FLUORIDE INTAKE AND URINARY EXCRETION IN PRESCHOOL CHILDREN RESIDING IN KOOHBANAN, IRAN, A CITY WITH HIGH FLUORIDE WATER AND FOOD

Hamid Reza Poureslami,[a] Payam Khazaeli[b]
Koohbanan, Iran

SUMMARY: The amount of fluoride (F) ion excreted in 24-hr urine of preschool children in Koohbanan, Iran, was measured. The total volume of urine over a 24-hr period of 26 healthy 4–5 yr-old children (14 boys and 12 girls with a mean body weight of 16 kg) was collected under carefully controlled conditions. From the F concentration in 1-mL samples, the total amount of F excreted during the 24-hr period was calculated. The amount of F ingested from food and water over the same period was determined by a checklist. The average amount of F ion in 24-hr urine of these children was 0.41 mg, and the total 24-hr F intake was 1.71 mg. The data indicate that the F intake in the Koohbanan preschool children is high, corresponding to 0.107 mg F/kg bw/day.

Key words: Dental fluorosis; Fluoride in food; Fluoride intake; Koohbanan, Iran; Preschool children; Urinary fluoride excretion; Waterborne fluoride.

INTRODUCTION

The most sensitive period for the development of dental fluorosis (DF) in the permanent incisor teeth from ingested fluoride (F) appears to be from beginning of enamel formation at age 3–4 months (mo) to 5 years (yr) of age.[1,2] However, there is relatively little information on F intake, excretion, and retention by children under 5 yr of age residing in areas with high F, possibly because of the considerable practical difficulties in obtaining data from young children, in particular, collecting 24-hr urine samples from those who are not toilet trained.

The aim of this study was to determine 24-hr F intake and 24-hr urinary F excretion in a group of children 4–5 yr of age in the Koohbanan, Iran. Recently, in our work, the F level in various foods in Koohbanan was found to be between 0.02 to 8.85 ppm and in drinking water 2.38 ppm.[3] In addition, the prevalence of DF (grade III) among 12–14-yr-old secondary school students of this city was recorded to be 93% based on the Tooth Surface Index of Dental Fluorosis (TSIDF) [unpublished findings].

MATERIALS AND METHODS

Fifty healthy children aged 4 and 5 yr were enrolled from different areas of Koohbanan city in the spring and summer seasons of 2008. All the children were born and raised in the city since birth and were not on any therapeutic diet or taking any dietary F supplements. The study was carried out to determine the total urinary F excretion in response to normal conditions of F intake (customary diet and municipal drinking water). Oral hygiene was practiced without use of F toothpaste for three days (two days before starting urine collection and the day of

[a]Department of Pedodontics, Kerman Oral and Dental Diseases Research Centre, Faculty of Dentistry, Kerman University of Medical Sciences, Jomhory Blvd., Kerman, Iran; E-mail: hamid42pour@ yahoo.com; [b]Department of Pharmaceutics, Faculty of Pharmacy, Kerman University of Medical Sciences, Jomhory Blvd., Kerman, Iran.

urine collection); urine was collected for a period of 24 hr. All urine produced by each child during the study period was collected by the parents, who had been instructed in the method of collection. Parents were asked whether they could collect the 24-hr urine of the child completely or not.

Based on the responses, 24 children who had night wetting or loss of urine control were excluded from the study. The urine samples of the 26 remaining children (14 boys and 12 girls) were coded. The volume in mL of each 24-hr urine sample was measured and recorded. Each child was also weighed wearing light indoor clothing without shoes and the data recorded. The total F ion concentration was measured using a F ion-specific electrode (Metrohm Co., Swiss) and meter.[3] For each child, the measured concentration of F (mg/mL) in a 1-mL urine sample was multiplied by the 24-hr urine volume (mL) to calculate the 24-hr urinary excretion of F in mg. Moreover, for these children the amounts of water and food products produced in Koohbanan that were consumed the child each day were recorded during three days by the parents on a specially designed checklist. Data were analyzed by SPSS 11.5 software package and presented as means and standard deviation (SD ±).

RESULTS AND DISCUSSION

Means of 24-hr consumption of water and food products plus 24-hr urinary F excretion of the boys and girls are presented in Tables 1–3.

