

Analysis of Iodine and Selenium Trace Elements in Umbilical Cord Blood in Cretinous Regions in Northwest China in 1999

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Abstract

Shaanxi Province located at Midwest inland of China was a typical iodine deficient disorders region. To investigate iodine and selenium levels of neonates in the Shaanxi sub-clinical cretinism region of China after supplement of iodine salt for nearly twenty years. We collected 56 umbilical cord blood samples from cretinous regions of Yijun County (a selenium deficient region) north of Shaanxi Province and Ziyang County (a selenium-enriched region) south of the province and from Lintong in Xi'an (a non-cretinous region for control). Among these samples 17 were collected from Ziyang, 20 from Lintong and 19 from Yijun. Seven trace elements of iodine, selenium, zinc, copper, iron, calcium and magnesium in the umbilical cord blood samples were measured and the results were processed statistically. There were no significant differences in the levels of iodine among all three counties. However, the level of selenium in Ziyang was the highest and in Yijun it was the lowest. The other trace elements such as Cu Zn Fe and Mg showed no significant difference among the three counties except for the Ca level which was lower in Yijun.

The regression equation was established with the backward method of multiple regression was:
 $Se = 0.180 + 0.00006654 Fe - 0.006 Cu - 0.005956 Mg + 0.1$

Key words: iodine, selenium, umbilical cord blood, IDD, Shaanxi province, China

Introduction

Shaanxi Province located at Midwest inland of China was a typical iodine deficient disorders region. According to the *The Atlas of Endemic Diseases and Their Environments in the People's Republic of China*, which was investigated by the Office of Lead Groups of Endemic Diseases Prevention and Control Central Committee of the Chinese Government and the Committee of Environmental Science under the Chinese Academy of Science the prevalence rate of endemic cretinism both in Yijun county and Ziyang county were about 0.1~1.0%, but Lintong county was a non-affected region¹. The iodine content in drinking water in both Yijun and Ziyang were less than 5 µg/L, Lintong was about 5~10 µg/L². The selenium (Se) content in soil, wheat, maize, and in human hair were identical, the Se level in Yijun was the lowest, and that in Ziyang was the highest³.

After supplement of iodine salt supported by the Chinese government for nearly twenty years in those areas in the northwest

China where iodine deficiency was serious the typical endemic goiter and cretinism have been basically under control⁴. However, there is still a large population of mentally retarded children in the regions⁵. The reasons are as follows: 1) insufficient supplement of iodine salt; 2) in addition to iodine deficiency, there might be some other unknown factors that cause the occurrence of mentally retarded children.

Materials and Methods

Samples: From the end of 1998 to the beginning of 1999, we collected 19 umbilical cord blood samples from Yijun County in north Shaanxi Province (an iodine and selenium deficient region where supplements of iodine salt have been performed for nearly 20 years) and 17 umbilical cord blood samples in Ziyang County (an iodine deficient and selenium enriched area where supplement of iodine salt has been performed for nearly 20 years) in Qinba Mountains south of Shaanxi Province. In addition, 20 samples as control were collected from normal neonates in Lintong County a suburb near Xi'an. In each case, 0.005 L of umbilical blood was sampled and sealed after agitation and then stored at the temperature of -20°C in a refrigerator. The parturient women of the above-mentioned different nutrient regions of selenium were local residents who appeared healthy and had been consuming only self-produced food, had with no familial genetic diseases and their newborn babies showed no abnormalities. The samples were per-

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Table 1 Results of determination of trace elements in umbilical cord blood samples in cretinous regions in Shaanxi province in 1999 (PPM)

Trace elements	Yijun (cretinous region) mean±SD (n=19)	Lintong (control) mean±SD (n=20)	Ziyang (cretinous region) mean±SD (n=17)	F
I	0.0344±0.0108	0.0356±0.0116	0.0336±0.0201	0.085
Se	0.0658±0.0130	0.0730±0.0172	0.1053±0.0521	7.978**
Ca	104.211±9.681	118.600±19.879	106.882±13.199	5.041**
Zn	2.207±1.497	2.930±2.807	2.856±0.557	0.867
Fe	631.947±97.649	648.000±135.779	604.647±125.621	0.618
Mg	24.861±2.668	24.450±3.088	21.509±5.409	4.038*
Cu	1.053±0.740	0.745±0.132	0.887±0.101	2.370

* P<0.05 ** P<0.01

formed in the three counties at the same time and were simultaneously tested after being gathered together.

Detection of trace elements

The determination was conducted in the Inspection House of Trace Elements in Xi'an, which is certified by State authorities. Selenium was determined using the atomic fluorescence method, and iodine was tested using colorimetry.

Statistical analysis: Statistics was performed on a Pentium-II 350 computer. One-way ANOVA of variance and multiple backward regression were conducted with the statistical software SPSS 10.0.

Results

The results of detection of trace elements in umbilical cord blood samples in cretinous regions in Shaanxi province in 1999 (Table 1)

Among the three counties, the level of iodine in umbilical cord blood samples was the lowest from Ziyang, but was not significantly different compared with Lintong. The level of selenium in Ziyang was the highest and in Yijun it was the lowest (Dunnett T3: P<0.05). The Ca level was lower in Yijun with a highly significant difference (Dunnett T3: P<0.05). The Mg level was the lowest in Ziyang, there were highly significant differences compared with Yijun and Lintong (Student-Newman-Keuls: P<0.05). The other trace elements such as Cu, Zn, and Fe showed no significant differences among the three counties.

