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The relationship between dental caries experience and fluoride concentration of drinking water in Mongolian children

Baek-Il Kim, Young-Nam Kim[1], Ho-Keun Kwon
Department of Preventive Dentistry and Public Oral Health, Yonsei University
[1]Department of Dental Hygiene, Yonsei University

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1. Introduction

Widespread use of fluoride has been a major factor in the decline in the prevalence and severity of dental caries in the world. When used appropriately, fluoride is both safe and effective in preventing and controlling dental caries[1]. Many epidemiologic studies showed that drinking water fluoride concentration in the amount of 1 ppm provided dramatic reduction in tooth decay with none of the cosmetically disfiguring side effects of enamel fluorosis[2]. The frequent exposure to small amount of fluoride each day will best reduce the risk for dental caries. As this point, water fluoridation program was the best way to control the dental caries with community base. But fluoridation of drinking water has been a subject of controversy for decades.

Anti-fluoridationists, opponents of water fluoridation, have taken their arguments against fluoridation. Those who oppose water fluoridation claim that ingestion of fluoride can lead to a variety of unwanted side effects as like cancer, hip bone fracture, dental fluorosis and renal toxicity[3]. And another claim were that dental caries was declining without water fluoridation and the effect of water fluoridation was overestimated. Korea also has very strong anti-fluoridationists group.

Address : Ho-Keun Kwon, Department of Preventive and Public Health Dentistry, College of Dentistry, Yonsei University, 134 Shinchon, Seodaemun-Gu, Seoul, Korea
Phone : 02-361-8050 E-Mail : yspd8050@yumc.yonsei.ac.kr

They also insisted water fluoridation is not effective to prevent dental caries. So we need to reevaluate the effect of water fluoridation. At this view point, Mongolia is a good place to evaluate the water fluoridation. At lots of area in Mongolia, drinking water contains the natural fluoride ion. Mongolian has lived with simple life style. Food intake patterns are simple and Mongolian intake less sugar compared with other country people[4].

Dental caries is multifactorial disease and is strongly affected from the food intake pattern. Simple food intake pattern and simple life style can reduce the effect of extraneous variables in carring out this study. Mongolian has the same ethnic origin with Korea. This can reduce the biologic difference in comparing the dental caries experience with two countries.

The purpose of this study is to reevaluate caries prevention effect of fluoridation. First, this study was to investigate the relation with dental caries experience of Mongolian children and fluoride concentration in drinking water.

Second, this study was to investigate the relation with fluorosis prevalence and fluoride concentration in drinking water in Mongolia.

2. Materials and methods

We selected five cities in Mongolia for this study. Ulanbaator, the capital of Mongolia (population: 846,000), Selenge(population: 102,000) and Khovd (population: 88,000) are major cities in Mongolia. And we selected Sainshand and Choibalsan area due to high fluoride concentration of drinking water. Seven schools were selected by the convenience cluster sampling method from the five cities in 2002. Total 2133 school children aged 7~14-year-old were recruited as the subjects.

Clinical examinations were conducted by two Mongolian and three Korean dental examiners in a standardized manner using dental mirrors. Caries examinations of permanent teeth were completed using WHO caries diagnostic criterions. Radiographs were not used. Oral hygiene was assessed using the simplified Oral Hygiene Index. Before the clinical examinations were conducted, the calibration training was performed to increase the reliability of the measurements. Dental caries calibration resulted in Kappa values of interexaminer agreement was 0.8.

We used Dean' s diagnosis criterion for dental fluorosis. This diagnosis criterion was composed of 0 to 4 scales. we considered dental fluorosis as over 1 point in this criterion.

Drinking water samples in each city were collected in polyethylene tube for the analysis of fluoride concentration. It was analyzed with ionizer-meter(Orion Research, Model 940) equipped with the fluoride electrode (Orion Research, Model 96-09) by use of direct measurement[5].

Data were cleaned and analyzed by personal computer using SAS Version 8.1 (SAS Institute Inc., Cary, U.S.A.). Frequency distributions were generated, and ANOVA was used to test for statistically significant differences between subgroups.

Table 1. Subject distribution and fluoride concentration of each areas by age

Age	Sainshand (3.60 ppm)	Choibalsan (0.96 ppm)	Khovd (0.57 ppm)	Selenge (0.22 ppm)	Ulanbaator (0.13 ppm)
total	359	199	359	295	935
7	41	31	20	30	89
8	30	33	53	44	125
9	30	-	36	27	87
10	38	-	55	33	105
11	37	19	41	37	105
12	57	45	44	37	130
13	63	36	71	36	131
14	63	36	39	51	163

Table 2. DMFT index in studied cities by age (mean±SD)

