**ABSTRACTS**

**DENTAL EFFECTS**

**TIMING OF FLUORIDE INTAKE IN RELATION TO DEVELOPMENT OF FLUOROSIS ON MAXILLARY CENTRAL INCISORS**

**Objectives:** Several studies have focused on the timing of fluoride intake relative to the development of dental fluorosis. This study deals with fluoride intake during the first 48 months of life in relation to the occurrence of fluorosis in early-erupting permanent teeth. **Methods:** Subjects were followed from birth to 48 months with questionnaires every 3–4 months. Questionnaires gathered data on intakes from water, diet, supplements, and dentifrice to estimate total fluoride intake. Early-erupting permanent teeth of 579 subjects were assessed for fluorosis using the Fluorosis Risk Index (FRI) at approximately age 9. Fluorosis cases were defined as having a definitive or severe FRI on both maxillary central incisors. Individuals with a questionable FRI were excluded. The importance of fluoride intake during different time periods was assessed using t-tests and logistic regression. **Results:** One hundred and thirty-nine (24%) subjects had fluorosis on both maxillary central incisors. Mean fluoride intake per unit body weight (bw) ranged from 0.040 to 0.057 mg/kg bw, with higher intake during earlier time periods and relative stability after 16 months. In bivariate analyses, fluoride intakes/kg bw during each of the first 4 years were individually significantly related to fluorosis on maxillary central incisors, with the first year most important (P < 0.01), followed by the second (P < 0.01), third (P < 0.01), and fourth year (P = 0.03). Multivariable logistic regression analyses showed that, after controlling only for the first year, the later years individually were still statistically significant. When all four time periods were in the model, the first (P < 0.01) and second years (P = 0.04) were still significant, but the third (P = 0.32) and fourth (P = 0.82) were not. **Conclusions:** The first two years of life were most important to fluorosis development in permanent maxillary central incisors; however, this study also suggests the importance of other individual years.


**Objective:** The purpose of this laboratory study was to determine the impact of the severity of dental fluorosis on the formation of caries in the human enamel and dentin. **Materials and Methods:** Thirty-three human molars were grouped according to a modified Thylstrup-Fejerskov index of fluorosis (TFI) into normal (N, TFI 0), mild fluorosis (ML, TFI 1-3), and moderate fluorosis (MD, TFI 4-6). Three mesio-distal sections were made in corono-apical axis of the tooth to provide enamel and dentin samples. The samples were embedded in an epoxy resin and polished. Half of the polished surface was covered with an acid resistant varnish and immersed in standard acidified buffer solution (pH 4.5) for 48 hr to create artificial caries lesions. They were then treated with 5% NaOCl for 45 min and sectioned longitudinally along the center into two halves. Cut surfaces were polished and observed under a confocal laser scanning microscope for depth of demineralization. Morphology of the demineralized zones was observed under a field emission scanning electron microscope (FE-SEM). Data were analyzed using one-way ANOVA and Sheffe tests (p = 0.05). **Results:** Statistically significant differences in depth of demineralization were found between N and MD groups (p = 0.046) in the enamel, and between N and ML (p = 0.002), N and MD (p < 0.001), ML and MD (p = 0.029) in dentin. FE-SEM observation of the normal enamel showed direct dissolution with large fissures. Spongy appearance of intertubular dentin gradually disappeared from N to MD. **Conclusions:** Moderately fluorosed enamel showed a significant caries
resistance. In contrast, mild and moderately fluorosed dentin was significantly caries susceptible in vitro.

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Keywords: Caries susceptibility; Conformal laser scanning microscope; Dental fluorosis; Dentin acid corrosion; Enamel acid corrosion; Field emission scanning microscope; Molar teeth.