Pearson Correlation of the trace elements in umbilical cord blood samples from the three counties (Table 2, 3, 4)

The establishment of a multiple regression equation—A regression equation was established with the backward method of multiple regression:

$$\text{Se} = 0.180 + 0.00006654 \text{ Fe} - 0.006 \text{ Cu} - 0.005956 \text{ Mg} + 0.135 \text{ I}$$

$$R^2 = 0.347 \quad F = 6.773 \quad P < 0.01$$

These findings suggest that the fitting degree is excellent and the equation has significance.

Discussion

We selected umbilical cord blood as the test samples because they can reflect the status of both mothers and newborns. The results demonstrate that after supplement of iodine salt for many years, the iodine levels in the samples from Yijun and Ziyang were at similar levels as that in the Xi'an suburb area, indicating that the

Table 2 Pearson Correlation of the trace elements in umbilical cord blood samples from Yijun (selenium insufficient region)

	Zn	Fe	Cu	Ca	Mg	I
Se	-0.040	-0.064	-0.245	0.311	0.276	-0.412
Zn		-0.137	0.279	-0.063	-0.078	0.265
Fe			-0.214	-0.530*	0.871**	-0.183
Cu				-0.192	-0.154	0.620
Ca					-0.439	0.173
Mg						-0.353

* P<0.05 ** P<0.01

Table 3 Pearson Correlation of the trace elements in umbilical cord blood samples from Ziyang (selenium enriched region)

	Zn	Fe	Cu	Ca	Mg	I
Se	0.214	-0.150	-0.038	-0.249	-0.633*	0.187
Zn		0.352	0.041	-0.208	-0.404	-0.026
Fe			-0.147	-0.092	0.304	0.078
Cu				0.359	0.110	0.265
Ca					0.478	-0.169
Mg						0.014

* P<0.05 ** P<0.01

Table 4 Pearson Correlation of the trace elements in umbilical cord blood samples from Lintong (non-cretinous region)

	Zn	Fe	Cu	Ca	Mg	I
Se	-0.168	-0.156	-0.035	0.167	-0.219	0.025
Zn		0.389	0.081	-0.185	0.463*	0.260
Fe			-0.015	-0.381	0.894**	0.194
Cu				0.377	-0.009	0.010
Ca					-0.252	-0.336
Mg						0.205

* P<0.05 ** P<0.01

supplement of iodine salt has gained some achievements. It also confirmed that it is difficult to control the prevalence of sub-clinical cretinism by iodine supplement alone. This suggests that in addition to iodine deficiency there might be some other external factors that currently play a role in the prevalence of sub-clinical cretinism after the iodine level became normal. Among the three counties, the level of selenium in Yijun was the lowest, in Lintong it was moderate, and in Ziyang it was the higher, which is in accordance with the results of previous investigations^{6,7}.

Increasing numbers of animal studies reveal that Se plays a role in sub-clinical cretinism as a factor of coordination, which aggravates the harm of iodine deficiency to brain tissue^{8,9}. Firstly, as the active center of GSHPX, Se exerts a protective action

similar to that of cellular membranes against the oxidation of lipid peroxide and hydrogen peroxide. The lipid peroxide would result in incomplete formation of a myelinated sheath, obstruction of synapse conduction, abnormalities in neuron development and severe disorders of brain function¹⁰. Meanwhile, peroxide would cause damage to the epithelium of the thyroid gland alveolus and fibrosis atrophy and consequently lead to the synthetic disorder of thyroxin. Secondly, the more recent studies confirmed that Se is not only the active component of type I and type II deiodinase, but also the active component of type III deiodinase¹¹⁻¹³. These findings suggest that Se may be closely related to the metabolism of the hormones from the thyroid gland. The enhancement of the activities of the enzymes containing Se depends on its level in the human body tissue and in blood serum. Only a proper level of selenium could ensure deiodinase (especially type II and type III) to keep their normal activities and to maintain the stability of the internal environment of thyroxin in the CNS to continue to function normally. In contrast, if Se were insufficient during the early stage of brain development, the activity of type II deiodinase would be reduced and thus affect the level of T₃, which would consequently result in abnormalities of brain development and retarded intelligence^{14,15}.

Ziyang County is enriched with selenium, but some mentally

retarded children still exist there. It is assumed that the cause is related to the following factors: First, among the three counties, the iodine level in Ziyang was the lowest while the level of selenium was clearly higher than those in the other two counties. It was reported that in conditions of insufficient iodine, high levels of selenium would aggravate mental retardation¹⁶⁻¹⁸. Second, in Ziyang County, intermarriage is more common, so there might be non-environmental factors to harm mental intelligence.

The Pearson Correlation multiple analysis and multiple regression statistical analysis, both of which were adopted in the present experiment, revealed that in a selenium deficient region, Fe correlated to Ca, and Mg significantly ($\gamma=-0.530, 0.871$). In selenium enriched regions, Mg correlated to Se significantly ($\gamma=-0.633$), but in a non-selenium deficient region, Mg correlated to Zn and Fe significantly ($\gamma=0.463, 0.894$). All these results suggest that trace elements present multiple and complicated correlation under various conditions.

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