URINARY FLUORIDE LEVELS FOR ASSESSMENT OF FLUORIDE EXPOSURE OF PREGNANT WOMEN IN POZNAN, POLAND

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SUMMARY: The aim of this study was to evaluate the fluoride (F) exposure of 31 pregnant women aged 22–34 living in Poznan, Poland, where the level of F in drinking water ranges from 0.4 to 0.8 mg/L. The assessment was made on the basis of F concentrations determined in fasting morning urine samples. Mean urinary F concentrations were 0.653 mg/L for women in their 28th week and 0.838 mg/L in their 33rd week of pregnancy, compared with a mean of 1.300 mg/L for the 30 healthy non-pregnant women of similar ages as a control group. These fasting morning urine levels were comparable to 24-hr samples and are similar to those observed in areas with fluoridated water. The results indicate that prenatal systemic administration of fluorides, still recommended by some authors, should not be implemented in this population.

Keywords: Fluoride exposure; Pregnant women; Urinary fluoride.

INTRODUCTION

Although promoted now for some years, prenatal systemic administration of fluoride (F) supplements to pregnant women for caries prevention in their offspring has continued to be controversial.[1] A 1991 workshop report on “Changing patterns of fluoride intake” concluded that “definitive support for recommending prenatal F supplementation to prevent dental caries is still lacking.”[2,3] Even so, prenatal F is still recommended by some dental authorities[4-7] and has been a standard practice in many countries, including Poland.[1] Moreover, since study results indicate that the placenta acts as a partial barrier for F,[8-10] some advocates of this method recommend the use of F supplements during pregnancy even in communities that already have the what is considered an “optimal” amount of F in the drinking water, in order to promote the passage of F to fetal circulation.[5-7,9] This practice raises serious concerns considering the potential negative effects of excessive amounts of F on fetal development.[10-12]

Under current conditions of increasing F intake from multiple sources, every decision regarding the use of F supplements should be based on a careful assessment of total F exposure. Evaluation of F exposure by measuring its concentration in urine is widely used, relatively simple, and non-invasive.[13-20]

Accordingly, the aim of this study was to assess by urinary analysis the F exposure of pregnant women residing in a city (Poznan, Poland) where the level of F in the drinking water ranges from 0.4 to 0.8 mg/L.

MATERIALS AND METHODS

The subjects of the study were 31 pregnant women aged 22–34, all in the second trimester of pregnancy at the start of the study, and 30 healthy non-pregnant women aged 21–34 in the control group. Recruitment was carried out in the Gynecology and Obstetrics Clinical Hospital in Poznan and was based on the women’s voluntarily agreement to participate in the study. From a questionnaire,

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data were collected about all subjects concerning the sources of F exposure such as diet, oral hygiene measures, and topical F treatments.

The study itself was preceded by a pilot study conducted on 11 generally healthy women aged 25–30, which aimed to compare mean F concentrations in morning urine samples and in 24-hour collections. Fasting morning urine samples were collected in the 28th and in the 33rd week of pregnancy in the study group but only once in the control group.

Urinary F concentrations were measured by standardized procedures at the Department of Biochemistry and Chemistry of Pomeranian Medical University with a F ion selective electrode ORION (Model 96-09). Determinations were made with 1.0 mL of urine to which was added an equal volume of TISAB buffer to adjust the pH to 5.0–5.5.

The data were analyzed statistically using Statistica (version 5) for Windows XP Professional (version 5.1) with significance taken as $p<0.05$.

RESULTS

The results of the pilot study revealed that mean F concentrations in fasting morning urine samples (1.28 mg/L) and 24-hour collections (1.340 mg/L) of the same woman do not differ significantly ($p>0.05$). The mean fasting morning urinary F levels in the 28th week of pregnancy were, however, significantly lower ($p<0.01$) than in the 33rd week (0.653 mg/L vs. 0.838 mg/L, respectively). In the control group the values were higher than in the study group (mean = 1.300 mg/L) ($p< 0.01$) (Table 1).

Table 1. F concentration (mg/L) in urine of women in study and control group

Fasting morning urine samples	Mean	Median	Minimum	Maximum	SD
28th week of pregnancy	0.653	0.638	0.154	1.365	0.316
33rd week of pregnancy	0.838*	0.858	0.299	1.689	0.352
Control group	1.300†	1.251	0.835	2.221	0.301

*$p<0.01$ compared with F concentrations in the 28th week of pregnancy.
†$p<0.01$compared with F concentrations in the 33rd and 28th week of pregnancy.

The questionnaire revealed that all women regularly used fluoridated toothpaste (F concentration 1000–1500 ppm), 14 pregnant women and 17 women in the control group consumed more than 0.4 L of black tea daily, five pregnant women and nine women in the control group consumed chicken meat and/or fish at least four times a week, and 19 pregnant women received a topical F gel treatment (1.25% F) in the 26th, 29th, and 32nd week of pregnancy (as a part of the University Dental Clinic caries prevention program for pregnant women).

Statistically significant differences between mean urinary F concentrations of women consuming different amounts of tea, chicken meat, and/or fish were observed (Tables 2 and 3). No statistically significant difference was found in the mean urinary F levels between groups receiving and not receiving topical applications of F gel (Table 4).