Age	Sainshand	Choibalsan	Khovd	Selenge	Ulanbaator	p-value*
7	0.24±0.66	0.74±1.39	0.65±1.04	0.20±0.76	0.58±1.02	0.0841
8	0.60±1.30	0.55±0.90	0.66±1.18	0.82±1.21	0.76±1.16	0.8003
9	0.53±0.90	-	0.75±1.25	1.15±1.46	0.78±1.28	0.4191
10	1.37±1.91	-	1.02±1.37	1.48±1.58	1.14±1.41	0.5043
11	0.57±1.09	0.89±1.10	1.44±1.82	1.46±1.50	1.63±1.81	0.0109
12	1.26±1.43	2.24±1.57	1.30±1.50	1.24±1.30	1.79±2.19	0.1627
13	2.44±2.19	1.53±1.96	1.13±1.46	2.53±1.80	2.33±2.34	0.0002
14	2.02±2.02	1.56±2.21	1.21±1.44	2.84±2.34	2.56±2.07	0.0002

*ANOVA test

3. Results

As the results of analyzing the drinking water samples in studied cities, in the fluoride concentration of drinding water, Sainshand was the highest(3.60 ppm) and Ulanbaator was the lowest(0.13 ppm). And the fluoride concentration of Choibalsan, Khovd, Selenge was 0.96 ppm, 0.57 ppm, and 0.22 ppm respectively.

Table 1 shows the subject distribution by age and fluoride concentration of each city. The subject nember of Ulanbaator city was the largest number of children because we selected 3 schools in Ulanbaator city. And the subject nember of Choibalsan was the smallest. In 9 and 10-year-old students of Choibalsan, numbers of subjects were too small and we excluded the data in analysis.

Table 2 shows the result of DMFT index of studied cities. DMFT index of groups aged 11, 13 and 14-year-old showed statistically significant difference among cities(ANOVA, $p < 0.05$). We used Duncan test as multiple comparison. In 11-year-old children, Sainshand(0.57) and Ulanbaator (1.63) showed the difference. In 13-year-old children, DMFT index of Khovd(1.13) showed statistical difference with Ulanbaator(2.33), Sainshand(2.44) and Selenge(2.53). In DMF index of 14-year-old children, Khovd(1.21) showed statistical difference with Selenge(2.84) and Ulanbaator(2.56). And Choibalsan(1.56) and Selenge(2.84) also showed statistical difference.

Table 3 presents the prevalence of dental caries

Table 3. Dental caries prevalence in the studied cities by age (%)

AgeSainshand	Choibalsan	Khovd	Selenge	Ulanbaator	
7	14.63	29.03	35.00	10.00	32.58
8	23.33	33.33	32.08	45.45	37.60
9	30.00	-	33.33	48.15	35.63
10	42.11	-	49.09	60.61	50.48
11	29.73	47.37	48.78	56.76	60.00
12	57.89	53.33	54.55	67.57	63.85
13	74.60	52.78	47.89	80.56	73.28
14	66.67	50.00	53.85	82.35	76.07

Table 4. Prevalence of dental fluorosis in the studied cities by age (%)

Age	Sainshand	Choibalsan	Khovd	Selenge	Ulanbaator
10	26.32	-	3.64	6.06	1.90
11	27.03	5.26	0.00	5.41	1.90
12	0.00	0.00	2.27	0.00	0.00
13	11.11	5.56	4.23	0.00	3.82
14	49.21	2.78	10.26	5.88	2.45

in studied cities. In dental caries prevalence of 12 ~14-year-old children, Selenge area was the highest. On the other hand, Choibalsan and Khovd were low. It was might due to optimal range of fluoride concentration.

Table 4 shows the prevalence of dental fluorosis of studied cities. Also Sainshand was likely to be the highest prevalence of dental fluorosis because of high fluoride of drinking water. Especially prevalence of dental fluorosis in 14-year-old children in Sainshand was very high(49.21%).

4. Discussion

The first community water fluoridation became in Grand Rapids in 1945 and was followed by large scale studies to evaluate effects of this program. Water fluoridation studies at Evanston in Illinois, Newberg in New York, and Brandford in Ontario showed similar reduction ranging from 48 to 70 percent. To date, progress reports on caries-preventive effects due to water fluoridation are available from 21 countries[6].

The findings of 97 studies in these countries showed that optimal water fluoridation program is highly effective. As measures in 57 of these studies, the most frequently observed reduction in the prevalence of dental caries in primary teeth range from 40 to 50%. Among the 72 studies that measured protection in permanent teeth, the most frequently observed range of protection rate was between 50% and 60%[7-9].

But the recently, dental caries reduction rate of water fluoridation were decreased to 30% or less. This phenomenon was due to dilution and diffusion effect[3]. The wide use of fluoride products can mask the dental caries reduction effect of water fluoridation. So in developed countries, we cannot estimate the real effect of water fluoridation. We thought that the Mongolia is a

good place to study the fluoride effect in drinking water. Water in Mongolia contained a variety of amount natural fluoride ion. But fluoride products are not used widely in Mongolia compared with developed countries.

