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Fluoridation – Are the Dangers Resolved?
(From New Scientist May 5, 1983)

During the past several years, reports in a series of highly re-
spected scientific journals, including The Journal of the American Chem-
ical Society (1), Science (2), and both The British Medical Journal (3)
and The British Dental Journal (4) have warned that individuals are re-
ceiving fluoride from a growing number of sources and that too much flu-
oride can be harmful. As pointed out in 1981 by John Emsley of King's
College, London (5) "A warning bell has sounded: through the agency of
the strong hydrogen bond, fluoride can change the chemistry of many com-
pounds. What it may be capable of doing in the living cell whether for
good or ill remains to be discovered."

Back in 1945, it was estimated that the daily fluoride intake from
drinking 1 liter of fluoridated water would be 1 milligram. At that time,
self medication with fluoride was frowned upon because of the danger of
overdosage. Now fluoride is being ingested from many everyday sources
in addition to water, namely food, dental health products, medications,
as well as pesticide, insecticide and fertilizer residues,and even the
air we breathe.

An editorial in The British Dental Journal (4) warned that fluoride
supplement dosage levels recommended 20 years ago are too high, and that
they need modifying in the light of recent research, because of the in-
gestion of small doses of fluoride from many sources. These include
foodstuffs and beverages rich in fluoride, such as sardines and tea. A
50-gram portion of canned sardines could contribute 0.8 mg fluoride. In
Britain, particularly, many receive more than 1 mg fluoride daily from
drinking tea. Veterinarians, horticulturists and environmental scientist
have known for years that fluoride at very low concentrations can damage
vegetation, aquatic life and livestock; biochemists, physiologists and
toxicologists all know that fluoride is a potent enzyme poison. Chemists
have learned to expect the unexpected from this unpredictable element.

In January 1981, Emsley and others reported in The Journal of the
American Chemical Society (1) that fluoride and amides – organic salts
of ammonia – can form a new strong hydrogen bond. Many components with-
in living cells contain amide groups. Since hydrogen bonds formed be-
tween amides are the most important weak hydrogen bonds in biological
systems, disruption of these bonds by fluoride in the formation of much
stronger bonds may explain how the chemically inert fluoride ion inter-
feres in the healthy operation of living systems.

Thus the crucial issue is not the level of fluoride in a community
water supply per se, but whether fluoridation increases the risk that
certain people develop levels of fluoride in blood, even for a short
time, that can damage their cells and systems.

By means of a simple reliable method of measuring levels of ionic
fluoride in the blood, developed at Sweden's Karolinska Institute, even

very small doses of fluoride have been found to cause "normal" blood fluoride levels to surge to potentially harmful values. In 1977, Eckstrand (6), demonstrated that in a healthy adult male weighing 60 kg who swallowed 10 milligrams of fluoride, (a dose of 0.166 mg fluoride per kilogram body weight), levels of ionic fluoride in the blood peaked after about an hour to just over 0.4 ppm per kg of body weight. The equivalent amount needed to achieve similar peaks in a 10-kg infant and a 20-kg child would be 1.66 mg and 3.33 mg fluoride, respectively.

In some communities, more than 75% of children use toothpaste by the age of 18 months. Since children under 3 years - due to poorly developed swallowing reflexes - are incapable of rinsing effectively, a pre-school child may swallow 0.3 to 0.4 grams of toothpaste at each brushing (7). From this source alone, a daily intake in excess of 0.5 milligrams fluoride is common (8). The fluoride level in most fluoridated toothpastes is 1000 ppm.

In 1976 adverse reactions following gel applications were reported (9). More recently, in 1980, Swedish researchers found, in a 25-year old adult weighing 54 kg, that blood ionic fluoride levels of just over 1 ppm were reached 30 minutes after gel treatment (10), a level close to those reported to result in impaired kidney function. According to a recent article in The British Medical Journal (3), babies in fluoridated areas, who drink dried milk formula made up with 1 ppm fluoride water, are ingesting up to 100 times the amount of fluoride they would obtain from mother's milk. All locally grown and manufactured foods and beverages may contain increased amounts of fluoride, and foods cooked in fluoridated water increase consumers' fluoride intake.

Because overall fluoride intake has risen, and average blood ionic fluoride levels of the population are higher, individuals who ingest sub-milligram doses of fluoride run a greater risk of their blood ionic fluoride concentrations peaking to above the threshold level that can cause dental fluorosis or other ill-effects. Dental fluorosis, no matter how slight, is an irreversible pathological condition recognized by authorities around the world as the first readily detectable clinical symptom of previous chronic fluoride poisoning. It is clearly wishful thinking to insist that tooth-forming cells are the only ones in the body sensitive to fluoride. Obviously, fluoride ingested from drinking water cannot be considered in isolation from other sources of fluoride intake.

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DIAGNOSIS OF FLUOROSIS IN THE EARLY PHASE - AN OSSEOUS
RADIOGRAPHIC STUDY ON FLUORIDE-EXPOSED WORKMEN

by

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SUMMARY: Bone density in 663 workers exposed to inor-
ganic fluoride and in 249 healthy adults was compared.
All subjects were x-rayed using copper wedgeplates.
Some cases underwent intensive investigation for as
long as seven years. Bone density of pelvis and ti-
bia of healthy adults is reported. Average bone den-
sity of workers exposed to inorganic fluoride was
greater than that of healthy adults.