Table 2. F concentration (mg/L) in urine of women drinking up to 0.4 L or more than 0.4 L of black tea daily

Daily volume of tea	28th week of pregnancy Mean [F]±SD	33rd week of pregnancy Mean [F]±SD	Control group Mean [F]±SD
≤0.4L	0.570±0.293	0.691±0.296	1.110±0.156
>0.4L	0.754±0.323	1.016±0.340*	1.446±0.270†

*p<0.02; †p<0.01 compared with group consuming up to 0.4L of tea daily.

Table 3. F concentration (mg/L) in urine of women consuming different amounts of chicken meat and/or fish

Frequency of chicken, meat, and/or fish consumption	28th week of pregnancy Mean [F]±SD	33rd week of pregnancy Mean [F]±SD	Control group Mean [F]±SD
< 4/week	0.679±0.334	0.868±0.363	1.216±0.246
= or > 4/week	0.517±0.154	0.680±0.263	1.496±0.341*

*p<0.02 compared with group consuming chicken, meat, and /or fish <4 times/week.

Table 4. F concentration (mg/L) in urine of women receiving and not receiving to fluoride gel applications in the 3rd trimester of pregnancy

Received F gel applications	28th week of pregnancy Mean [F]±SD	33rd week of pregnancy Mean [F]±SD
Yes	0.706±0.326	0.875±0.388
No	0.567±0.292*	0.779±0.292†

*p=0.33; †p=0.54 compared with group receiving fluoride gel applications.

DISCUSSION

Since F excretion is not constant throughout the day, 24-hour samples of urine are more reliable than random samples for the estimation of average F exposure. However, under ambulatory conditions evaluation is often performed on the basis of single specimens. The study of Villa et al.[13] on fractional urinary F excretion in children revealed that the average values of the morning F excretion rate or concentration is essentially the same as the total corresponding daily average. Paez and Dapas[14] noted that there is a close relationship between the concentration of F in the first morning sample and in the 24-hour specimen. Similarly, our pilot study confirmed that F concentrations in fasting morning urine samples and 24-hour collections are comparable. Accordingly, we concluded that F levels in morning urine samples can be a good estimator of F exposure of the women in our study and control groups.

The values for F concentrations in human urine quoted in the literature vary, depending on the age of the population, level of F in the drinking water, and additional sources of F intake. Early studies performed by Likins et al.[15] and by Zipkin et al.[16] revealed that in regions with F levels in the drinking water ranging from 0.5 to 4.0 ppm, children and adults had urinary F concentrations similar to those in the drinking water.

Paez and Dapas[14] detected higher F levels in morning urine samples of 30 healthy adults. They ranged from 0.32 to1.70 ppm (mean 0.90), 1.1 to 2.2 ppm (mean 1.75 ppm), and 2.2 to 7.2 ppm (mean 4.84 ppm) in persons consuming water with the level of F 0.1 ppm, 1.0 ppm, and 2.6–8.0 ppm, respectively.

Czarnowski et al.[17] reported data on F levels in drinking water and urine of the inhabitants of 94 localities in northern and central Poland. Urinary F concentrations from 0.1 to 2.67 mg/L (mean 1.1 mg/L) where drinking water F ranged from 0.02 to 2.45 mg/L.

Adult urinary F determined by Toth et al.[18] in four experimental regimens ranged from 0.232 mg/L after the control period (tap water with less than 0.1 mg F/L), through 0.451 mg/L after a period of fluoridated salt consumption, 0.610 mg/L after a period of F tablets administration, to 0.671 mg/L after drinking fluoridated milk. Relatively low values of excreted F might be explained by the fact that participants were asked to abstain from drinking black tea and F mineral water, from eating high F food, and to refrain from using F-containing dental products during the study.

The range for F concentrations in urine of the non-pregnant women we examined in Poznan was higher (0.835–2.221 mg/L) than the F level in the drinking water in the city (0.4–0.8 mg/L) and can be compared to that detected by Paez and Dapas[14] in a community with 1.0 mg F/L in the water supply. This finding confirms that, under current conditions of increasing F exposure from different sources, the estimation of total F intake of a given population cannot be based solely on the level of F in the drinking water.

The difference of F concentrations in urine samples of the study and the control group may be explained by incorporation of F into fetal hard tissues and, accordingly, decreased elimination of F in the urine, which was demonstrated earlier by Hanhijarvi.[19] This fact must be remembered when evaluating F exposure in women who are pregnant.

The statistically significant increase in urine F concentrations observed in the 33rd week of pregnancy compared to the level in the 28th week suggests that F metabolism is changing with the progress of pregnancy. This fact has been emphasized by other authors[21] and might be connected with the lower uptake of F in fetal calcified tissues and decreased bone calcification toward the end of pregnancy.

Differences between F levels in groups consuming various amounts of tea, fish, and/or chicken meat confirm that these dietary components are key sources of F intake.[22,23] The lack of detectable differences in urinary F concentrations of women receiving and not receiving F gel applications indicates that this procedure does not contribute to the long term increase of F levels in body fluids. Similarly, the study of Marthaler et al. revealed that weekly brushing with F gel was not frequent enough to affect mean F excretion.[20]

In conclusion our data suggest that in the population of pregnant women residing in Poznan, where the level of F in the drinking water ranges from 0.4-0.8 mg/L, the use of additional F supplements is contraindicated. Total F intake assessed on the basis of F concentration in urine is relatively high and comparable to the level observed in areas with fluoridated water.

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