

## URINARY FLUORIDE OF SCHOOLCHILDREN IN GDAŃSK

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**SUMMARY:** The aim of this study was to determine the concentration of fluoride in urine of 1240 children (635 boys, 605 girls), aged 7-14, living in Gdańsk, Poland, and to examine whether a correlation exists between age and gender, school location, and fluoride level in the urine. Urinary F<sup>-</sup> was determined with a fluoride ion specific electrode. The mean urinary F<sup>-</sup> concentration in children attending two schools near a fluoride-bearing phosphate fertilizer waste disposal site with 1.0 - 1.5 mg F<sup>-</sup>/L in the drinking water was  $2.16 \pm 1.14$  mg F<sup>-</sup>/L. At three other schools near a phosphate fertilizer plant but with only 0.2 - 0.5 mg F<sup>-</sup>/L in the drinking water, the mean urinary F<sup>-</sup> concentration was  $1.05 \pm 0.49$  mg F<sup>-</sup>/L. In the first two schools the urinary F<sup>-</sup> concentration in boys was significantly higher than in girls. No age – dependent differences were found in children in any of the schools.

Keywords: Children in Gdańsk, Environmental fluoride, Poland, Urinary fluoride, Waterborne fluoride.

### INTRODUCTION

Exposure to excessive amounts of fluoride may be caused not only by elevated fluoride levels in drinking water and foodstuffs but also by pollution from fluoride compounds of industrial origin. In Poland health hazards connected with environmental exposure to fluoride are high in priority.<sup>1</sup> In the Gdańsk region both kinds of exposure are found. On one hand, a large phosphate fertilizer plant is located near the city. Emission of fluoride from the plant depends on both the magnitude of production and technical innovations in the production process. In recent years several improvements were introduced which substantially decreased fluoride air pollution. On the other hand, the eastern districts of the city are situated in an area with relatively high water fluoride levels (1-3 mg F<sup>-</sup>/L) of natural origin. Moreover, in Wiślinka, a suburb near the city border, there is a phosphate fertilizer waste disposal site. The wastes contain about 0.2 % of soluble fluorine compounds.<sup>2</sup> As a result, area inhabitants may be exposed to excessive amounts of fluoride, and local monitoring of exposure to this pollutant is advisable. Although different methods of assessing exposure to fluoride are available, it is generally accepted that the best indicator of exposure is the urinary fluoride concentration in the population under investigation.

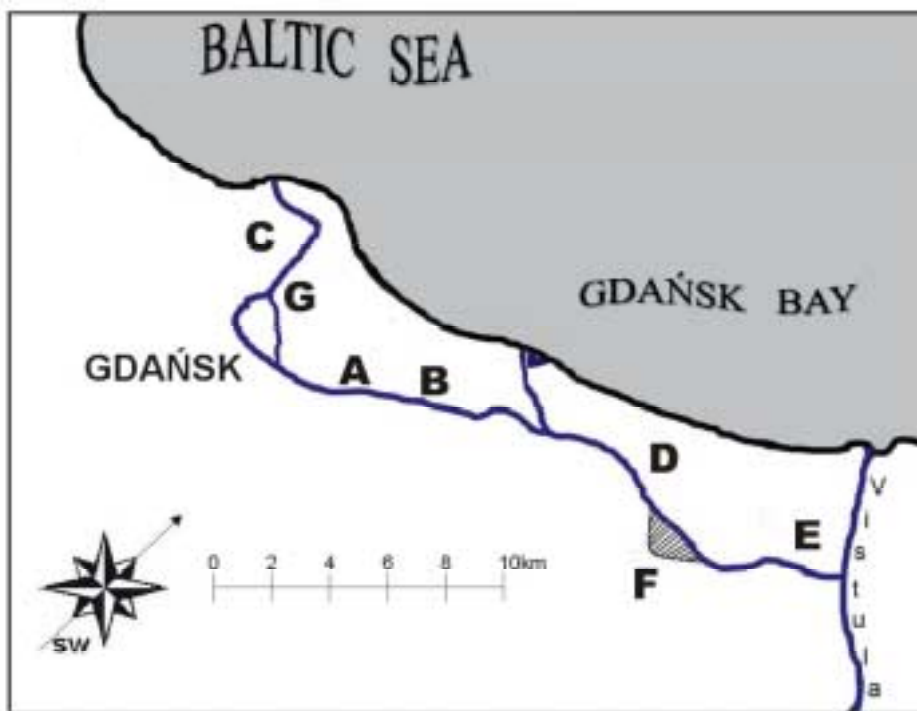
The aim of this study was to determine the fluoride level in urine of children attending elementary schools in Gdańsk and to assess whether there is a correlation between this parameter and age or sex of the children as well as the location of the schools.