Bone density increased in direct relation to ex-
posure time. In some cases, other radiographic changes
were also observed. Density of bone seems to decrease
with the passage of time after discontinuance of expo-
sure.

KEY WORDS: Bone fluorosis; Early x-ray diagnosis; Industrial fluorosis.

Introduction

It is well known that chronic fluoride intoxication in humans can pro-
duce distinct bone diseases, including generalized osteosclerosis, altera-
tion in bone structure and ossification of interosseous membranes and mus-
cle attachments. Among radiographic findings are increase of radiographic
bone opacity and formation of excrescences around bone. Whereas diagnosis
of fluorosis in the latter phase is no problem, early fluoride-induced
changes in osseous radio-opacity are not obvious. Many factors affect the
quality of the radiographic films, such as the projection condition of
x-ray and the development process. Opinions differ regarding the reading
of films. Thus the diagnosis of fluorosis in the early phase has present-
ed a problem. Some doctors believe that bone density had increased where-
as others attribute the apparent increase in bone density to the projec-
tion and developing condition.

To obtain an objective index for diagnosis in the early phase, we
have been using copper-wedge plates which are x-rayed with the body to
compare bone density. Since 1975, we have investigated 663 workers ex-
posed to inorganic fluoride, some of whom have been intensively studied,
and 249 healthy adults. By this method the diagnosis of fluorosis in the
early phase was possible.

From Hunan Metallurgical Industrial Hygiene Institute, Shu Mu Ling, Chang-
sha, Hunan, People's Republic of China.

Materials and Methods

Our study involved 212 aluminum and 451 phosphate fertilizer plant male workers, ranging in age from 20 to 56 (average 31.9), who had been exposed to fluoride for 2-29 years. The fluoride in their drinking water is below 1 mg/l. None had been previously diagnosed as having fluorosis at any stage.

Of 249 healthy adults who served as controls, aged from 18 to 55 (average 30.2), 224 were male and 25 female. Fluoride in their water supply was below 1 mg/l. The air to which they were being exposed was low in fluoride.

Preparation of Copper Wedge Plates:

1. For comparing pelvic density, wedge plates were made of 10 layers of 0.2 mm copper slices (containing Cu 99.9%). The first layer is 0.2 mm thick, the second 0.4 mm; the tenth is 2 mm. Each layer is 2 cm wide and 1 cm long. The outer edges of the wedge-plates are welded.

2. For comparing tibia density, wedge plates are made the same as above, but each layer is 0.1 mm.

At the time of projection under x-ray, the copper wedge plate is placed on the side of body and its shadow should be x-rayed out of soft tissues.

Construction of Photo-electric Meter: In a wood box, 20 x 25 x 18 cm, a 10V, 7.5A lamp was used. Light rays penetrated through a 1 cm square window. The pelvic or tibia area with which density is being compared with the copper wedge-plates should be placed in the window. A 3DU33 photo-electric tube which is connected to a milli-ampere meter, receives light rays. The changes in current are proportional to the transmission of light.

The Investigation of Bone Density Index: In pelvic films, antero-posterior projection, the density of iliac spongiosa in a 1 cm square area which is at the same low margin level of the sacro-iliac joint is compared with the copper wedge-plates. In this way the corresponding wedge-plates index is found.

In tibia films of the antero-posterior projection, the density of spongiosa in the upper section is compared with the wedge-plates to determine the index. The area used to compare bone density should be homogeneous in density; intestinal gas and areas in which the density is partially higher should be avoided.

Results

Bone Density of Healthy Adults: Using the above-described method, we found that bone density of healthy adults had a normal distribution, as in Table 1. The pelvis averaged 7.00 in the index and the standard deviation (s.d.) was 0.8. The tibia averaged 5.2 and the s.d. was 0.40 (Table 2).

Li Yumin and Wu Keqin

Table 1

Pelvic Density Index
249 Healthy Adults

Index	5	6	7	8	9	10
Number	7	54	126	56	5	1
Total Cases %	2.81	21.68	50.6	22.49	2.01	0.4

Table 2

Tibia Density Index
107 Healthy Adults

Index		4	5	6
Number of cases		6	76	25
Total cases %		5.6	71.0	23.4

The t test of density index among every age group and both sexes suggested that there were no significant differences.

Bone Density of Workers Exposed to Fluoride in Industry: 663 aluminum and phosphate fertilizer plant workers were investigated. Bone density of fluoride workers was higher than in healthy adults. The results of pelvic studies are shown in Tables 3 and 4; of 176 aluminum plant workers, who were studied for tibia density, in Table 5.