Table 1. Mean F content of food and water consumed by 4–5 yr old children in Koohbanan, Iran, and the amount of 24-hr F intake via the food and water

Food product	Mean of food consumed g (±SD)	F concentration mg/kg	F intake mg
Bread	52.23 (15.72)	7.24	0.3781
Pea	5.96 (5.67)	0.05	0.0003
Cooked potato	37.80 (26.23)	5.22	0.1973
Apricot	18.50 (23.83)	0.48	0.0088
Cucumber	60.96 (8.10)	0.15	0.0091
Leek & chervil	0.92 (1.05)	5.33	0.0049
Lamb& beef	15.65 (7.16)	0.15	0.0023
Chicken	8.84 (5.05)	0.19	0.0016
Egg	24.65 (12.39)	0.09	0.0022
Drinking water	466.00 (168.40)	2.38	1.1090

One of the best methods for monitoring urinary F levels is collection and analysis of 24-hr pooled samples from each contributor.[4] Understandably, for the present study, this method demands conscientious cooperation on the part of parents and children. Consequently, the numbers of participants in the present study were necessarily small. The mean urinary F excretion/child/day in the present study (0.41 mg) is approximately the same as in English children.[5] As mentioned in that report, a higher daily urinary F excretion in Sri Lankan children can be attributed to higher urine volume due to greater water consumption with higher air temperatures.[5]

Table 2. Age, weight, F level in urine, 24-hr volume of urine, and 24-hr F excreted in urine of 4–5 yr-old boys in Koohbanan, Iran

Number of sample	Age mo	Weight kg	F in urine µg/mL	24-hr urine mL	24-hr urinary F mg
47	56	17.1	0.71	511	0.363
39	57	16	0.70	385	0.270
43	55	16.7	2.50	367	0.918
50	51	17.2	2.20	508	1.118
30	50	14.8	1.74	503	0.875
51	59	16	0.53	522	0.277
24	48	14.4	0.40	276	0.110
52	53	15	0.60	385	0.231
13	51	10.4	0.80	263	0.210
10	58	17.5	0.66	510	0.337
36	56	15	0.55	443	0.244
45	60	17.5	0.43	665	0.286
16	60	15	0.56	417	0.233
17	56	16.5	0.70	460	0.322
Mean	55	16.04	0.93	443.93	0.414
±SD	0.320	1.1	0.68	106.13	0.312

Table 3. Age, weight, F level in urine, 24-hr volume of urine, and 24-hr F excreted in urine of 4–5 yr-old girls in Koohbanan, Iran

Number of sample	Age mo	Weight kg	F in urine µg/mL	24-hr urine mL	24-hr urinary F mg
49	54	14.8	2.49	349	0.869
31	58	16.5	1.01	486	0.491
7	52	16	0.82	383	0.314
6	54	17.9	0.62	438	0.272
48	55	18.5	0.43	473	0.203
46	56	16.5	0.62	445	0.276
25	59	18	0.73	562	0.410
26	56	16.5	0.77	354	0.273
29	50	14.1	0.86	273	0.235
2	55	18.3	0.91	463	0.421
11	55	17	1.07	441	0.472
9	59	17.5	0.87	658	0.572
Mean	56	16.80	0.93	443.75	0.401
±SD	0.222	1.41	0.52	101.32	0.187

In a pilot survey performed simultaneously with the present study, mean 24-hr urinary F excretion of fifteen children, 12–14 years old, living in Koohbanan who showed signs of grade III TSIDF on their permanent incisors, was 1.4 mg/day, which is over three times higher than in the 4-5-year-old age group. The amount of 24-hr urinary F excretion among German children aged 3–6 yr who had a daily intake of 0.930 mg F from all sources was found to be 0.479 mg.[6] A study of English children aged 5–6 yr who had a daily F consumption of 0.76 mg through fluoridated milk and toothpaste, showed 0.30 mg F in the 24-hr urine sample that increased to 0.61 mg after an intake of 2.0 mg F.[7]

Based on the results of the above studies,[6,7] approximately 51%, 39%, and 30%, respectively, of the F intake were excreted, whereas in the present study 24% of F intake (1.71 mg) was excreted in the urine (0.41 mg). This relatively low level of excretion may be due to the high altitude of Koohbanan (ca. 2000 m above sea level). According to some studies, living at high altitudes causes hypoxia leading to greater F accumulation of F in body tissues and an increase in DF.[8-10] Among the 4–5 yr-old children in our study with a mean body mass of 16 kg, a daily consumption of 1.71 mg F corresponds to a dosage of 0.107 mg F/kg bw/day). Consequently, because this dosage is twice the widely cited maximum of 0.05 mg F/kg bw/day for the prevention of DF,[11] it is predictable that these children will show signs of DF after eruption of their permanent incisors.

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