Fluoride and IQ research in China

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Main content

- **Endemic fluorosis in China**
- Research of the effect of fluoride on neurotoxicology in China
- Endemic fluorosis in Jiangsu Province
- Our research results on fluoride and IQ

Endemic fluorosis in China

Caused by drinking water

Sun DJ. The progress on the state and prevention of endemic disease in China. Chin J Dis Control Pre. 2002

Endemic fluorosis in China

Endemic fluorosis in China

- The highest concentration of fluoride in drinking water was over 30 mg/L in China.
- There were 1306 counties with endemic fluorosis areas caused by drinking water.
- There were 150445 villages with endemic fluorosis areas.
- Total number of dental fluorosis patients were 40.66 millions.
- Total number of skeletal fluorosis parients were 2.60 millions.

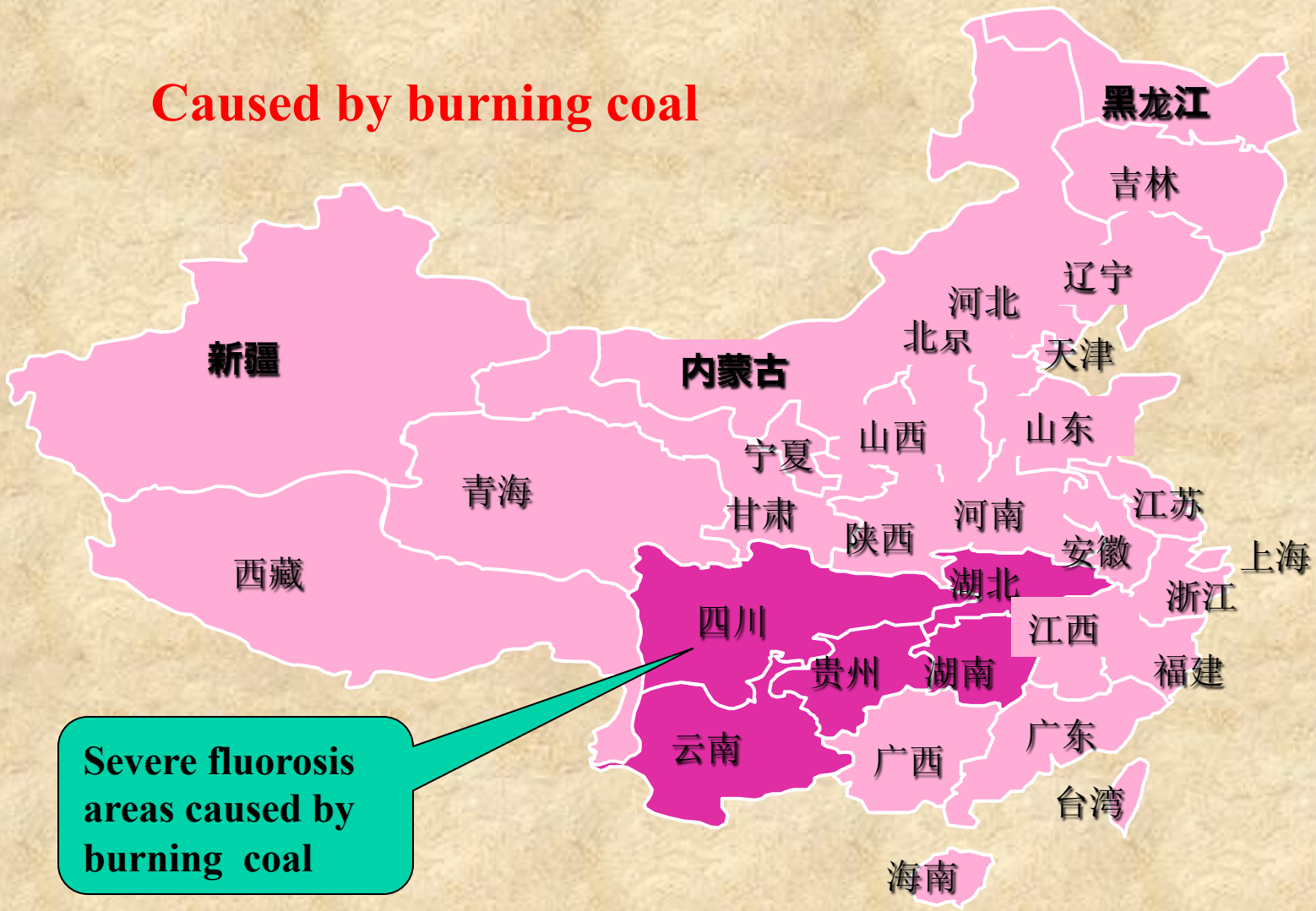
Sun DJ. The progress on the state and prevention of endemic disease in China. Chin J Dis Control Pre. 2002

Endemic Fluorosis

Geographic distribution of skeletal fluorosis in China caused by higher drinking water (in 1980's)

Region	No. Village affected	Population affected (10^6)	Cases of skeletal fluorosis (10^6)	Prevalence of skeletal fluorosis (%)
North-West	10727	6.2579	0.1470	2.35
Northern and -Eastern China	69558	52.4256	0.6250	1.20
North-West	32710	17.6490	0.3584	2.11
South-West	412	0.5104	0.0046	0.90
Southern-China	1395	1.6714	0.0037	0.23

Endemic fluorosis in China



Sun DJ. The progress on the state and prevention of endemic disease in China. Chin J Dis Control Pre. 2002