Table 3

Pelvic Density Index
212 Aluminum Plant Workers

Index	7	8	9	10
Number	47	135	24	6
Total Cases %	22.1	63.7	11.3	2.9

Table 4

Pelvic Density Index
451 Phosphate Fertilizer Workers

Index	6	7	8	9	10
Number	26	110	219	90	6
Total Cases %	5.8	24.4	48.6	19.9	1.3

Four years of intensive investigation of 64 aluminum plant workers who had been exposed to fluoride for 7-26 years (average 15.6 years), disclosed no case of decrease in pelvic density. In 34 workmen (53.1% of the total), pelvises had increased more than 1 point in the index during four years; 9 workers (26.5% of 31 persons investigated) increased more than 1 point in the index (Table 6) during two years.

Table 5

Tibia Density Index
176 Aluminum Plant Workers

Index	5	6	7
Number	48	115	13
Total Cases %	27.3	65.3	7.4

Table 6

Changes in Pelvic Density Index
64 Aluminum Workers

Index	7	8	9	10	Year
Number	21	35	7	1	
Total Cases %	32.8	54.7	10.9	1.6	1975
Number	3	16	11	1	
Total Cases %	9.7	52.0	35.5	3.2	1977
Number	6	17	25	16	
Total Cases %	9.4	26.6	39.1	25.0	1979

Intensive investigation of 20 aluminum plant workers for seven years, whose length of service was 7-24 years (average 16.1 years) revealed that in 12 persons bone density increased more than 1 point in the index. In only one had it decreased 1 point in the index. The results are shown in Table 7.

Table 7

Changes in Pelvic Density Index, During
Seven Years in 20 Aluminum Workers

Index	7	8	9	10	Year
Number of cases	9	10	1		1975
Total cases %	45.0	50.0	5.0		
Number of cases	4	7	7	2	1982
Total cases %	20.0	35.0	35.0	10.0	

In 14 aluminum plant workers in whom fluoride exposure had been discontinued, duration of nonexposure ranged from 8 to 16 years. Their years of service, before discontinuance, ranged from 6 to 29 years. In 5 persons the index decreased, in 3 it increased (Table 8).

Table 8

Changes in Pelvic Density Index in 14 Aluminum Workers
in Whom Fluoride Exposure was Discontinued

No. X-ray	Years of Exposure	Years of Nonexposure	Index in 1975	Index in 1982
187	6	16	8	7.5
197	9	14	9	8
424	8	14	7	7.5
280	10	12	7	6
287	29	12	8	7
286	12	11	8	9
272	10	11	7	7
283	10	11	9	8
282	6	11	8	8
194	6	10	8	8
281	12	10	7.5	9
279	8	9	8	8
-	18	9	10	10
278	10	8	7.5	7.5

The relationship between changes in pelvic density and other radiographic changes: In 49 subjects pelvic density increased, in 14 other x-ray changes, such as excrescences around bone, became worse or alteration in bone structure became obvious (Table 9).

The relationship between pelvic density index and formation of excrescences around some bones is presented in Table 10.

Table 9

Relationship Between the Changes of Pelvic Density Index
and Other Osseous Radiographic Findings

No. X-ray	Years of Exposure	Index				Other X-ray Findings
		1975	1977	1979	1982	
199	13	6		9.5		Cortex of radius thicker
118	14	8		8.5	10	Changes in osseous structure more obvious
293	15	7		8.5	9.5	Bone structure thicker and sparser
124	16	7.5		9.5		Bone structure thicker
040	20	8		10		Bone structure coarser
296	18	8			9	Abnormal ossification in left ilium enlarged
299	21	8			10	Cortex of tibia thicker
091	21	8			9	Excrescences in obturator foramen, radius, fibula intensified
281	22	7.5			9	Excrescence in obturator foramen, tibia intensified
200	13	7.5	8		9	Bone structure coarser
105	16	7	8		9	Excrescences in L-4 intensified
142	17	8	9	10		Excrescences in tibia, acetabulum intensified
144	13	8	9		10	Bone structure coarser.
154	13	8	8	10		Excrescence in acetabulum intensified

All these cases have excrescences around some bone: tibia, radius, obturator foramen or ilium. Only intensified changes listed.

Table 10

Pelvic Density Index Related to
Formation of Bone Excrescences
in 98 Aluminum Workers

Index	7	8	9	10
No. of excresc. cases	4	12	20	15
Total cases	14	33	32	19
Excresc. cases / Total cases %	28.6	36.4	60.6	78.9

Discussion

It is well known that osteosclerosis and excrescences around bone are characteristic of fluorosis (1). Reports of industrial and endemic fluorosis are numerous (2-4).

According to Roholm (5) fluorosis can be classified in three stages. In addition Fritz described two prestages (6). The earlier the stage of the disease, the more difficult is the diagnosis. Some authors, who are engaged in diagnosis of the early phase, have recommended effective methods (6,7,8).

Waldbott (9,10) in his extensive studies of the nonskeletal phase of fluorosis has found such manifestations as malaise, headaches, backaches,

gastrointestinal disorders, arthralgia, and paresthesias, which we believe are primary clinical symptoms of fluorosis. In our original investigation in 1975, we checked the clinical symptoms on 83 healthy adults and 227 workmen at an aluminum plant. The results appear in Table 11.

