DIETARY FLUORIDE INTAKE OF CHILDREN AGED 3-7 YEARS IN REMOTE AREAS OF THAILAND

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Abstract. The objectives of this study were to measure dietary fluoride intake in children aged 3-7 years, to correlate dietary fluoride and fluoride content in water for used in schools and to estimate fluoride gained from the daily diet. Fifty food samples were collected in 45 schools under the jurisdietion of the Border Patrol Police Department. The schools were sampled by multiple stratified cluster random sampling. The food samples were weighed, then measured for fluoride content by a micro-diffusion method. Statistical analysis was conducted using the Kruskal-Wallis test. Dietary fluoride in each age group was compared by Student's *t* test. Analysis for the relationship between dietary fluoride and fluoride content in water was done using Kendall's tau-b. Our results showed that mean of dietary fluoride in lunce was 0.08 ± 0.1 ppm. There were no differences when comparing dietary fluoride between different regions of Thailand ($p = 0.07$). No correlation was found between dietary fluoride and fluoride content in water used in different schools ($r_\tau = 0.017$, $p = 0.85$). The daily dietary fluoride intake in children aged 3-6 years was 0.002-0.004 mgF/kg BW/day, in children aged 7 years was 0.003-0.004 mgF/kg BW/day in boys and 0.002-0.004 mgF/kg BW/day in girls.

INTRODUCTION

Fluoride supplement is a measure to prevent dental caries. In cases where fluoride content in water was less than 0.6 ppm, fluoride supplement is recommended. In order to prevent fluoride toxicity, the dosage depends upon age and the fluoride content of the water (AAPD, 1999-2000). In addition to fluoride from water, we also gain fluoride from food, such as seafood, fish and chicken. Dry seafood had fluoride as high as 290 ppm, cooked fish 40 ppm, chicken 0.6-10.6 ppm. These foods had high fluoride due to the presence of bone which contains high fluoride. Dry tea has 400 ppm fluoride. Tea prepared with deionized water has fluoride 0.1-4.2 ppm (Levy *et al*, 1995). In Thailand, there are few data on dietary fluoride. In 1974, there was a study about fluoride content in various vegetables, which ranged from 0.1-0.6 ppm. Chinese cabbage contains the highest fluoride (Kridakorn *et al*, 1974). Phathumvanit *et al* (1987) estimated dietary fluoride in children 4-6 months of age by measuring fluoride in each kind of food, and then calculated the daily gain. It was estimated that children gain fluoride from food about 0.02 mgF/kg BW/day. They concluded that children gain very little fluoride from food and a fluoride supplement should be given in a case of water with a fluoride content less than 0.3 ppm. Nowadays we have changed the age at which we start giving fluoride supplement. Fluoride is given when children are 6 months old and are categorized into 3 groups: 6 months-3 years, 3-6 years, 6-16 years (AAPD, 1999-2000). The age at risk of dental fluorosis is 2-8 years (Burt, 1992). Data regarding fluoride content in food of children at risk for dental fluorosis in Thailand have never been reported.

It is more difficult for children in remote areas along the borders of Thailand to receive continuous dental services than children in urban areas. Prevention of dental caries is the most important. Schools in remote areas of Thailand are under the jurisdiction for Border Patrol Police Department, usually known as Border Patrol Police Schools. These schools are centers for education, so planning of dental services needs baseline data of the children in these schools. Children aged between 3-6 years usually attend a kindergarten, and children 7 years and over attend a primary school. The schools usually provide lunch for children under the Agricultural for School Lunch Program. Under this project, teachers and students grow plants and raise animals and use these products to prepare nutritionaly rich food for their

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lunch. Therefore, lunch is usually the most important meal for these children. Studying the fluoride content in their lunches can provide important baseline information for planning preventive dental measures by fluoride supplement.

The objectives of this study were to measure dietary fluoride intake of children aged 3-7 years in Border Patrol Police Schools, to correlate dietary fluoride and fluoride content in water use in these schools and to estimate daily dietary fluoride intake.