Endemic fluorosis in China

Endemic Fluorosis

Table 1. Fluorine content of coal, clay, coal-clay, coal-clay ash, drinking water, corn and hot pepper in two villages in Zhijin County, Guizhou Province, China

Sample type	Hualuo Village			Majiazhuang Village		
	No. of samples	F level (mg/kg)		No. of samples	F level (mg/kg)	
		Mean	Standard deviation		Mean	Standard deviation
Coal	11	108	80.2	5	104	65.5
Clay	10	6100	2450	6	1900	373
Coal-clay	10	805	211	5	481	119
Coal-clay ash	10	640	451	5	333	176
Drinking water	7	0.12	0.03	3	0.14	0.03
Corn	10	30.6	7.6	7	33.4	13.2
Hot pepper	9	513	389	6	343	238

Endemic Fluorosis

Skeletal fluorosis

Endemic fluorosis in China

- The prevalence of fluorosis in burning coal areas was very severe.
- Only five provinces, but the total skeletal fluorosis patients were 1.335 millions.
- The prevalence of endemic fluorosis was much higher than that in drinking water areas.

Sun DJ. The progress on the state and prevention of endemic disease in China. Chin J Dis Control Pre. 2002

Endemic fluorosis in China

Zhao XH, et al.. China Public Health. 2000

Endemic fluorosis in China

Endemic fluorosis in China

- The highest level of fluoride in brick tea was over 1000 mg/kg.
- The endemic fluorosis caused by brick tea were mainly in the areas of ethnic minorities in China. They have the traditional customs of using (or drinking) brick tea.
- The prevalence of endemic fluorosis in these areas was not very clearly.

Endemic Fluorosis

Investigations of fluorosis in some endemic fluorosis areas caused by drinking brick tea

		dental fluorosis		skeletal fluorosis	
Year	side	No.of investigate	%	No.of investigate	%
1984	Sichuan	1199	72.64		
1985-1998	Sichuan	4313	57.43		24.75
1991	Neimeng	2299	100.00	108	22.22
1995	Ganshu		84.42		
1997	Neimeng	1045	79.43		

Endemic Fluorosis

- The distribution of the areas and the prevalence of fluorosis caused by drinking brick tea are now being investigated in China
- The current results indicate that in these areas the dental fluorosis in children were mild, but the skeletal fluorosis were comparative severe

Endemic fluorosis in China

- In China, endemic fluorosis was described about 1570 years ago (265-420 in Jing Dynasty).
- The nationwide investigation of endemic fluorosis caused by drinking water and burning coal was carried out from 1980's in China. The distribution and the prevalence of endemic fluorosis has become increasingly clear.

Endemic fluorosis in China

- The investigation of endemic fluorosis caused by Brick tea was carried out in 1990's.
- But the prevalence and distribution of that in China have not been defined clearly because there were 56 nationalities impacted, and the areas with brick tea fluorosis were very large.

Endemic fluorosis in China

- Now about 90% endemic fluorosis villages have had their tap water sources (shallow to deep wells) changed to levels of fluoride <1.0 mg/L.
- Over 80% villages with high level of fluoride caused by burning coal were used safety stove

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- Endemic fluorosis in Jiangsu Province
- Our research results on fluoride and IQ

Published papers in Chinese

- Fluoride and neurotoxicity 63 Dai, et.al (1983)
- Fluoride and brain injured 20 Dai, et al (1989)
- Fluoride and IQ 10 1991
- Fluoride and IQ 40 (in English)