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### MATERIALS AND METHODS

Samples of urine were obtained from 1240 children (635 boys and 605 girls, aged 7-14) attending five elementary schools located in different parts of Gdańsk. Urine spot samples were collected in the morning in polyethylene bottles. Three of the schools (A, B, and C – Figure) are situated in the industrial and harbor area where the phosphate fertilizer plant is located. The fluoride concentration in drinking water in this area is 0.2-0.5 mg F<sup>-</sup>/L. Two other schools (D and E) are located at the eastern border of the city, close to the fluoride-rich Żuławy area and in the vicinity of a phosphate waste disposal site, where the fluoride concentration in drinking water is 1.0-1.5 mg F<sup>-</sup>/L, and even approaches 2.0 mg F<sup>-</sup>/L.



**Figure.** Location of investigated schools A-E; F= phosphate fertilizer waste disposal site; G = phosphate fertilizer plant. The wind rose shows the prevailing wind is from the southwest.

For the analyses, the specific gravity of each urine sample was measured. The fluoride concentration in the urine samples was determined directly after dilution with equal volumes of TISAB buffer (pH = 5.2) by a fluoride

ion-specific electrode and a reference pH-meter (Orion 920). The accuracy of measurements was tested with Seronorm™ Trace Elements Urine (Nycomed Pharma AS, Oslo, Norway). The coefficient of variation in urine samples was  $\pm 3.5\%$ .

Statistical analysis was performed using Student's t-test and calculated with Microsoft Excel 97, a spread sheet program.

### RESULTS AND DISCUSSION

It is generally accepted that urinary fluoride is normally the best immediate indicator of environmental or occupational exposure to fluoride. Urine samples are easily obtainable, and more than 90% of ingested or inhaled fluoride is excreted in urine. In persons not exposed to excessive levels of intake, the mean urinary fluoride level does not usually exceed 1.0-1.5 mg F<sup>-</sup>/L<sup>3,4</sup> and depends mainly on the water supply. Usually higher mean urinary fluoride levels are found in adults than in children. However, in our experience, no age-dependent statistically significant differences are observed.<sup>2,5</sup> In regions of endemic fluorosis much higher levels are sometimes found, and they may even surpass 10 mg F<sup>-</sup>/L.<sup>3,6,7</sup>

In the present study urinary fluoride concentrations were adjusted to a specific gravity of 1.024 and are presented in Tables 1-3. The fluoride concentration in urine of 992 children attending three of the schools (A, B, and C) were quite similar with a mean level of 1.05 mg F<sup>-</sup>/L. (Table 1). Such a level is usually found in persons not exposed to excessive amounts of fluoride.<sup>2,4,8-10</sup>