MATERIALS AND METHODS

Sampling of food

Lunches for children aged 3-7 years old who attended schools in remote areas of Thailand were collected during 19 July - 8 October 1999. Forty-eight schools were selected for this study by a multiple stratified cluster random sampling method. These schools are under the jurisdiction of the Border Patrol Police Department. Their lunches are provided by the Agriculture for school lunch program. Lunches intake of children at school were weighed. All kinds of food were collected in plastic containers and kept in an ice box and then transfered to a freezer at -80ºC until analysis.

Measurement of dietary fluoride

After the food was left at room temperature and weighed. Fifteen ml of deionized water was added, then grounded. The total fluoride in 2 g of ground food was measured by the microdiffusion method of Taves (1968) as described in Chuckpaivong *et al* (2000). Each sample was measured 4 times. Efficiency of measurement was evaluated by using reverse extraction at standard fluoride solution at a concentration of 0.1 and 1 ppm. Fluoride content per 1 g of food was calculated from the measured fluoride.

Estimation of fluoride per body weight of children

Children were usually weighed 3 times annually. Teachers did the weight measurement and evaluated whether the children had standard or understandard weight by comparison with standards of Thai people aged 1 day-19 years. These standards were prepared by the Department of Health, Ministry of Public Health, in 1987. We used the weight of children in 1999 to calculate the mean percentage of children that had weights in the standard range of kindergarten children whose age was 3-6 years and of children in the 1st year of primary school whose age was 7 years old. Since we found that 92.3% of children in kindergarten and 90.8% of 1st year primary school students had normal weight as indicated in Table 2, so we used the standard weight of Thai children for estimation of daily dietary fluoride intake per body weight in to calculate fluoride intake by the formula.

$$\frac{\text{Amount of lunch taken (g) x 3 x fluoride content in 1 g of food}}{\text{standard weight of each age group}}$$

Statistical analysis

The collected data were analyzed using Kruskal-Wallis test comparing dietary fluoride among regions. The comparison of dietary fluoride in each age group was undertaken using Student's *t*-test and Kendall's tau-b for analyzing the correlation between fluoride in food and water for use in the schools.

RESULTS

Since three schools did not provide lunch for students at the time we collected samples, we go only 50 samples from 45 schools. Fluoride content was ranged from 0.02 to 0.63 ppm with a mean of 0.08 ± 0.1 ppm were detected. When dietary fluoride in lunches of children in various regions, were compared, there were no statistical differences ($p = 0.07$) as shown in Table 1. No correlation was found between dietary fluoride and fluoride in water of the schools ($r_\tau = 0.017$, $p = 0.85$). In the same age group, boys had a significantly higher food intake than girls ($p = 0.01$, 0.02). Of young children attending kindergarten, boys had an average of 197.85 g of food intake and girls had an average of 174.17 g. In the first year of primary school, boys and girls had food average of 256.97 and 212.31 g respectively. Since fluoride gain per kg body weight from lunch can be calculated by assuming that each child had 3 meals per day we multiplied this value by 3 to estimate fluoride gained from food per 1 kg body weight per day. From our study, boys and girls attending kindergarten were estimated to gain 0.002-0.004 mgF/kg BW/day of fluoride from food. Boys and girls in the first year in primary school gained fluoride 0.003-0.004 and 0.002-0.004 mgF/kg BW/day from food respectively as shown in Table 2.

Table 1
Fluoride content of lunch and water for use at school in different region of remote areas.

Region	No. of food	Fluoride content in lunch (μgF/g)			Fluoride content in water for use[a] (school) (ppm)		
		Min	Max	Mean ± SD	Min	Max	Mean ± SD
Central and East	8	0.04	0.36	0.13 ± 0.11	0.02	0.87	0.22 ± 0.26
Northeast	12	0.03	0.63	0.11 ± 0.17	0.01	0.18	0.04 ± 0.04
North	11	0.03	0.11	0.05 ± 0.02	0.01	0.34	0.06 ± 0.04
South	19	0.02	0.30	0.08 ± 0.07	0.01	0.37	0.09 ± 0.12
Total	50	0.02	0.63	0.09 ± 0.10	0.01	0.87	0.10 ± 0.14

[a]Fluoride content of water for use in 45 schools are from our previous study (Chuckpaiwong *et al*, 2000).