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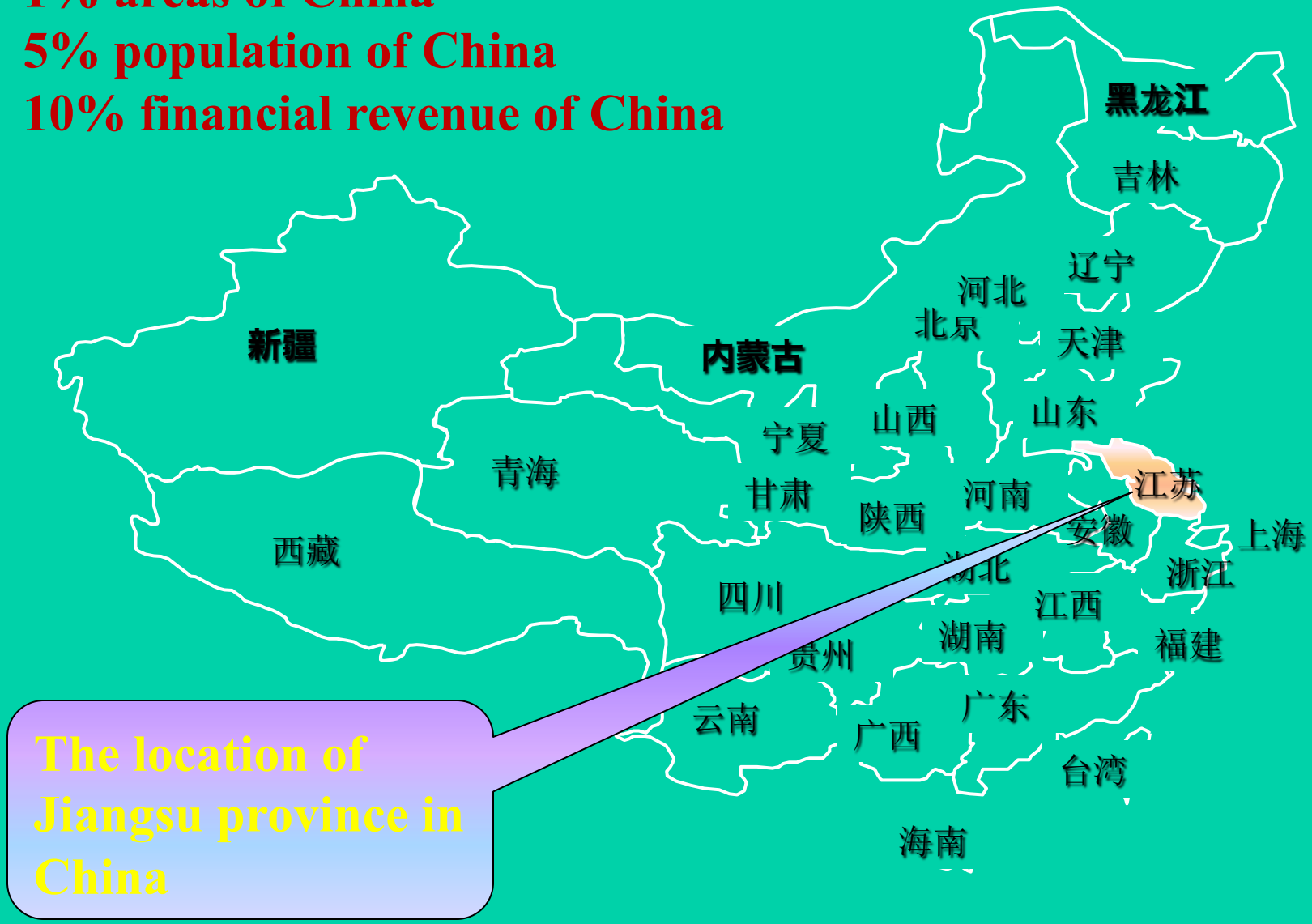
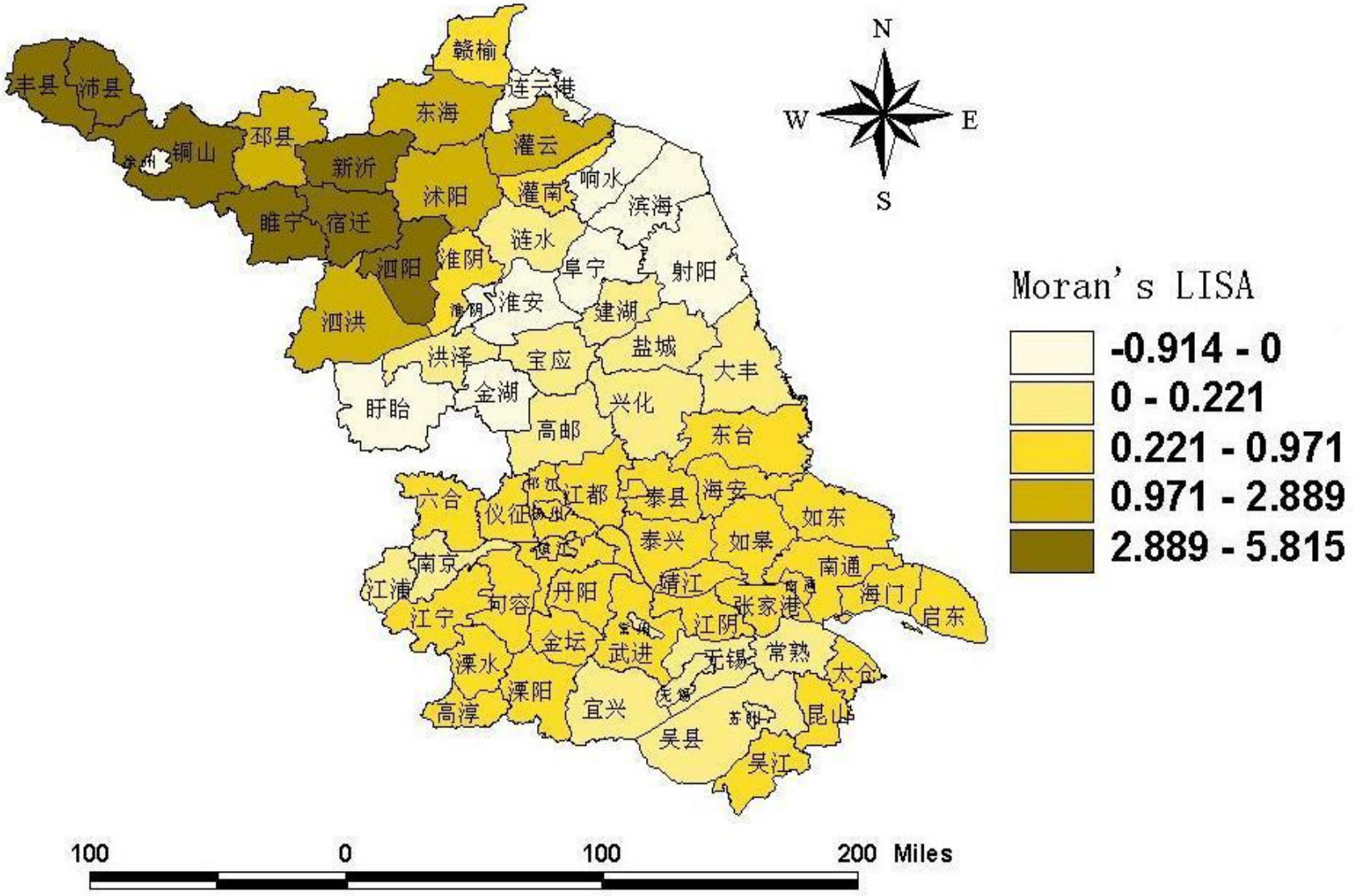
1% areas of China
5% population of China
10% financial revenue of China