Considering fluorosis as permanent osteosclerosis, we have investigated the density of bone. The results demonstrate that fluoride-induced density of bone increases in industrial workers. In fluorosis, spongy

Table 11
Clinical Differences Between 227 Aluminum Plant Workers and 83 Healthy Adults

	Years of Service	No. of Cases	Head-ache %	Malaise %	Gastric & Intest. Disorders %	Arthralgia & Backache %	Insomnia %
Healthy	0	83	9.6	31.3	10.8	18.1	10.8
Adults	5-	160	8.8	45.6	23.1	19.4	11.2
Workmen	10-	50	18.0	50.0	22.0	22.0	24.0
	15-	17	23.5	82.4	0	64.7	35.3

bone becomes coarser and more compact (4,11), and high calcium deposits accumulate in it (2,12). Therefore, density of bone is based on the osseous structure. In our investigation, if bone density is above 9 points in the index, the radiographic findings correspond to 0-1 stage of fluorosis according to Fritz (6), showing density of bone-structure and enlargement of bone trabeculae in pelvis and lumbar spine.

There are a few reports of osteoporosis in endemic fluorosis (13). However, in our investigation, we have not found one subject with continuing exposure to fluoride in whom pelvic density has decreased as in other descriptions of industrial fluorosis (2, 3). Perhaps the nutrition levels in workers are more adequate than that of the general population in endemic fluorosis areas or other unknown factors are involved.

Can a fluorosis victim recover after cessation of fluoride exposure? In a few reports, the degree of skeletal sclerosis declined but ossification of ligaments persisted (2,11). Our results demonstrate that the density of bone has decreased after cessation of fluoride exposure (Table 8). In 5 subjects, bone density decreased 0.5-1 index points. However, patient number 281 residing in a fluoride-polluted area even though he was no longer exposed to fluoride pollution at work, deserves special attention (see Table 8). The increases in bone density were accompanied by more intensified excrescences (Table 9). This may cast light on the cause of increases in bone density.

Ossification of ligaments and formation of excrescences around bones are characteristics of fluorosis (2,4). Our results show that the greater the pelvic density, the more excrescences occur around the bone (Table 10). Changes in pelvic density, however, preceded the ligament's ossification or the appearance of excrescences around bone.

Conclusion

Concerning the diagnosis of fluorosis in the early phase, the history of exposure to fluoride combined with use of copper wedge-plates suggest the following:

1. When pelvic density is 9 points in the index, regardless of whether or not there are subtle accompanying shadows along the bone of the forearm and leg, this case can be diagnosed as stage 0-1 fluorosis.

2. When pelvic density is higher than 9 index points with excrescences in at least two places, this case can be diagnosed as stage 1 fluorosis.

3. In the diagnosis of fluorosis, in stages 2 and 3, the wedge-plate method of comparing bone density is no longer necessary.

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URINARY FLUORIDE EXCRETION AMONG FLUOROTICS

by

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SUMMARY: In a fluorotic belt of Western India, where fluoride (F^-) in drinking water ranged from 1.42 to 11.80 mg per litre, urinary F^- excretion varied from 0.8 to 30.4 mg per litre. A statistically significant correlation was (a) positive between increasing F^- values in drinking water and urinary F^- excretion and (b) negative between calcium in drinking water and urinary excretion. In children 9 years and above, urinary F^- excretion was always higher than mean drinking water F^-. Fluoride in urine increased with severity of dental fluorosis. Urinary F^- values fluctuated after defluoridation was instituted.

KEY WORDS: Urinary fluoride; Fluorosis; India

Introduction

Fluoride ions are cumulative in nature; they are deposited in teeth, bones and soft tissues. F^- in urine, the principal route of F^- excretion from the human body, depends on a) total intake, b) the form in which F^- is taken into the body, c) whether the individual is relatively unexposed or regularly exposed, and d) the health status of the individual with regard to kidney function or disease.

McClure and Kinser (1) showed that urinary F^- is a function of intake for consistently exposed individuals. In Rajasthan, where a large population is exposed to high F^- levels in water (1.42-11.80 ppm), individuals have reached a state of steady balance (2). The present study aims at measuring a) urinary F^- excretion among children with different degrees of dental fluorosis, and b) the role of water quality in urinary F^- excretion among children residing in the fluorotic belt.

Material and Methods

An epidemiological study of endemic fluorosis was carried out in a fluorotic zone in Western India (3). Drinking water samples were collected and analyzed by standard methods (4). Urinary F^- was determined at the Neeri Chemistry Laboratory, Nagpur, by means of ion sensitive fluoride specific electrode. F^- values throughout this study have been expressed as mg per litre (ppm). Dental fluorosis has been classified according to Dean's (5) criteria with Møller's (6) modification.

Results

Table 1 shows the drinking water quality,   urinary F⁻ values and
alkalinity in a population of school children, 113 of whom were examined.
Correlation between increase in F⁻ drinking water and urinary F⁻ excre-
tion was significantly positive. Similarly, a negative correlation be-
tween calcium in drinking water and urinary F⁻ was significant. Alkalin-
ity of drinking water and urinary F⁻ were not significantly related.