DENTAL FLUOROSIS AND DENTAL CARIES AMONG 12-YR-OLD CHILDREN FROM HIGH- AND LOW-FLUORIDE AREAS IN LITHUANIA

This investigation concerns the prevalence and severity of dental fluorosis and the occurrence of dental caries among 12-yr-old children living in high- and low-fluoride areas in a country with high caries figures and a developing oral health care system. The sample included a total of 600 lifetime residents from high-fluoride (HF; 1.7-2.2 ppm) and low-fluoride (LF; 0.2 ppm) areas in Lithuania. The diagnoses of dental fluorosis followed the Thylstrup-Fejerskov Index (TFI), and a diagnosis of dental caries followed the World Health Organization criteria. In the HF area, 66% of the 12-yr-old children had dental fluorosis (TFI score > 0) compared with 4% in the LF area. The maximum TFI severity scores in the two areas were 7 and 3, respectively. The mean number of teeth with fluorosis was 4.5 [95% confidence interval (CI) = 4.0, 5.0] for the HF group and 0.2 (95% CI = 0.1, 0.2) for the LF group. In the HF group, 72% had a decayed, missing or filled teeth (DMFT) score of > 0, compared with 87% in the LF group. The mean DMFT was 2.0 (95% CI = 1.8, 2.3) in the HF group and 3.5 (95% CI = 3.2, 3.8) in the LF group. Current untreated caries (DT) occurred (DT > 0) in half of both the HF and LF groups. Regardless of the concentration of fluoride in the drinking water, the prevalence of past (DMFT > 0) and present (DT > 0) caries was high, calling for more emphasis on the prevention of tooth decay in countries such as Lithuania with high caries figures and a developing oral healthcare system.

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Keywords: Dental caries; Dental fluorosis; Lithuania; Thylstrup-Fejerskov index.

PREVALENCE OF ENAMEL DEFECTS AND THE RELATIONSHIP TO DENTAL CARIES IN DECIDUOUS AND PERMANENT DENTITION IN INDAIATUBA, SAO PAULO, BRAZIL

The aim of this study was to determine the prevalence of hypoplasia, demarcated opacity, and dental fluorosis among schoolchildren with deciduous and permanent dentition and also to determine whether an association with dental caries was present. The sample consisted of 624 schoolchildren aged 5 and 309 aged 12. The dmft and DMFT indexes were used to assess dental caries prevalence, DDE to assess enamel defects, and the Dean classification to assess dental fluorosis. The Chi-squared test was used to test significance (p < 0.05) and odds ratio to analyze prevalence of dental caries and enamel defects. A positive association between dental caries and enamel defects (hypoplasia, demarcated opacity, and dental fluorosis) was observed for schoolchildren aged 5. However, only hypoplasia and demarcated opacity were associated with caries experience in permanent dentition. The results of this study indicated that children had increased odds of dental caries when enamel defects were present, both in deciduous and permanent dentition. Further studies are needed to verify this association.

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Keywords: Demarcated opacities; Dental caries; Dental fluorosis; Enamel defects; Hypoplasia; Indaiatuba, Sao Paulo, Brazil.
Source: Cadernos de saude publica/Ministerio da Saude, Fundacao Oswaldo Cruz, Escola Nacional de Saude Publica 2007;23(2):435-44 [in Portuguese].
HEALTH/TOXIC EFFECTS IN HUMANS

Editor’s Note: When published more than ten years ago, the following valuable report warning about serious hazards of handling concentrated hydrofluoric acid was unfortunately overlooked for abstracting in *Fluoride*.

**FATALITY DUE TO ACUTE FLUORIDE POISONING FOLLOWING DERMAL CONTACT WITH HYDROFLUORIC ACID IN A PALYNOLOGY LABORATORY**

A 37-year-old male laboratory technician was performing acid digestion of sedimentary rock samples with 70% w/w concentrated hydrofluoric acid in a fume cupboard. He was believed to be seated when he knocked over a small quantity (100–230 mL) of the hydrofluoric acid onto his lap, splashing both thighs. He sustained burns to 9% of his body surface area, despite washing his legs with water from a makeshift plumbing arrangement that supplied water at low pressure. No calcium gluconate gel was applied to the affected area and contaminated clothing was not removed during the flushing with water. Following flushing, because he was still in severe pain and shock, he immersed himself in a chlorinated swimming pool at the rear of the workplace, where he remained for approximately 35–40 min before ambulance help arrived. At that time he was hypothermic and hypocalcaemic on admission to an intensive care unit at a nearby hospital, and soon became unconscious. His condition continued to deteriorate despite subcutaneous injections of calcium gluconate and administration of intravenous calcium and magnesium. His right leg was amputated seven days after the incident. He subsequently died from multi-organ failure 15 days after the spill. Adequate personal protective equipment during the handling of concentrated hydrofluoric acid could have prevented this death. The purpose of this paper is to raise awareness of the inherent dangers associated with dermal contact with concentrated hydrofluoric acid and of the importance of observing strict precautions when handling it.

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Keywords: Calcium gluconate gel; Chlorinated water; Dermal contact; Fluoride fatality; Hypocalcaemia; Hypothermia; Hydrofluoric acid; Intravenous Ca and Mg; Rock digestion.

**EFFECT OF HIGH FLUORIDE CONCENTRATION IN DRINKING WATER ON CHILDREN’S INTELLIGENCE**

**Background and Aim:** In recent years, various human and laboratory animal studies linking fluoride with diminished intelligence have been published. Although adverse effects of high intake of fluoride on intelligence and mental acuity continue to be reported, they are still controversial. The aim of this research was to investigate the relationship between fluoride in drinking water and IQ in children who had lived all their lives in two villages near the Qazvin in Iran with different levels of fluoride in the drinking water.