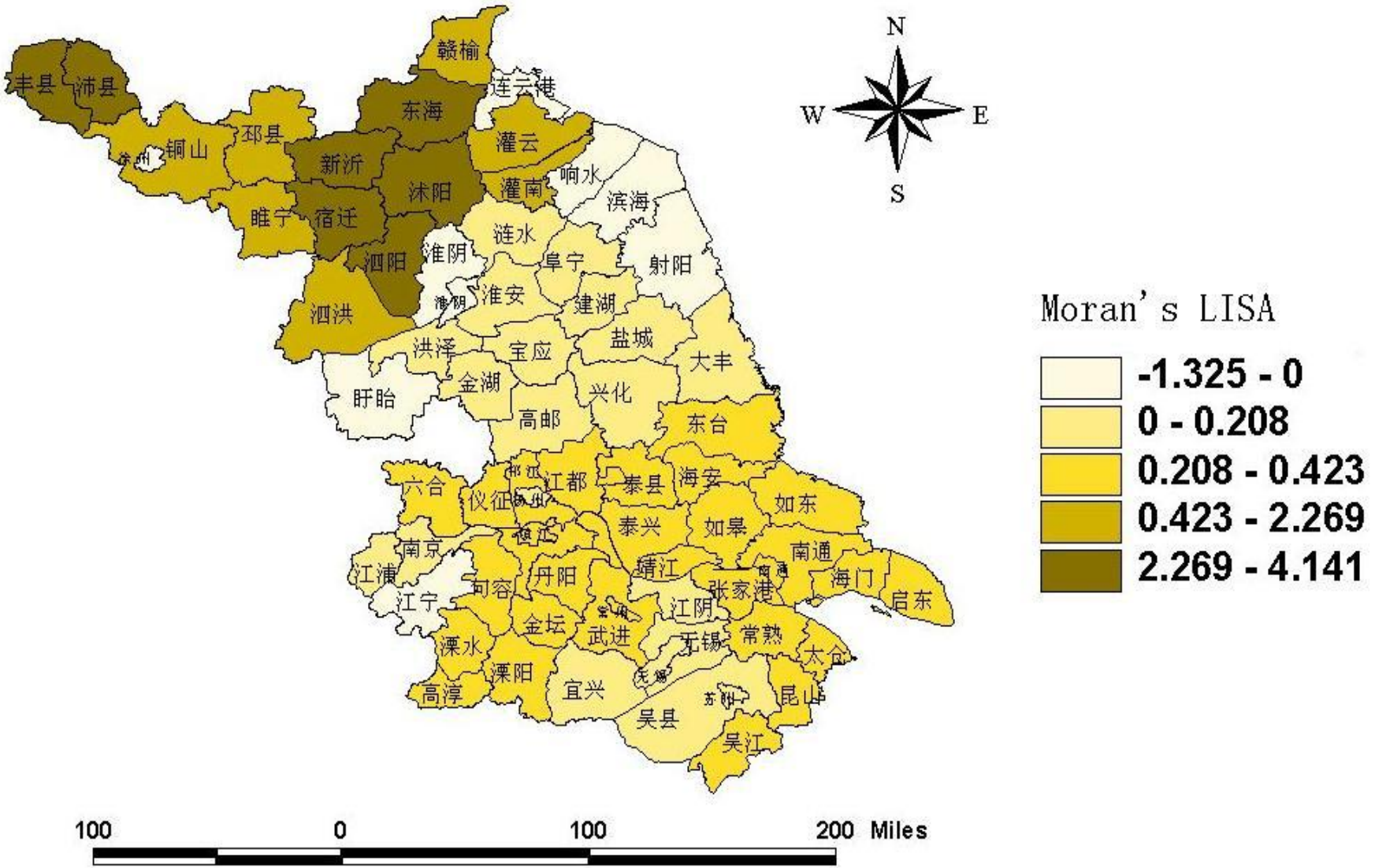
Endemic Fluorosis

Jiangsu Province:

In Jiangsu Province there is only one type of endemic fluorosis and that is caused by high level fluoride in drinking water



The distribution of the fluoride level (mg/L) in Jiangsu Province (the map of Moran's LISA)



The distribution of the prevalence of dental fluorosis in Jiangsu Province (the map of Moran's LISA)

Endemic Fluorosis

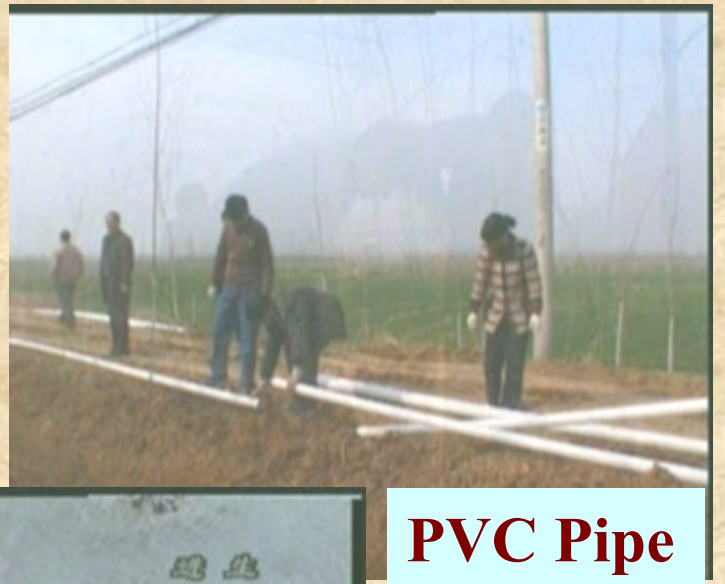
There are 2026 villages with endemic fluorosis (236 severe, 298 moderate, 992 mild), the population in the endemic fluorosis were 3.66 million. The average prevalence of dental fluorosis in these areas was 66.76%, estimated cases of skeletal fluorosis were about 0.2 million.