Table 1
Drinking Water Quality Compared to Urinary Analysis

F⁻	pH	Drinking Water Quality				TDS*	Chlorides	Number	Average Urine Analysis	
		Alka-linity	Ca	Mg	Hardness as CaCO₃				F⁻	Alkalinity
1.42	9.0	383	50.4	115.7	640	2501	411.1	10	2.24	1040
2.60	8.2	450	30.4	28.1	192	681	14.0	43	6.16	1172
3.55	8.0	1040	28.8	53.5	258	1846	172.5	23	4.80	1231
4.00	7.9	700	27.2	27.1	180	1491	118.0	6	7.35	1420
6.90	8.3	807	11.2	18.9	174	1629	139.0	17	6.06	1107
7.50	7.4	824	24.0	37.8	216	2953	60.0	5	7.96	Not done
11.80	8.5	1064	14.4	25.2	140	3408	11.9	9	10.95	1131

Note: All observations are in terms of ppm. *TDS: Total dissolved solids.
Correlation between urinary F⁻:
and drinking water F⁻ r = +0.88 t:4.08 p < 0.001
and drinking water Ca r = −0.73 t:2.34 p < 0.05
and drinking water alkalinity r = +0.60 t:1.72 p > 0.1

In Table 2, urinary F⁻ excretion is compared with drinking water F⁻
according to severity of dental fluorosis. Up to 4 ppm F⁻ in drinking
water, urinary F⁻ excretion was higher than drinking water F⁻. As the
level of F⁻ in drinking water increased, urinary F⁻ values decreased.
The lowest urinary F⁻ value detected was 0.8 ppm in a child with very
mild dental fluorosis whose drinking water contained 1.42 ppm F⁻.   On
the other hand, a child manifesting severe dental fluorosis excreted 30.4
ppm F⁻ in urine while consuming 4 ppm F⁻ in water.

Table 3 shows the mean value of F⁻ in drinking water versus urinary
F⁻ in relation to age and degree of dental fluorosis. From 9 years of
age upwards, mean F⁻ excretion through urine was always higher than mean
drinking water F⁻. Increasing severity of dental fluorosis was directly
related to increase in urinary F⁻ excretion (117% to 150% among fluorotics).

In the area studied, only six months previously, the State Public
Health Engineering Department had provided a new water supply containing
2.6 ppm F⁻. Of 113 children, 33 were residing in the area where this
change had taken place. Their previous drinking water sources were con-
firmed. Fluoride values of their previous water source were compared to
the present water source and urinary excretion, as shown in   Table 4.
Urinary excretion increased in all but 4 children who previously had been
consuming water containing 7.5 ppm F⁻.

Table 2

Urinary F⁻ Level vs Severity of Dental Fluorosis

F⁻ in Drinking Water	Number	Mean-Urinary F⁻ (ppm) vs Dental Fluorosis						Mean Urinary F⁻ in Fluorotics
		Normal	Question-able	Very Mild	Mild	Moderate	Severe	
1.42	10	1.50	3.61	1.60	-	4.47	-	3.03
2.60	43	11.93	5.48	6.13	3.90	5.74	3.77	4.88
3.55	23	1.67	6.42	3.30	3.60	5.51	5.70	4.77
4.00	6	1.70	3.80	3.10	4.20	5.70	11.10	4.33
6.90	17	-	2.42	7.45	6.78	4.58	3.40	5.55
7.50	5	9.40	8.40	-	-	-	6.10	6.10
11.80	9	4.90	17.00	2.50	19.20	13.20	8.80	10.92

Table 3

Mean F⁻ Values of Drinking Water and Urine (ppm)
Compared to Dental Fluorosis and Age of Children

Age	Number		Normal	Question-able	Very Mild	Mild	Moderate	Severe	Mean
7	3	DW*	11.80	7.20	-	-	-	-	8.50
		Urine	4.90	12.00	-	-	-	-	8.45
8	8	DW	7.50	7.50	7.25	-	6.00	11.80	8.00
		Urine	9.40	8.80	4.75	-	6.53	8.80	7.49
9	6	DW	-	3.50	-	1.30	2.60	2.96	2.59
		Urine	-	7.50	-	3.40	3.30	5.33	4.88
10	12	DW	3.10	5.20	6.80	4.00	3.35	3.93	4.39
		Urine	4.25	5.25	5.40	8.40	7.25	19.70	8.37
11	18	DW	2.16	2.93	3.26	2.60	.4.16	2.60	2.95
		Urine	11.20	6.23	4.20	0.80	6.80	4.93	5.69
12	22	DW	-	2.42	4.08	-	4.07	3.77	3.58
		Urine	-	3.90	5.95	-	6.86	5.80	5.62
13	19	DW	--	2.57	2.60	8.46	2.88	2.60	3.82
		Urine	-	7.35	6.54	12.30	5.38	2.40	6.79
14	25	DW	2.60	4.31	3.71	4.50	8.60	4.82	4.75
		Urine	9.70	4.07	5.76	5.42	9.55	4.88	6.56
Mean	113	DW	5.43	4.45	4.61	4.17	4.52	4.64	4.82
		Urine	7.89	7.01	5.43	6.06	6.52	6.97	6.73
Urinary excretion			145%	157%	117%	145%	144%	150%	139%

*DW = Drinking water

Table 4

Urinary F⁻ in Persons Whose Drinking Water Sources Were
Changed to 2.6 ppm 6 Months Previously