**Materials and Methods:** In this cross-sectional study, 41 children aged 7–11 years were selected from the high fluoride Najmabad area with 2.5 mg fluoride ion/L (ppm) in the drinking water, and 85 children of the same ages were selected from the low fluoride Zoyar area with 0.4 mg fluoride ion/L (ppm) in the drinking water. The intelligence quotient (IQ) of each child was measured by the Raven's test. The history of illnesses affecting the nervous system, head trauma, birth weight (>2.5 kg), residential history, age, and sex of children were investigated by questionnaires completed by the children’s parents. Data were analyzed by Chi-Square test with p<0.05 as the limit of significance.

**Results:** In the high fluoride area the mean IQ of children was 87.9±11, which was significantly lower (p = 0.025) than the 98.9±12.9 mean IQ of children in the low fluoride area. In the high fluoride area, 56.1% of the children were in the retardation (<70 IQ), borderline (70–79), or dull normal (80–89) categories, whereas only 16.5% of the children in the low fluoride area were in these ranges.

**Conclusion:** Based on the findings of this study, exposure of children to high levels of fluoride may carry the risk of impaired development of intelligence.
FLUORIDE-RELATED BONE DISEASE ASSOCIATED WITH HABITUAL TEA CONSUMPTION

Acquired osteosclerosis is ordinarily a rare disorder of bone formation but an important consideration in adults with sclerotic bones or elevated bone density findings. In such patients, malignancy, hepatitis C, and fluorosis should all be considered when making a diagnosis. We describe four patients evaluated at our Metabolic Bone Disease Clinic from May 1, 1997, to July 1, 2006, whose bone disorders resulted from chronic fluoride exposure due to excessive intake of tea. Three of these patients had toxic serum fluoride levels (>15 micromol/L = 0.285 mg F⁻/L). Although the clinical presentation of the patients varied, all four had an unexpectedly elevated spine bone mineral density that was proportionately higher than the bone mineral density at the hip. Other clinical features included gastrointestinal symptoms such as nausea, vomiting, and weight loss; lower extremity pain sometimes associated with stress fractures of the lower extremities; renal insufficiency; and elevated alkaline phosphatase levels. Readily available, tea often contains high levels of fluoride. Obsessive-compulsive drinking behaviors and renal insufficiency may predispose to excessive fluoride ingestion and accumulation. The current cases show that fluoride-related bone disease is an important clinical consideration in patients with dense bones or gastrointestinal symptoms and a history of excessive tea consumption. Furthermore, elevated fluoride intake should be considered in all patients with a history of excessive tea consumption, especially due to its insidious nature and nonspecific clinical presentation.

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Keywords: Alkaline phosphatase; Bone disease; Bone mineral density; Excessive tea consumption; Fluorosis; Hepatitis C; Osteosclerosis; Renal insufficiency; Serum fluoride; Stress fractures; Weight loss.

COMBINED STUDIES ON FLUORIDE AND ARSENIC

SCREENING HIGH-FLUORIDE AND HIGH-ARSENIC DRINKING WATERS AND SURVEYING ENDEMIC FLUOROSIS AND ARSENISM IN SHAANXI PROVINCE IN WESTERN CHINA