Endemic Fluorosis

Since 1996, about 95% endemic fluorosis villages have had defluoridation projects which provide (use deep underground water or surface water) tap water with low fluoride level (<1.0mg/L) for the residents.

Endemic Fluorosis

Hydria



PVC Pipe

water tap

Endemic Fluorosis

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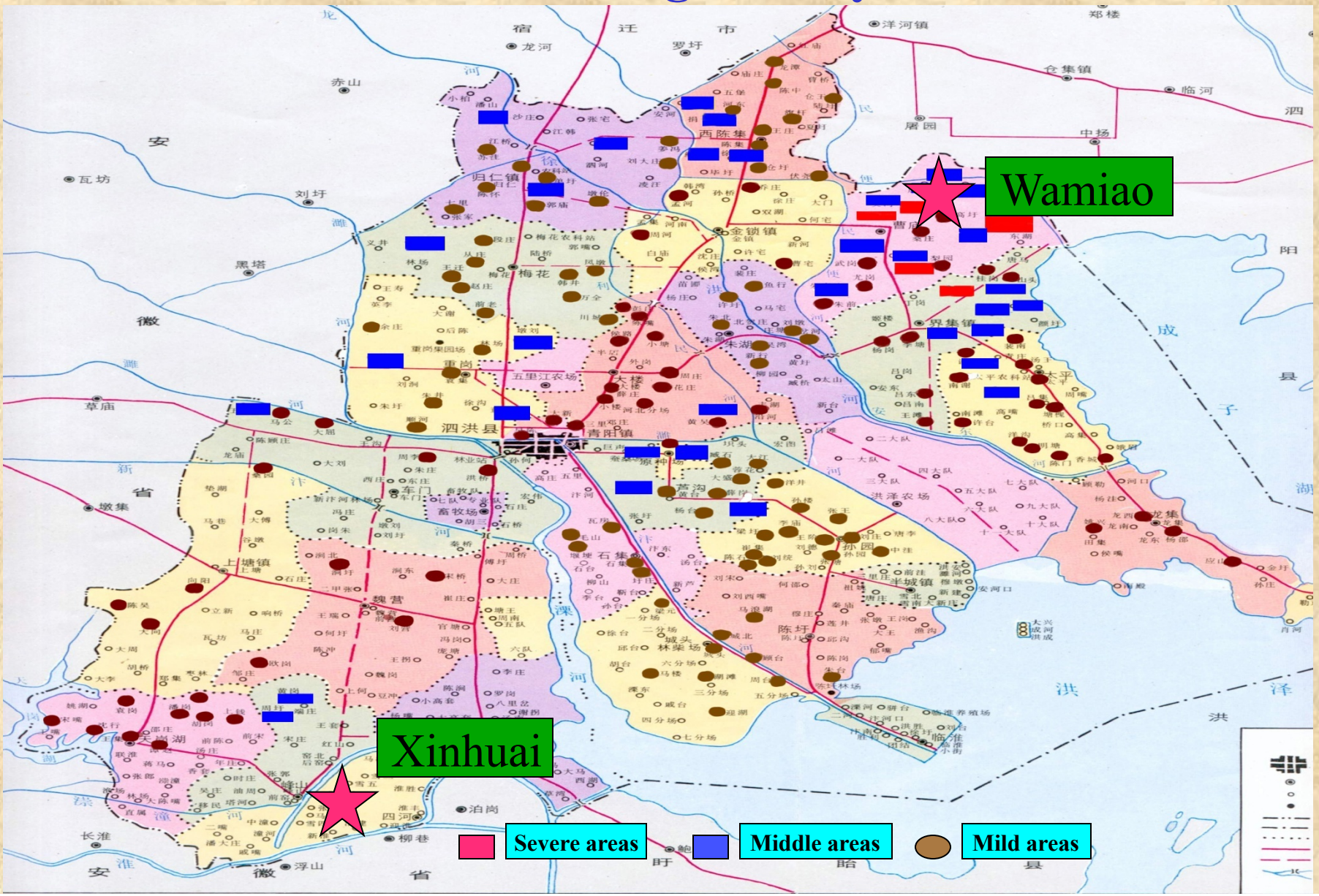
Research work in Jiangsu CDC

- Risk assessment of the fluoride in environment on resident's health
- Assessment of the effect of defluoridation projects
- Study on the damage mechanism of fluoride on nervous system (with Zhejiang Normal University)
- Technology of the defluoridation
- and others

Fluoride and Childrens' IQ

The distribution of endemic fluorosis areas in Sihong County



Material and Methods

- In Wamiao 93% of children (222 out of 238) were included for the study, while in Xinhuai, 95% were included (290 out of 305).
- Children who had been absent from either village for two years or longer, or who had a history of brain disease or head injury, were excluded.

Household shallowwell

Material and Methods

- The children in Wamiao were divided into five subgroups according to the level of fluoride in their drinking water: <1.0 mg/L (group A), 1.0–1.9 (B), 2.0–2.9 (C), 3.0–3.9 (D), >3.9(E), while those in Xinhuai were considered as a single group (F).

