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Letter to Editor

Fluoride and Cadmium Content in Urine of Children in Gdańsk

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Abstract

The aim of this study was (a) to determine the concentration of fluoride and cadmium in urine of 1240 children (635 boys, 605 girls) from Gdańsk, aged 7-14; and (b) to examine whether a correlation exists between age and sex of children, the location of the schools, and the urinary levels of fluoride and cadmium. Fluoride was determined potentiometrically using a fluoride-specific electrode. Cadmium was determined by atomic absorption spectrometry. The mean fluoride concentration in urine in children attending two schools located close to a phosphate fertilizer waste disposal site was 2.14 ± 1.16 mg F^-/L, in three others 1.05 ± 0.49 mg F^-/L. The mean cadmium concentration in urine was 0.17 ± 0.19 µg Cd/L. In children aged 7 the cadmium concentration was significantly lower than in older ones.

Keywords: fluoride, cadmium, urine, children, Gdańsk

Introduction

Exposure to excessive amounts of toxicants is most often connected with environmental pollution or inappropriate nutritional or social habits. Cadmium and fluorine are elements of major health concern which accumulate in the body. The main source of cadmium in the environment is metallurgy of zinc, lead and copper, and combustion of coal. Also, water and foodstuffs in polluted areas contain more cadmium. Another source of this metal is cigarette smoke [1]. Fluorides are present in the vicinity of aluminium and magnesium foundries, phosphoric acid and phosphate fertilizer plants, petroleum refineries, pottery kilns and factories where glass etching, erasing or welding is performed. A very important source of fluoride is drinking water [2,3].

Both cadmium and fluoride are excreted with urine and this material is commonly used to monitor environmental and occupational exposure to these elements. The relationship between exposure to cadmium and fluoride and their concentration in urine has been confirmed in many studies [1,2,4].

Children are particularly exposed to harmful effects of environmental pollutants. On account of growth and intensive metabolism they need relatively more food than adults and in consequence they absorb larger doses of toxicants [5]. Also, absorption of many metals from the gastrointestinal tract is more efficient in children than in adults. Moreover, young children are additionally exposed orally through dust and dirt during play. Therefore, monitoring of many pollutants in children is very important and recommended by agencies engaged in environmental health problems.

The aim of this study was to determine the fluoride and cadmium levels in urine of children attending elementary schools in Gdańsk and to examine whether a relationship exists between the age of the children and the location of the schools and the urinary concentration of investigated pollutants.

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Materials and Methods

Samples of urine were collected from 1240 children (635 boys and 605 girls) aged 7-11 attending elementary schools located in Gdańsk. 52 children were aged 12-14. The specific gravity of every urine sample was measured. The concentration of fluoride was determined in all samples, concentration of cadmium in 231 samples. Two of the schools (D and E) were situated in the vicinity of a phosphate fertilizer waste disposal site.

Determination of Fluoride

Fluoride concentration in samples of urine was determined directly after dilution with equal volumes of TISAB buffer by a fluoride-specific electrode (Orion) against a Ag /AgCl reference electrode [6].

Determination of Cadmium

Cadmium concentrations were determined directly by flameless atomic absorption spectrometry. Samples of urine diluted with equal volumes of 0.8M nitric acid were put in a graphite cuvette and determined on an Avanta ∑ atomic absorption spectrometer (GBC) [7].

The accuracy of measurements was tested with Seronorm control urine (Nycomed Pharma AS, Oslo , Norway). The determined levels were within the assigned 5 % confidence range.

Statistical analysis was performed using Student′s t-test.

Results and Discussion

Results of fluoride and cadmium determinations in urine normalized to standard specific density 1.024 are presented in Table 1 and Figure 2.

The mean fluoride concentration in urine of 992 children attending three of the investigated schools (A, B, C) was 1.05 mg F^-/L. Such a level is usually encountered in persons not exposed environmentally or occupationally to fluoride [6, 8, 9, 10]. In 248 children attending two other schools (D, E) the fluoride level was significantly higher.

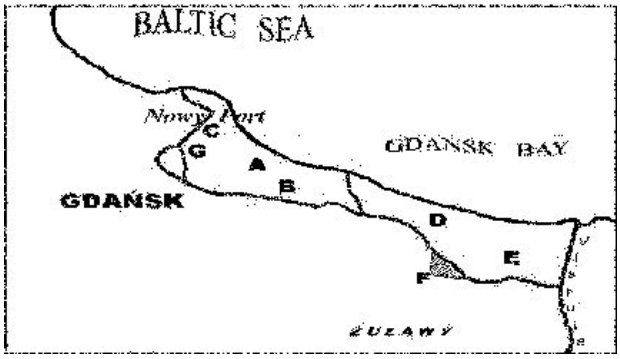

Fig 1. Location of investigated schools. A-E = schools; F= phosphate fertilizer waste disposal site; G= phosphate fertilizer plant