The objectives of this study were to screen high-fluoride and high-arsenic drinking waters, to evaluate the effectiveness of fluoride-reducing projects, and to assess the present condition of endemic fluorosis and arsenism in Shaanxi province in western China. For screening high-fluoride drinking waters, five water samples were collected from each selected village where dental fluorosis was detected in 8–12 year-old children. For evaluating the effectiveness of fluoride-reducing projects, four water samples were collected from each project at end-user level. Fluoride concentrations in water samples were measured by fluoride-selective electrode method or spectrophotometry. Dental fluorosis in children aged 8–12 years was examined according to Horowitz’s Tooth Surface Index of Fluorosis. Skeletal fluorosis in adults was detected clinically and radiologically according to Chinese Criteria of Clinical Diagnosis of Skeletal Fluorosis. For screening high-arsenic waters, 20 water samples were collected from each village selected from areas characterized by the geographic features to induce high-arsenic underground water, i.e., alluvial plains, ore mining or smelting areas, geothermal artesians, and thermal springs. Arsenic concentrations in water samples were determined by spectrophotometry or arsine generation atomic fluorospectrophotometry. Arsenism in adults aged 40–89 years was examined in villages with arsenic concentrations in drinking water above 0.05 mg/L according to Chinese Criteria for Classification of Endemic Arsenism Areas.
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and Clinical Diagnoses of Endemic Arsenism. The results showed that the fluoride level of 7144 water samples was 1.17 ± 0.93 mg/L. There were 3396 (47.6%) high-fluoride waters (fluoride level above 1.0 mg/L) distributed in 786 (45.1%) villages, where about 0.8 million (50.0%) of the population lived. Additionally, the 1315 fluoride-reducing projects were studied. The fluoride level of the projects was 2.79 ± 1.09 and 0.98 ± 0.47 mg/L before and after building the projects, which remained at the relatively lower level of 1.03 ± 0.47 mg/L. However, 58.0% of the projects still provided drinking waters with fluoride concentrations above 1.0 mg/L. Overall, the rates of dental fluorosis and skeletal fluorosis were 38.2% and 11.8%, respectively. The mean arsenic level of 1732 water samples was 0.010 mg/L with considerable variation. There were 174 (14.9%) high-arsenic waters (arsenic level above 0.010 mg/L) distributed among 41 (38.7%) villages. The arsenic level in 53 (4.5%) water samples was above 0.025 mg/L. There were three villages with arsenic levels in drinking water above the Chinese National Permissible Limits (0.050 mg/L), and the prevalence rate of arsenism reached 37.0% in these three villages with 3.7%, 22.2%, and 11.1% of subjects suffering from mild, moderate, and severe arsenism, respectively. Conclusion: The wide distribution of high-fluoride drinking waters contributes to the prevalence of dental and skeletal fluorosis in Shaanxi province, and the quality of fluoride-reducing projects should be further improved. Ore mining and smelting create high-arsenic drinking waters, resulting in a high prevalence of arsenism in Shang-luo city. Proper measures should be taken to deal with water pollution in the ore mining and smelting areas in order to solve the high-arsenic water problem in Shaanxi province.

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Keywords: Endemic arsenism; Endemic fluorosis; Ore mining and smelting; Shaanxi province; China; Skeletal fluorosis; Water arsenic; Water fluoride.

TOXIC FLUORIDE AND ARSENIC CONTAMINATED GROUNDWATER IN THE LAHORE AND KASUR DISTRICTS, PUNJAB, PAKISTAN, AND POSSIBLE CONTAMINANT SOURCES

The present study is the first attempt to put forward possible sources of As, F⁻, and SO₄²⁻ contaminated groundwater in the Kalalanwala area, Punjab, Pakistan. Five rainwater and 24 groundwater samples from three different depths were analyzed. Shallow groundwater from 24 to 27 m depth contained high F⁻ (2.47–21.1 mg/L), while the groundwater samples from the deeper depth were free from fluoride contamination. All groundwater samples contained high As (32–1900 µg/L), in excess of WHO drinking water standards. The SO₄²⁻ ranged from 110 to 1550 mg/L. Delta 34S data indicate three sources for SO₄²⁻: air pollutants (5.5–5.7 per thousand), fertilizers (4.8 per thousand), and household waste (7.0 per thousand). Our important finding is the presence of SO₄²⁻, As, and F⁻ in rainwater, indicating their contribution from air pollution. We propose that these pollutants originate, in part, from combustion of brick factories, and were promotionally mobilized by the alkaline nature of the local groundwater.

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Keywords: Air pollution; Arsenic; Brick factories; Coal; Fertilizers; Fluoride; Household waste; Punjab, Pakistan; Sulphates.

EFFECTS OF INDIVIDUAL AND COMBINED EXPOSURE TO SODIUM ARSENITE AND SODIUM FLUORIDE ON TISSUE OXIDATIVE STRESS: ARSENIC AND FLUORIDE LEVELS IN MALE MICE

Arsenic and fluoride are potent toxicants, widely distributed through drinking water and food, and often result in adverse health effects. The present study examined the effects of sodium meta-arsenite (100 mg/L in drinking water) and sodium fluoride (5 mg/kg) ingested orally, once daily, and administered either alone or in combination for 8 weeks, on various
biochemical variables indicative of tissue oxidative stress and cell injury in Swiss albino male mice. A separate group of mice was first exposed to arsenic for 4 weeks followed by 4 weeks of fluoride exposure. Exposure to arsenic or fluoride led to a significant depletion of blood delta-aminolevulinic acid dehydratase (ALAD) activity and glutathione (GSH) level. These changes were accompanied by increased levels of blood and tissues reactive oxygen species (ROS) level. An increase in the level of liver and kidney thiobarbituric acid reactive substance (TBARS), along with a concomitant decrease in the activities of superoxide dismutase (SOD), catalase, and glutathione peroxidase (GPx), and reduced GSH content were observed in both arsenic and fluoride administered mice. The changes were significantly more pronounced in arsenic than in the fluoride exposed animals. It was interesting to observe that during combined exposure the toxic effects were less pronounced compared to the effects of arsenic or fluoride alone. In some cases antagonistic effects were noted following co-exposure to arsenic and fluoride. Arsenic and fluoride tissue concentration levels increased significantly on exposure. However, their concentrations decreased significantly with concomitant exposure for 8 weeks. On the other hand, the group that was administered arsenic for 4 weeks followed by 4 weeks of fluoride administration showed no such protection, suggesting that the antagonistic effect of fluoride on arsenic or vice versa is possible only during interaction at the gastrointestinal sites. These results are new and interesting and require further exploration