Material and Methods

- The Combined Raven's Test for Rural China (CRT-RC) was used to measure the children's IQ, published by Huadong Normal University

Material and Methods

- The scores for IQ in the CRT-RC were ranked as: mental retardation (IQ <70), borderline (IQ 70–79), dull normal (IQ 80–89), normal (IQ 90–109), bright normal (IQ 110–119), superior (IQ120–129), and very superior (IQ >129).

Results and Discussion

Table 1 Level of fluoride in drinking water in Wamiao and Xinhuai

Village	No. samples	Fluoride in drinking water（mg/L）		t	*p*
		Mean ±S.D	Range		
Wamiao	222	2.47±0.79	0.57 — 4.50	44.97	<0.001
Xinhuai	290	0.36±0.15	0.18 — 0.76		

Table 2 Level of fluoride in urine, in mg F/L, in Wamiao and Xinhuai

Village	No.samples	Urinary fluoride (mg/L)		t	*p*
		Mean±S.D.	Range		
Wamiao	155	3.47±1.95	0.90 — 12.50	13.82	<0.001
Xinhuai	135	1.11±0.39	0.37 — 2.50		

Results and Discussion

Table 3. Ratio of urinary fluoride to creatinine in children in Wamiao and Xinhuai

Village	No.samples	Urinary fluoride/Cre (mg F/mmol Cre)		t	*p*
		Mean±SD	Range		
Wamiao	155	0.82±0.75	0.13 — 4.69	8.96	<0.001
Xinhuai	135	0.24±0.10	0.09 — 0.71		

Results and Discussion

Table 4. Children's IQ in Wamiao and Xinhuai

Village	male		female		total		
	N	Mean±SD	N	Mean±SD	N	Mean±SD	Range
Wamiao	122	94.73±13.09	100	88.72±12.16*	222	92.02±13.00	54-126
Xinhuai	159	100.69±13.52#	131	100.08±12.87#	290	100.41±13.21#	60-128

*P <0.01 compared with male data of Wamiao village.

#P< 0.01 compared with Wamiao village.

Results and Discussion

Table 5. IQ distribution of children in Wamiao and Xinhuai

IQ	Wamiao				Xinhuai			
	Male	Female	Total	(%)	Male	Female	Total	(%)
130 or higher	0	0	0	(0)	0	0	0	(0)
120-129	5	0	5	(2.25)	11	3	14	(4.83)
110-119	9	4	13	(5.86)	38	28	66	(22.76)
90-109	62	43	105	(47.30)	75	75	150	(51.72)
80-89	31	34	65	(29.28)	25	17	42	(14.48)
70-79	12	14	26	(11.71)	9	4	13	(4.48)
69 or lower	3	5	8	(3.60)	1	4	5	(1.72)
Total	122	100	222	(100)	159	131	290	(100)

Results and Discussion

Table 6. Level of fluoride in drinking water and children's IQs

Village & Group	Fluoride in drinking water (mg/L)		IQ and the rate of retardation		
	No. samples	Water fluoride level (Mean±SD)	No. children	IQ (Mean±SD)	Rate of IQ<80 (%)
Xinhuai					
F	290	0.36±0.15	290	100.41±13.21	6.55
Wamiao					
A	9	0.75±0.14	9	99.56±14.13	0.00
B	42	1.53±0.27	42	95.21±12.22*	9.52
C	111	2.46±0.30	111	92.19±12.98**	14.41*
D	52	3.28±0.25	52	89.88±11.98**	21.15 **
E	8	4.16±0.22	8	78.38±12.68**	37.50 **

* $P<0.05$, ** $P<0.01$ compared with the group F.