Also food intake pattern of Mongolia is simple and sugar consumption is less. This kind of life style can reduce the extraneous variable effect of fluoride study in drinking water.

In this study, we selected Ulanbaator city and 4 cities. These cities were representative cities in Mongolia. Choibalsan was located in east of Mongolia. Sainshand was located in south of Mongolia. Selenge was located in north of Mongolia. Khovd was located in west of Mongolia. Especially in Sainshand, there was very high fluoride concentration of drinking water(3.60 ppm). On the other hand, in Choibalsan, there was optimal fluoride concentration(0.96 ppm).

It has been stated that the range of fluoride concentration of community water supply sufficient to protect against caries is from 0.7 ppm to 1.0 ppm[10]. In Choibalsan, fluoride concentration of drinking water was 0.96 ppm. It was in the optimal range of fluoride concentration. Khovd(0.57 ppm) also showed very close to optimal range of fluoride concentration. DMFT index of this area was lower than the other areas($p < 0.05$).

Driscoll et al.[11] found that too higher fluoride concentration than optimal levels of fluoride in the drinking water may diminish the caries protection effect. Akpata et al.[12] found that there were higher caries experience in some African population exposed to higher fluoride in drinking water. In our studies, Sainshand area was 3.5 ppm of fluoride concentration in drinking water and it was higher than the optimal level. This area showed much higher dental fluorosis prevalence than other areas except for 12-year-old children. Fluorosis prevalence(0%) of 12-year-old might be due to inter-examiner error between questionable and mild fluorosis. Though this inconsistency, fluorosis prevalence of this area tended to be high and also DMFT index of this area was slightly higher than other areas. This result is the same as Akpata[12] that insisted that very high concentration of fluoride can reduced dental caries prevention effect.

Therefore the optimal fluoride concentration is very important for water fluoridation[2]. From this study result, we found that optimal fluoride concentration did not increase the fluorosis but reduce the caries prevalence.

5. Conclusion

The purpose of this study is to reevaluate the caries prevention effect of fluoridation. For this, we selected Ulanbaator city and 4 cities of representatives in Mongolia. Total 2133 of 7~14-year-old schoolchildren were recruited for this study. Caries examinations of permanent teeth were conducted using WHO caries diagnostic criterions and we used Dean's diagnosis criteria for dental fluorosis. The obtained results were as follows:

1. In the optimal fluoride concentration cities(Choibalsan: 0.96 ppm and Khovd: 0.57 ppm), 13, 14-year-old children group showed

statistically significant lower DMFT index than in low fluoride concentration cities(Selenge: 0.22 ppm and Ulanbaator: 0.13 ppm) children($p < 0.01$). But the prevalence of dental fluorosis is similar to those of low fluoride concentration cities.

2. In high fluoride concentration city(Sainshand: 3.6 ppm), children showed high dental fluorosis rate.
3. Higher fluoride concentration level in drinking water than optimal level can reduce the caries prevention effect.

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국문초록

몽골 아동의 치아우식경험도와 음용수내 불소농도와의 관련성

김백일, 김영남[1], 권호근
연세대학교 치과대학 예방치과학교실
[1]연세대학교 원주의과대학 치위생학과

색인어: 몽골, 불소, 아동, 음용수, 치아우식증

본 연구의 목적은 음용수내 함유된 불소의 치아우식 예방효과를 재평가하고자 하는 것이다. 이를 위하여 몽골 어린이의 치아우식경험도와 음용수 내 불소 농도의 관련성에 대하여 조사하였고 치아불소증 유병률도 함께 조사하였다. 저자들은 이를 위해 몽골을 대표할 수 있는 울란바타르시와 다른 4개 도시들을 선정하였고, 총 2,133명(7-14세)의 학생들을 조사하였다. 영구치 치아우식증과 치아불소증에 대한 조사는 각각 WHO 치아우식증 진단 기준과 Dean의 치아불소증지수를 사용하여 시행하였으며 얻어진 결과는 다음과 같다:

1. 최적의 음용수 내 불소 농도를 보이는 도시(Choibalsan: 0.96 ppm과 Khovd: 0.57 ppm)에 사는 13, 14세의 어린이의 DMFT index는 낮은 불소 농도의 도시(Selenge: 0.22 ppm와 Ulanbaator: 0.13 ppm)에 사는 어린이들보다 통계학적으로 유의하게 낮았다($p < 0.01$). 그러나 치아불소증 발생률은 낮은 불소농도의 도시와 비슷하였다.
2. 음용수 내 불소농도가 높은 도시(Sainshand: 3.60 ppm)에 사는 어린이들은 다른 도시보다 더 높은 치아불소증유병률을 나타냈다.
3. 음용수 내 불소농도가 최적의 수준보다 과다하게 높은 경우 오히려 치아우식예방효과를 감소시켰다.