

Conclusion

Southern Xinjiang is the severest endemic area of IDD in China, and also one of the provinces without reaching the stage goal of IDD elimination. Spread of iodized salt of 35 mg/kg ± 10 mg is the convenient, effective and safe iodine supplement measure for IDD control. In southern Xinjiang with rich resource of non-iodized salt, it is difficult to spread iodized salt because of restriction of local food habit of minority, economy, culture and special geographical environment. Developing oral intake of iodinated oil in women of reproductive age by taking 400 mg for two times a year is an effective measure for emergent iodine supplement, in order to prevent neonate cretinism and intelligence disability of children from occurrence.

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