Results and Discussion

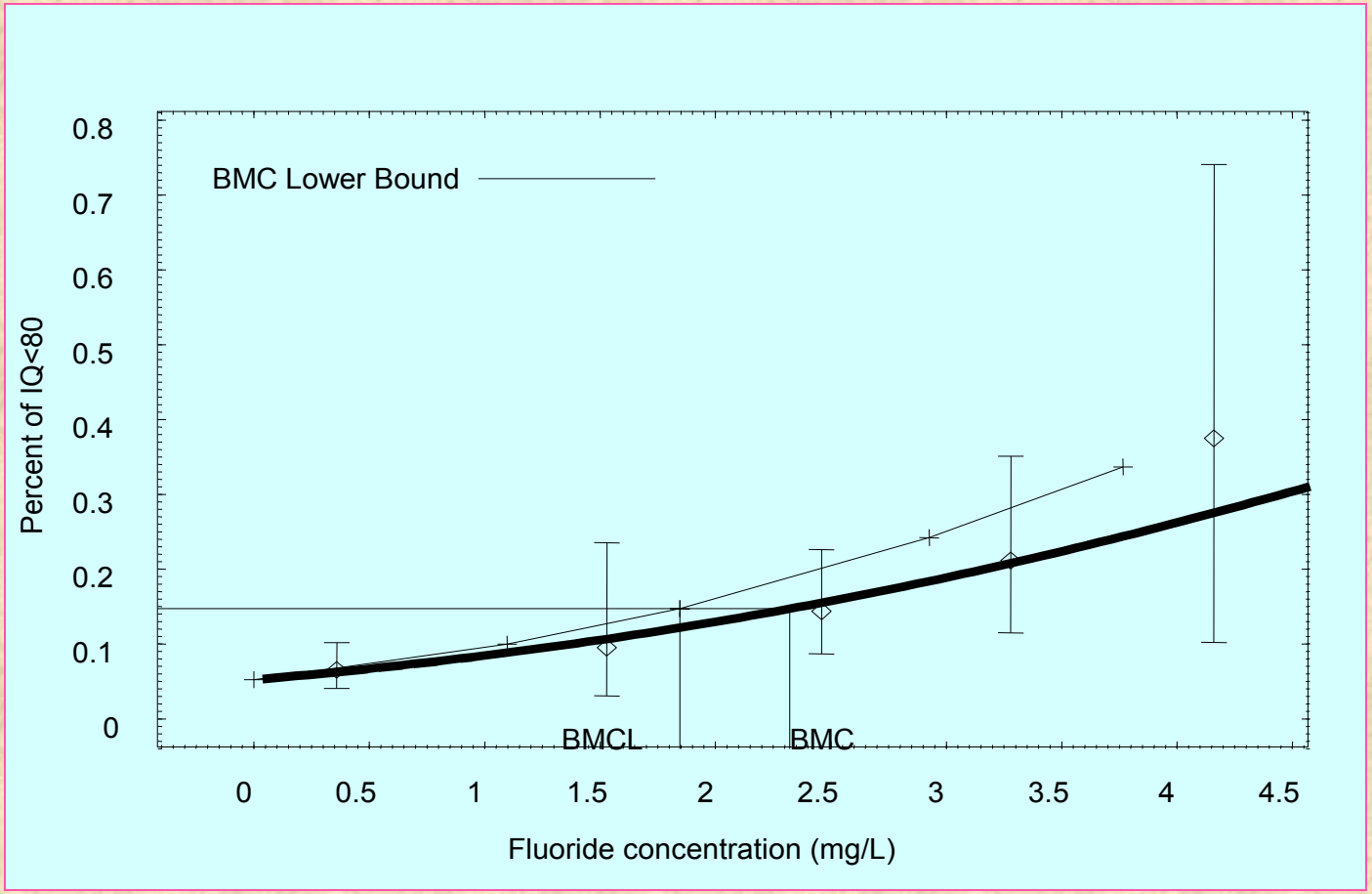


Figure 1 Concentration-response relationship between an IQ<80 score and the level of fluoride in drinking water.

Results and Discussion

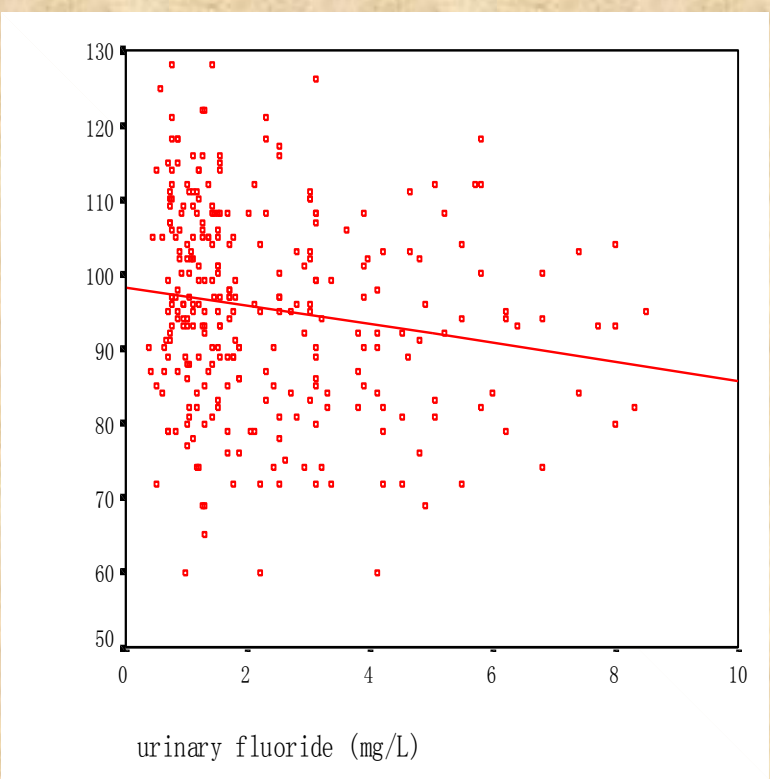


Figure 2. Correlation between urinary fluoride (directly measured) and IQ

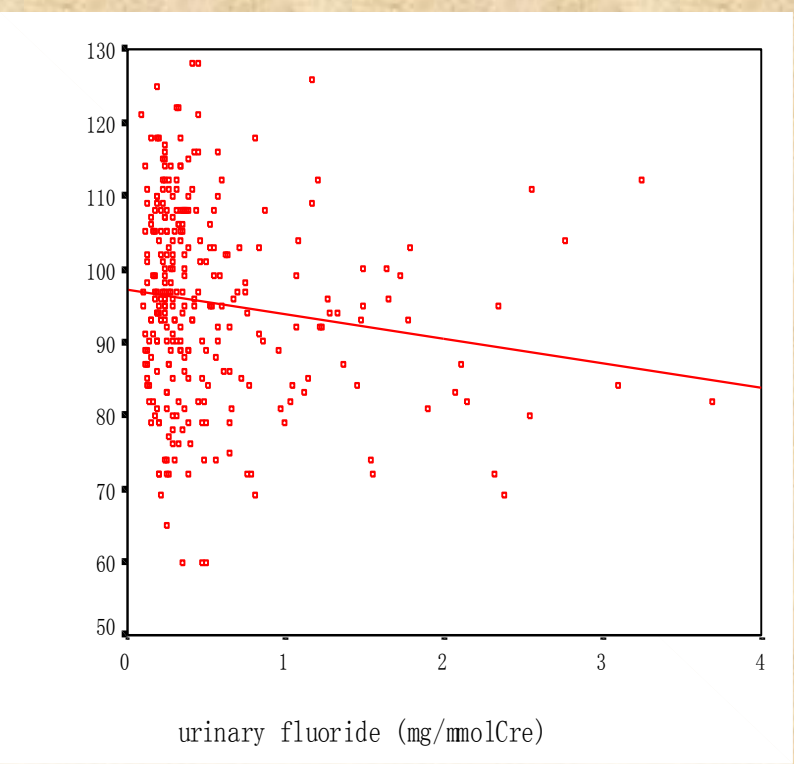


Figure 3. Correlation between urinary fluoride (creatinine-adjusted) and IQ

Results and Discussion

Table 7. Fluoride in drinking water and in urine (Mean±SD)