Former Drinking Water F⁻	Number	Present Urinary Fluoride (ppm)		
		Average	Range	S.D. (±)
3.55	20	5.16	1.3 - 14.6	2.78
6.90	9	7.51	3.5 - 16.0	3.46
7.50	4	3.15	3.4 - 8.8	2.46
TOTAL	33	5.94	1.3 - 16.0	3.08

Discussion

Variability in F⁻ content of drinking water sources and recent at-
tempts at 'defluoridation' in the area studied caused us to observe the
pattern of urinary F^- excretion among its inhabitants. The effect of F^-
on human health stems largely from F^- present in drinking water. Hence
for comparison with urinary F^- excretion, drinking water F^- has been used
as an index (7). Hodge and Smith (8) concluded that, for a single indi-
vidual, 24-hour urinary samples form the basis of interpretation and de-
cision; for community surveys, however, spot samples can be utilized
when exposure of the people under study is presumably comparable and ex-
pression in terms of concentration, reliable. In addition, while col-
lecting spot urine samples,   precautions were taken to avoid physio-
logical variations by collecting samples within school premises during
half an hour.

McClure et al. (1) have reported 46-78% clearance of F^- in urine in
adults; Zipkin et al. (9) 54-65% excretion in urine. In the present se-
ries, however, it varied from 117-150% among fluorotics and up to 157% in
the questionable stage. A possible explanation may be (a) the younger
age of the population sampled, (b) a recent new water supply for a large
section of the sample. Urinary F^- of the 33 children, compared with
their present and past drinking water F^- values and mean urinary excre-
tion was higher than both past and present fluoride levels, with the ex-
ception of four children, who excreted 5.15 ppm F^- in urine compared to
past consumption value of 7.15 ppm F in water (Table 4). A possible ex-
planation may be that previously stored F^- is gradually liberated in the
urine. Likins et al. (10) likewise reported that after institution of
defluoridation in Bartlett, Texas, in March, 1952 - drinking water fluo-
ride was reduced from 8 ppm to 1 ppm - urinary F^- decreased over a period
of 27 months. A change in the water supply revealed that children 9 yrs.
old and above excreted a higher level of F^- in urine than in drinking wa-
ter.

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NORMAL URINARY FLUORIDE LEVELS IN JAPANESE SUBJECTS: RELATIONSHIP
BETWEEN URINARY FLUORIDE LEVELS AND ENVIRONMENTAL FLUORIDE

by

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SUMMARY: Normal values of F⁻ in 24-hour urinary excretion in 4700 healthy Japanese subjects residing in an environment not polluted by fluoride and not occupationally exposed to fluoride were studied. In male adults the normal values averaged 0.78 mg F/day, in female adults 0.56 mg F/day, in boys 0.23 mg F/day, and in girls 0.20 mg F/day. On the other hand, urinary fluoride excretion of persons residing in areas where fluoride levels in air or water were high and of workers exposed to airborne fluoride at work were significantly higher than normal. The normal values were more useful for evaluating the fluoride body burden in Japanese subjects.

KEY WORDS: Urinary fluoride, Japanese; Environmental fluoride

Introduction

Since 1950, industrialization and urbanization have progressed markedly in Japan. With the rapid development of aluminum smeltering, of phosphate fertilizer production, of the ceramics and steel industry, problems of air pollution by fluoride have yearly progressed and have become a cause for concern (1).

In Japan, airborne fluoride is a more serious health problem than waterborne fluoride. More than 90% of the total population now has access to communal water supplies; water fluoridation is not practiced.

Urinary fluoride excretion is widely considered one of the best in-
dices of fluoride absorption (2). Ishikawa (3) in our department has ob-
served that approximately 50% of fluoride absorbed is excreted in 24 hrs.
In the present paper normal 24-hr. urinary fluoride excretion values in
Japanese subjects have been presented according to seasons and compared
with values in persons exposed to fluoride air pollution.

Materials and Methods

In order to estimate the normal 24-hr. urinary fluoride excretion
values in Japanese subjects, urine samples were collected from about
4700 healthy persons residing in 9 different districts of the eastern
part of Japan where fluoride in drinking water was less than 0.1 ppm and
fluoride in air was 0.05 $\mu g/m^3$. The subjects had not been exposed to flu-
oride in their working environment.

On the other hand in epidemiological investigations on the effects
of environmental fluoride on human health in several districts in the
eastern part of Japan during the past 20 years (4-7), 24-hr. urine spe-
cimens of about 1100 persons residing in a fluoride-polluted environment
and 287 workers occupationally exposed to airborne fluoride were collect-
ed. No cases of kidney disease have been detected in these subjects.
Urinary fluoride levels and fluoride levels in air or water in the liv-
ing or working environment were related.

