

Fluoride Intake in Korean Children Aged 3-6 Years by the Duplicate-Diet Technique

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Abstract

This study was conducted to determine the fluoride intakes in 120 preschool children aged 3-6 residing in Jumunjin (community water fluoridation area) and Kangnung (non-fluoridation area). The parents duplicated all the diets that their children ingested in a day. The acid-diffusible fluoride in the diet was isolated by the acid-diffusion technique and measured with a fluoride electrode. The mean daily fluoride intakes from all kinds of diet by children residing in Jumunjin and Kangnung were 0.445 ± 0.354 mg/day and 0.131 ± 0.097 mg/day, respectively. It is concluded from this investigation that the amount of fluoride intake of children living in Jumunjin (fluoridated areas) did not exceed the upper intake level designated by the Institute of medicine of the US National Academy of Science to avoid the risk of dental fluorosis (2.2 mg/day in 4- to 8-year-olds).

Introduction

The prevalence of dental caries in developed countries has declined over the past several decades, which considered mainly due to the widespread use of fluoride in variety method. On the other hand, trends of increased fluoride ingestion and a rise in enamel fluorosis have appeared in both fluoridated and non-fluoridated areas. Therefore, an accurate analysis of fluoride intake in children residing in fluoridated and non-fluoridated areas is important in that the level of fluoride necessary for adequate prevention of dental caries is only marginally less than that which can cause fluorosis. And It is necessary for proper uses of fluoride that we investigate accurate amount of intakes of fluoride from diet and water which children ingest residing in fluoridated area and non-fluoridated area.

Materials and Method

The two communities in this study from which food and beverages were collected were the fluoridated community of Jumunjin and the non-fluoridated community of Kangnung, Kangwondo, Korea. These communities were selected because of their documented fluoride histories; their proximity to one another; and the similarity of their demographic and socioeconomic characteristics. 120 preschool children aged 3-6 were selected for collecting food and beverages. The parents duplicated all the diets (food and beverages) that their children ingested in a day.

Food samples were weighed and processed by homogenization prior to analysis. A sufficient amount of deionized water was added to a preweighed amount of each food sample, and the total weight of the water and the food was recorded so the grams of food per gram of homogenate could be calculated. Each food sample was then thoroughly homogenized, and duplicate aliquots(30ml) were frozen(-20 ° C) until the time of analysis. All food homogenates and those beverages that could not be analyzed directly, such as juices and milk, were analyzed for fluoride using the hexamethyldisiloxane (HMDS) diffusion method of Taves as modified by Rojas-Sanchez et al. The acid-diffusible fluoride in the liquid homogenate was isolated by the acid-diffusion technique using H₂SO₄-HMDS and trapped by NaOH solution and measured with a fluoride electrode(Orion Research EA940).

Water and carbonated beverages were directly analyzed for fluoride using fluoride-ion specific electrode. A 10-ml aliquot of each sample was mixed with an equal volume of Total Ionic Strength Buffer(TISAB II) and placed directly under the electrode. The resulting millivolt readings were recorded and the fluoride concentration of each sample was calculated from a standard curve constructed on the basis of the millivolt readings for a series of fluoride standards analyzed at the same time, under the same conditions.

The mean fluoride content, minimum and maximum values, standard deviation were determined for each food and beverage classification group, and a Student's t-test was used to test for differences between the two communities. A significance level of $\alpha=0.05$ was used to test all hypotheses. Statistical analyses were performed using SAS V6.12.

Results and Discussion

The data of fluoride intakes were obtained from 120 children with 60(34 boys, 26girls) residing in Jumunjin and 60(25 boys, 35 girls) in Kangnung. The children participated in this investigation were aged 65.10(SD 11.81) months in Jumunjin and 60.93(SD 10.15) months in Kangnung.

Table 1. Fluoride intake from diet in Korean children aged 4-6 years

Diet classification	Total(N=104) (mg/day) ^a	Jumunjin(N=56) (mg/day) ^a	Kangnung(N=48) (mg/day) ^a	p-value ^b
Water ^c	0.136±0.162	0.226±0.174	0.030±0.030	<0.001
Beverages ^d	0.031±0.052	0.029±0.035	0.033±0.067	0.726
Food ^e	0.130±0.211	0.190±0.267	0.061±0.069	<0.001
Total	0.296±0.307	0.445±0.348	0.123±0.092	<0.001

^aMean standard deviation(SD)

^bStudent's t-test for differences between the two communities

^cDrinking water

^dIncludes all commercial beverages such as juices, carbonated beverages and milk

^eAll duplicated food sample was homogenized in a bowl for duplicate analysis

The mean fluoride intakes from all diets of children aged 3~6 in this research are shown in table 1. The mean daily fluoride intake from all diets as the children's living area were 0.445mg/day(SD 0.348) to Jumunjin and 0.123mg/day(SD 0.092) to Kangnung. As would be expected, the fluoride intakes from water alone, food alone and all diets were significantly different between the two geographical groups ($p < 0.001$) determined by t-test. But because all the beverages ingested by the children were circulated commercially, the fluoride intakes from beverage were not significantly different between the two groups. The duplicate-diet method is considered the most accurate way of sampling diet and appears to indicate a substantially lower level of fluoride intake than previously estimated by other methods. In this study, dietary surveys were conducted to ensure that the collected food samples were a true representation of the child's diet for that day.

Conclusion

This study was conducted to determine the fluoride intakes in Korean children aged 3~6 years. We adopted duplicate diet method to analyze the amount of fluoride which children ingest in a day. The mean daily fluoride intakes from all kinds of diet by children residing in Jumunjin and Kangnung were 0.445 ± 0.354 mg/day and 0.131 ± 0.097 mg/day, respectively. In this research, we observed similar results compared to that of previous investigators in Korea and other country. It is concluded from this investigation that the amount of fluoride intake of children living in Jumunjin(fluoridated areas) and Kangnung(non-fluoridated area) did not exceed the upper intake level designated by the Institute of medicine of the US National Academy of Science to avoid the risk of dental fluorosis(2.2mg/day in 4- to 8-year-olds).

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