No. Samples	Fluoride in drinking water (mg/L)	Urinary fluoride	
		mg/L	mg/mmolCre
142	0.39±0.15	1.14±0.49	0.25±0.22
32	1.15±0.29	2.59±1.70	0.61±0.47
80	2.44±0.30	3.67±1.97	0.85±0.67
32	3.22±0.18	3.77±1.86	0.86±0.81
4	4.05±0.01	4.65±2.39	2.17±1.73

Pearson correlation coefficients were 0.653 and 0.503 respectively, $p<0.001$)

Results and Discussion

Table 8. Mean IQ of children and family income in Wamiao and Xinhuai

Family income (yuan/yr)	Wamiao		Xinhuai	
	No. children	IQ(Mean±SD)	No. children	IQ(Mean±SD)
1000 or below	42	93.88±12.04	40	99.45±11.82
1001-2000	128	91.73±12.41	173	100.54±13.23
2001-3000	39	93.36±15.24	59	100.34±14.39
over 3000	13	84.85±13.37	18	101.61±12.88
Total	222	92.02±13.00	290	100.41±13.21

There were no significant relationships in both Wamiao and Xinhuai village (Pearson correlation coefficients: –0.096 and 0.027, respectively, $p>0.05$).

Results and Discussion

Table 9. Mean IQ and education level of parents in Wamiao and Xinhuai

Parents education level	Wamiao		Xinhuai	
	No. children	IQ (Mean±SD)	No. children	IQ (Mean±SD)
Primary school and below	74	93.26±12.69	38	103.50±11.72
Junior high school	118	92.16±12.59	131	100.09±13.19
Senior high school and above	30	88.43±15.05	121	99.79±13.64

No significant relationships were present between the children's IQ and education level of parents, in both Wamiao and Xinhuai village (Pearson correlation coefficient: –0.119 and 0.113, respectively, $p>0.05$)

Results and Discussion

Table 10. Urinary iodine in children in Wamiao and Xinhuai

Village	No. samples	Urinary iodine (μg/L)		t	*p*
		Mean±SD	Range		
Wamiao	46	280.70±87.16	131.31 – 497.05	1.04	>0.3
Xinhuai	40	300.96±92.88	148.46 – 460.89		

Table 11. Ratio of urinary iodine to creatinine in children in Wamiao and Xinhuai

Village	No. samples	Urinary iodine/Cre (μg l/mmol Cre)		t	*p*
		Mean±SD	Range		
Wamiao	46	93.24±46.86	36.86 – 251.03	1.07	>0.28
Xinhuai	40	81.27±55.91	22.76 – 298.74		

Results and Discussion

Table. Blood lead levels of children in Wamiao and Xinhuai village

Village	No. Samples	Blood lead (μg/L)		t	*p*
		Mean±SD	Range		
Wamiao	71	21.95±13.65	1.36-54.96	0.698	>0.48
Xinhuai	67	23.61±14.17	1.36-61.12		

Results and Discussion

- There were significant concentration-response relationship between the level of fluoride in drinking water and the children's IQ. As the fluoride level in drinking water increased the IQ fell and the rates of mental retardation and borderline intelligence increased.

Results and Discussion

- The BMD of 2.32 mg F/L and the BMDL of 1.85 mg F/L were calculated from the dose – response relationship between the levels of fluoride in drinking water and the rates of mental retardation (IQ<70) and borderline intelligence (IQ between 70-79).

Results and Discussion

- Reference value dose (RfD) is modeled after the equation

  RfD = BMDL/UF*MF

- If the UF and MF were both set at 1.

  RfD = 1.85 mg/L

- The UF could be set at 2.

  RfD = 0.925 mg/L

Results and Discussion

- No significant differences were found between the two village in the levels of iodine in the urine and lead in blood of the children.
- Thus urinary iodine and blood lead levels do not appear to affect the differences in IQ in children between the two villages.

Results and Discussion

- We also found there are not significant relationship between the age and IQ and the parents education levels and IQ.

The level of fluoride and IQ in different group by dental fluorosis

Group	No.	Water F	IQ	Urine F	Serum F
0	301	0.50±0.53	99.76±3.50	1.13±0.71	0.044±0.017
1	65	1.88±1.07	94.18±13.77	2.70±1.15	0.071±0.023
2	59	2.44±0.66	93.27±13.10	3.69±1.61	0.082±0.016
3	63	2.67±0.63	91.51±12.84	3.85±1.79	0.085±0.019
4	24	2.89±0.81	95.33±14.64	3.81±1.80	0.084±0.018

We are doing now

- The follow-up for research children in two villages
- Investigate the dental fluorosis, Urine F, Serum F, IQ, and so on for the children in these two villages who burn after the drinking water changed for the low level of fluoride(<1.0mg/L)

Thank You !