Table 1

The Normal Values of F⁻ Excretion (mgF) in the 24-Hour Urine
of Japanese Subjects by Sex and Age

Sex	Age (Years)	No. of cases	Arithmetic Mean	S.D.	Geometric Mean	S.D.	Median
Male	10 - 19	1175	0.24	0.14	0.21	1.66	0.22
	10-12	510	0.23	0.12	0.20	1.62	0.21
	13-15	533	0.23	0.14	0.21	1.62	0.22
	16-19	132	0.30	0.18	0.26	1.82	0.27
	20 - 29	80	0.45	0.25	0.40	1.58	0.39
	30 - 39	201	0.77	0.47	0.64	1.82	0.66
	40 - 49	517	0.78	0.46	0.66	1.78	0.67
	50 - 59	82	0.77	0.41	0.67	1.78	0.58
	60 - 69	125	0.80	0.59	0.63	2.04	0.65
	70 +	69	0.62	0.48	0.48	2.04	0.51
Female	10 - 19	1036	0.21	0.13	0.17	1.74	0.17
	10-12	445	0.20	0.12	0.17	1.74	0.17
	13-15	481	0.20	0.14	0.16	1.74	0.16
	16-19	110	0.25	0.15	0.21	1.78	0.20
	20 - 29	37	0.46	0.33	0.35	2.19	0.37
	30 - 39	513	0.53	0.36	0.44	1.86	0.45
	40 - 49	568	0.58	0.35	0.50	1.87	0.51
	50 - 59	38	0.59	0.25	0.64	1.55	0.53
	60 - 69	165	0.41	0.23	0.36	1.70	0.37
	70 +	93	0.37	0.31	0.30	1.91	0.38

Determination of urinary fluoride was carried out with the Ion Analyzer
(Orion Res., Inc., Cambridge, U.S.A. Model 407), fluoride electrode (Model
94-09) and specific ion electrode (Model 901-0.1) (8).

Figure 1

24-hour Urinary F⁻ Volume of Control Japanese
Subjects, by Sex and Ten Year Group
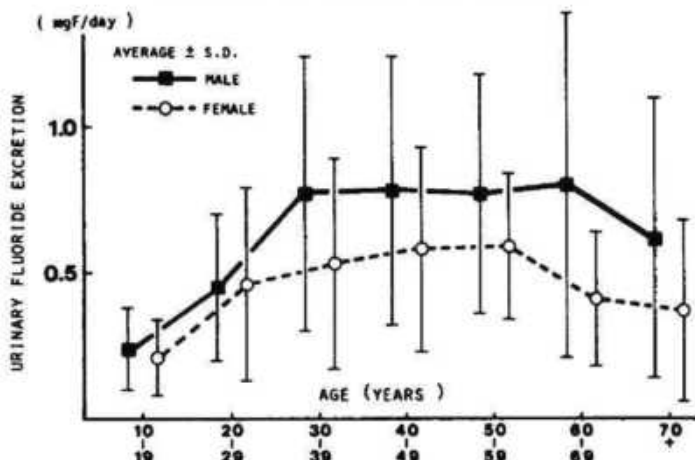
Discussion and Results

Normal 24-Hour Urinary Fluoride Excretion in Japanese Subjects: 24-hour fluoride excretion was measured in about 4700 normal subjects ranging from 10 to 84 years in age. The results shown in Table 1 and Figure 1 are classified according to sex and age.

Table 2

The Normal Values of F⁻ Concentration (ppm F⁻) in the 24-Hour
Urine of Japanese Subjects by Sex and Age

| Sex	Age (years)	No. of Cases	Arithmetic Mean	S.D.	Geometric Mean	S.D.	Median
	10 - 19	1175	0.28	0.15	0.25	1.66	0.26
	10-12	510	0.26	0.14	0.23	1.58	0.24
	13-15	533	0.29	0.16	0.26	1.66	0.27
	16-19	132	0.35	0.16	0.30	1.66	0.34
Male	20 - 29	80	0.34	0.15	0.31	1.51	0.31
	30 - 39	201	0.54	0.32	0.45	1.82	0.48
	40 - 49	517	0.53	0.32	0.46	1.74	0.47
	50 - 59	82	0.57	0.34	0.48	1.78	0.49
	60 - 69	125	0.50	0.32	0.42	1.82	0.44
	70 +	69	0.43	0.30	0.35	1.95	0.37
	10 - 19	1036	0.26	0.16	0.23	1.66	0.24
	10-12	445	0.24	0.14	0.21	1.62	0.23
	13-15	481	0.26	0.16	0.22	1.66	0.23
	16-19	110	0.35	0.20	0.30	1.74	0.30
Female	20 - 29	37	0.33	0.24	0.26	2.04	0.26
	30 - 39	513	0.40	0.25	0.34	1.78	0.36
	40 - 49	568	0.45	0.26	0.40	1.74	0.40
	50 - 59	38	0.47	0.28	0.52	1.70	0.40
	60 - 69	165	0.31	0.15	0.27	1.62	0.28
	70 +	93	0.31	0.24	0.26	1.82	0.24

In males, the normal values reach peak level of about 0.8 mgF/day during the 30's which persists until the 60's and falls in the 70's. Whereas the normal values in females rise more slowly, they reach the peak level of about 0.6 mgF/day in the 40's, which persists through the 50's and falls in the 60's.