Table 2
Estimation of fluoride intake /body weight/ day.

	Age (year)	
	Preschool children 3 - 6	School children (Grade1) 7
% of normal weight	92.3 ± 7.1	90.8 ± 9.6
Fluoride content (ppm or μg/g)	0.08 ± 0.09	0.09 ± 0.11
Standard of normal weight in Thai children (kg)		
Male	11.7 - 23.0	17.2 - 25.5
Female	11.3 - 23.1	17.0 - 25.4
Amount of food intake (g)		
Male (N)	197.85 ± 90.34(273)[a]	256.97 ± 109.26(113)[b]
Female (N)	174.17 ± 86.88(317)	221.31 ± 89.62(74)
Estimate of F^- intake (μgF/kg body weight/lunch)		
Male	0.69 - 1.35	0.91 - 1.34
Female	0.60 - 1.23	0.78 - 1.17
Estimate of F^- intake (μgF/kg body weight/day)		
Male	0.002 - 0.004	0.003 - 0.004
Female	0.002 - 0.004	0.002 - 0.004

[a,b]Significant difference ($p = 0.001, 0.02$).

DISCUSSION

We studied dietary fluoride of children aged 3-7 years old. This age limit was selected because children go to a kindergarten at the age of 3 years and the risk of dental fluorosis does not exceed 8 years (Burt, 1992). In addition, enamel formation of the incisors is completed by the age of 7 years (Fomon and Ekstand, 1996). Children were devided into 2 age groups: 3-6 years in kindergarten and 7 years in the 1st year of primary school in order to use the result for planning dental prevention. Most children in remote areas are from poor families, so lunches provided by schools are an important meal for every student. Therefore, we measured fluoride from lunches and estimated the dietary fluoride gain per day assuming that each child had 3 meals per day, which is the maximum daily intake since some children might have less than 3 meals per day.

Fluoride content in food on average was 0.08 ± 0.1 ppm which was considered very low. In addition, there were many differences among samples because food was collected from different sources and from different areas. We also studied the correlation between fluoride in food and in the

water for use at schools, since water was used for agricultural purposes and lunch preparation in the school. However, we found no correlation. Most of the food we collected for analysis were lunches of which rice was the main component. Other kinds of food eaten with rice were much different. Phatumvanit *et al* (1987) reported fluoride content in rice was 0.169 ppm. This was much higher than our study which measured fluoride content in the whole lunch comprising rice and accompanying dished. Our result differed from previous studies which measured the fluoride content in each kind of food. However, our study measured the actual amount of fluoride consumed in were 50 samples of lunches and used standard weight for calculation because about 90% of the children studied had normal weight.

We found that boys and girls aged 3-6 years gain equal fluoride, 0.002-0.004 mgF/kg BW/d. Boys and girls aged 7 years gain fluoride 0.003-0.004 and 0.002-0.004 mgF/kg BW/day, respectively. These levels were lower than the daily fluoride allowance gain fluoride by Burt (1992) which estimated children of 3, 4 and 6 years old in a range of 0.04-0.05, 0.05-0.06 and 0.03-0.05 mgF/kg BW/day respectively. There was no estimation for children aged 7 years old but children 8 years old should gain 0.03-0.05 mgF/kg BW/day, and then estimated the amount of food consumed in each age group which may be incorrect since different food were consumed. Our study showed that fluoride gain in these children was very little. However, the exact fluoride gain in these children might be less than the value we report because the study of Trautner and Siebert (1986), which measured blood fluoride after a meal, found that fluoride gain from a meal was very low, about 1-30% compared to sodium fluoride (NaF). In conclusion, the dietary fluoride intake of children aged 3-7 years was very small.

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