**Table 1.** Urinary fluoride concentration of schoolchildren in Gdańsk

| School | N   | $\bar{x}$<br>mg F <sup>-</sup> /L | SD    | min max<br>mg F <sup>-</sup> /L | $\bar{x}^a$<br>mg F <sup>-</sup> /L | SD    | min max<br>mg F <sup>-</sup> /L |
|--------|-----|-----------------------------------|-------|---------------------------------|-------------------------------------|-------|---------------------------------|
| A      | 506 | 1.06                              | 0.500 | 0.29<br>4.8                     | 1.22                                | 0.56  | 0.43<br>5.24                    |
| B      | 120 | 1.07                              | 0.496 | 0.29<br>3.0                     | 1.16                                | 0.541 | 0.27<br>3.18                    |
| C      | 366 | 0.676                             | 0.359 | 0.20<br>3.10                    | 0.793                               | 0.399 | 0.21<br>5.24                    |
| A+B+C  | 992 | 0.919                             | 0.446 | 0.20<br>4.80                    | 1.05                                | 0.494 | 0.21<br>5.24                    |
| D      | 112 | 2.09*                             | 0.98  | 0.52<br>4.8                     | 2.39*                               | 1.3   | 0.5<br>4.4                      |
| E      | 136 | 1.56*                             | 0.78  | 0.20<br>4.7                     | 1.93*                               | 1.01  | 0.60<br>6.0                     |
| D+E    | 248 | 1.80*                             | 0.87  | 0.20<br>4.80                    | 2.16*                               | 1.14  | 0.50<br>6.00                    |

<sup>a</sup>Adjusted to specific gravity of 1.024.

\*Significant ( $p < 0.001$ ) in relation to schools A, B, and C.

In the urine of 248 children attending two other schools (D and E) the urinary fluoride concentration was significantly higher, and its mean value was 2.16 mg F<sup>-</sup>/L. This may have two contributing causes. First, drinking water in this area has a higher fluoride level (1.0-1.5 mg F<sup>-</sup>/L) of natural origin than in other parts of the city (0.2-0.5 mg F<sup>-</sup>/L). Second, these schools are located close to a phosphate waste disposal site which pollutes the surroundings.

In the schools D and E located in the area of the waste disposal site, significantly higher urinary fluoride concentrations were found in boys (2.31 ± 0.54 mg F<sup>-</sup>/L) than in girls (1.94 ± 0.83 mg F<sup>-</sup>/L) (Table 2), which may be caused by greater physical activity of the boys. In the other three schools (A, B, and C) there were no significant sex-dependent differences in urinary fluoride levels. In addition, no age-related differences in urinary fluoride in the population of children could be detected (Table 3).

These findings of elevated urinary fluoride levels in children require further monitoring of exposure to fluorine compounds.

**Table 2.** Sex-dependent fluoride concentration in urine of children

| School | Sex | N   | mg F <sup>-</sup> /L | SD    |
|--------|-----|-----|----------------------|-------|
| A      | F   | 246 | 1.20                 | 0.61  |
|        | M   | 260 | 1.24                 | 0.52  |
| B      | F   | 66  | 1.14                 | 0.51  |
|        | M   | 54  | 1.19                 | 0.61  |
| C      | F   | 179 | 0.75                 | 0.296 |
|        | M   | 187 | 0.84                 | 0.473 |
| A+B+C  | F   | 491 | 1.03                 | 0.545 |
|        | M   | 501 | 1.08                 | 0.295 |
| D      | F   | 70  | 2.03                 | 0.88  |
|        | M   | 89  | 2.51*                | 0.51  |
| E      | F   | 46  | 1.79                 | 0.737 |
|        | M   | 43  | 1.91                 | 0.954 |
| D+E    | F   | 116 | 1.94*                | 0.830 |
|        | M   | 132 | 2.31*                | 0.543 |

\*Significantly different ( $p < 0.001$ ).

**Table 3.** Age-dependent fluoride concentration in urine of children

| School | Age       | 7                     | 8     | 9     | 10    | above 10 |
|--------|-----------|-----------------------|-------|-------|-------|----------|
| A,B,C  |           | F <sup>-</sup> [mg/L] |       |       |       |          |
|        | $\bar{X}$ | 1.044                 | 1.14  | 1.093 | 1.009 | 1.041    |
|        | ±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  | 2.080 | 2.17  | 1.784    |
|        | ±SD       | 1.04                  | 1.78  | 0.839 | 0.975 | 0.747    |
|        | N         | 41                    | 52    | 43    | 52    | 60       |

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