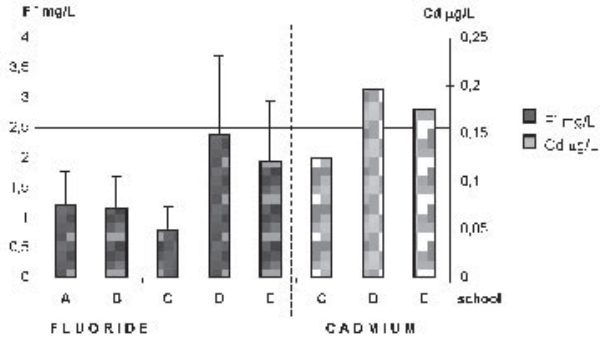

Fig. 2. Fluoride and cadmium concentrations in urine of children in relation to attended school.

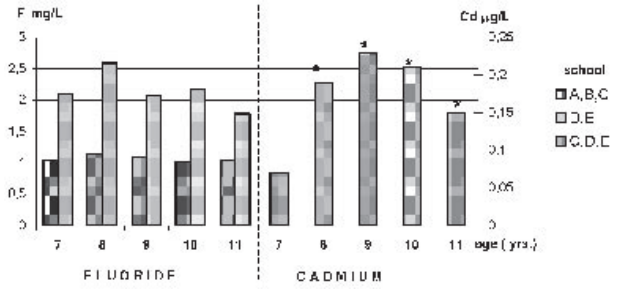

Fig. 3. Age-dependent fluoride and cadmium concentrations in urine of children.

Table 1. Fluoride and cadmium concentrations in urine of children.

School	F^- mg/L			Cd µg/L		
	n	$\bar{x}$	±SD	n	$\bar{x}$	±SD
A	506	1.22	0.56	-	-	-
B	120	1.16	0.54	-	-	-
C	366	0.79	0.39	58	0.124	0.159
D	112	2.39	1.30	72	0.196	0.190
E	136	1.93	1.01	100	0.175	0.157

$\bar{x}$±SD = mean value ± standard deviation; n = number of children

Table 2. Age-dependent fluoride and cadmium concentration in urine of children.

School	Age (yrs.)	7	8	9	10	11 and above
F- mg/L						
A B C	$\bar{x}$	1.04	1.14	1.09	1.01	1.04
	±SD	0.541	0.422	0.554	0.394	0.462
	n	175	152	252	245	168
D E	$\bar{x}$	2.10	2.59	2.08	2.17	1.78
	±SD	1.04	1.78	0.839	0.975	0.747
	n	41	52	43	52	61
Cd µg/L						
C D E	$\bar{x}$	0.07	0.19	0.23	0.21	0.15
	±SD	0.06	0.14	0.25	0.22	0.14
	n	34	40	42	63	52

This may be caused by two factors. First, these schools were located in the vicinity of a phosphate fertilizer waste disposal site which might pollute the surroundings. Second, drinking water in this area has a higher fluoride level (1.0 – 1.5 mg F^-/L) of natural origin than in other quarters of the city (0.2-0.4 mg F^-/L). This elevated urinary fluoride level in children requires continuous monitoring of exposure to fluorine compounds.

Cadmium was determined in children attending three schools (C, D, E). The mean urinary cadmium level in the investigated group was 0.17 ± 0.19 µg Cd/L. Other authors (11, 12,13) found in unexposed children levels from about 0.1 to 0.5 µg Cd/L. No significant differences in urinary cadmium levels between children from different schools were found. Only in a group of 11 children the cadmium level in urine was significantly higher than in the whole investigated group, which might be a consequence of cigarette smoking [11].

In Table 2 and Figure 3 the obtained results were presented according to age of the children and the location of the investigated schools. The results of this study indicate that the fluoride level in urine was not age-related but was dependent on the water fluoride concentration which is different in various places where the schools were located.

A different relation was found for cadmium. There is a significant difference ($p < 0.001$) between cadmium levels of children aged 7 and older ones. However, so far no reliable explanation of this difference was found.

In one of the investigated schools (D) located next to the waste disposal site (F) the fluoride concentration in urine of boys was significantly higher (2.51±0.51 mg F^-/L) than in girls (2.03 ± 0.88 mg F^-/L), which may be caused by greater physical activity in an area polluted with phosphate wastes containing fluorides. In the other schools (A,B,C,E) no sex-dependent differences in urinary fluoride and cadmium levels were found.

The results of this study indicate that further monitoring of exposure to fluoride and cadmium in the investigated population is advisable.

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