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Keywords: Arsenic; Catalase; Fluoride; Glutathione peroxidase; Reactive oxygen species; Sodium meta arsenite; Sodium fluoride; Superoxide dismutase; Swiss albino male mice; Thiobarbituric acid-reactive substance.

GROUNDWATER AND URINARY FLUORIDE

FLUORIDE IN DRINKING WATER AND HUMAN URINE IN SOUTHERN HARYANA, INDIA

The objective of this study was to determine the fluoride content in drinking water and urine samples of adolescent males aged 11-16 years living in Southern Haryana, India. A total of 30 drinking water sources in the studied habitations were assessed for fluoride contamination. Fluoride was estimated in the urine of 400 male children randomly selected from these habitations. The fluoride concentration in drinking water and urine samples was determined using the USEPA fluoride ion selective electrode method. The mean fluoride concentrations in drinking water samples of Pataudi, Haily Mandi and Harsaru villages were 1.68±0.35, 3.22±1.18 and 1.78±0.12 mg/L, respectively. The mean urinary fluoride concentration was 2.26±0.024 mg/L at Pataudi, 2.48±0.77 mg/L at Haily Mandi, and 2.43±0.84 mg/L at Harsaru village. The higher fluoride levels in the urine of children may be associated with higher fluoride levels in drinking water. The accuracy of measurements was assessed with the standard addition method in water and urine. Mean fluoride recovery was 98.0% in water and 99.1% in urine. The observed levels were reproducible within an error limit of ±3%.

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Keywords: Fluoride in drinking water; Fluoride ion selective electrode method; Southern Haryana, India; Human urine samples.
APATITE CRYSTAL FORMATION

EFFECT OF FLUORIDE IONS ON APATITE CRYSTAL FORMATION IN RAT HARD TISSUES

Crystal perforation caused by fluoride exposure has been observed in human dental enamel. The mechanism underlying this crystal perforation and whether fluoride directly affects crystal formation remain unclear. The purpose of the present study is to clarify the phenomenon of crystal perforation and to provide a possible mechanism of fluoride ions on the formation of apatite crystals. In this study, we examined the hard tissues of rats having received water freely containing a relatively low fluoride level (0.1, 0.3, 0.5 and 2 mg/L). In addition, we have focused our attention on carbonic anhydrase activity in the developing enamel matrix obtained from 0.1 to 0.5 mg/L fluoride groups because this enzyme is needed for initiating the crystal nucleation process. From electron microscopy, we observed the presence of perforated enamel crystals obtained from the 15-week-old rats in the 0.5 and 2.0 mg/L fluoride groups, suggesting that fluoride intake could interrupt the formation of the crystal nucleation process due to the lack of the central dark line. From the longitudinal sections of perforated crystals in the enamel, it appears that crystallization would occur continuously toward c-axis at the peripheral area, whereas the central area would remain amorphous, resulting in crystal perforation in the developing tooth enamel. Moreover, crystal defects with a fuzzy structure appeared in the bone, suggesting an increase of amorphous mineral in the bone. The results of the enzymatic analysis in the developing enamel matrix obtained from the 8-week-old rats showed the tendency of crystal quality to decline with an increase in fluoride levels. In addition, immunoblotting analysis indicated that the quantity of carbonic anhydrase was markedly reduced in the 0.5 mg/L fluoride group, suggesting that fluoride directly interfered with the synthesis of carbonic anhydrase necessary for enamel-forming cells, rather than being directly involved in crystal formation. From these results, we conclude that regardless of its amount, fluoride intake definitely has harmful effects on the formation of apatite crystals, resulting in perforated crystals in the enamel and an increase of amorphous minerals in the bone.

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Keywords: Apatite crystal formation; Bone abnormality; Carbonic anhydrase; Central dark line; Crystal abnormality; Dental enamel; Electron microscopy.