With regard to the differences in urinary fluoride content between sexes, higher values are found in males than in females except in the 20's. The normal urinary fluoride excretion averaged 0.78 ± 0.46 mgF/day in 718 male adults aged 30-49 and 0.56 ± 0.36 mgF/day in 1081 female adults aged 30 to 49. Among adults more than 30 years of age, differences between sexes were significant ($p < 0.01$).

Table 2 summarizes the results for normal 24-hr. urinary fluoride concentration according to sex and age. Average normal values in the 10-year old group are shown in Figure 2. The normal fluoride concentration shows a pattern similar to that of normal urinary fluoride excretion, except that the normal concentration for males falls in the 60's, whereas the excretion amount falls in the 70's.

Figure 2

24-hour Urinary F⁻ Level of Control Japanese Subjects
by Sex and Ten Year Group
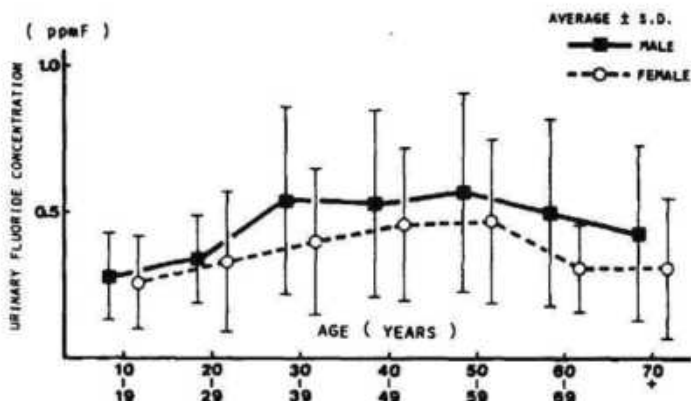
In school children aged 10 to 18, the 24-hr. urinary fluoride concentration and content, shown in Figure 3 are classified according to sex and three age groups.   The average values at ages 16 to 18 of both sexes are slightly higher than those of ages 10 to 12 or 13 to 15 ($p < 0.05$).   The normal urinary fluoride excretion averages 0.23 ± 0.13 mg/day in 1043 boys aged 10 to 15, 0.20 ± 0.13 mg/day in 926 girls aged 10 to 15.

Seasonal Variations in Normal 24-Hour Urinary Fluoride Excretion: Seasonal variation in urinary fluoride levels was observed in about 700 chil-

Figure 3

24-hour Urinary F⁻ Excretion of Control School Children
Aged 10-18, by Sex and Three Year Group
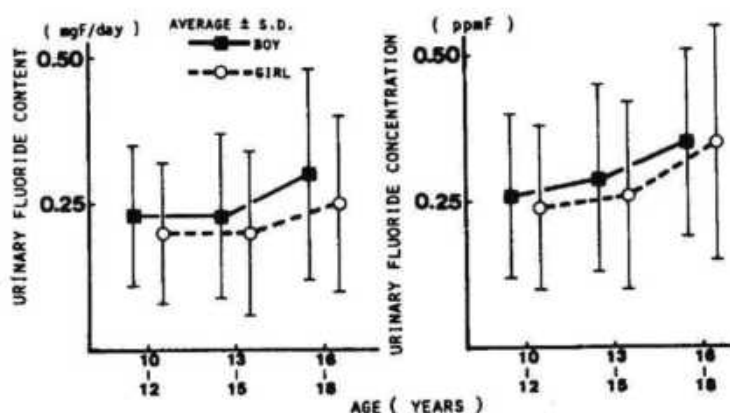
dren aged 10-15 and in 200 adults aged 40-49 in Sakata city as shown in Figures 4 and 5. The 24-hour urinary fluoride content in adults is significantly greater in spring and winter than in other seasons (Figure 4), but the concentration is significantly higher in spring than in autumn

Figure 4

24-hour Urinary F⁻ Levels, Seasonal Variations of
Control Adults Aged 40-49, by Sex
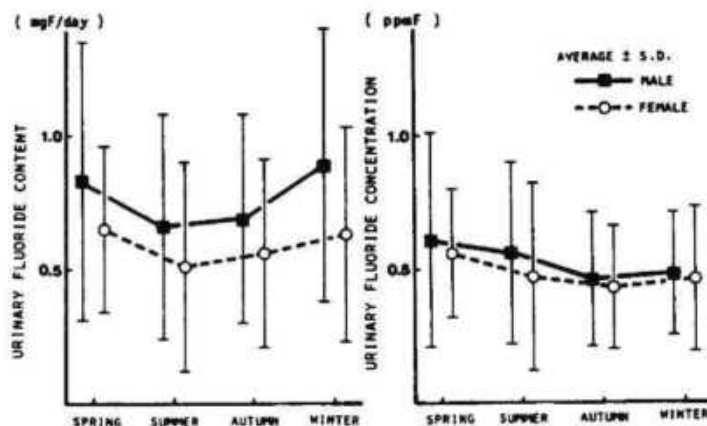
($p < 0.01$). Figure 5 shows that the seasonal variations in the urinary fluoride levels in school children are similar to those of adults, but the factors that influence the seasonal variations are not clear.

Figure 5

Seasonal Variation of 24-hour Urinary F⁻ Levels
in Control School Children Aged 10-15, by Sex
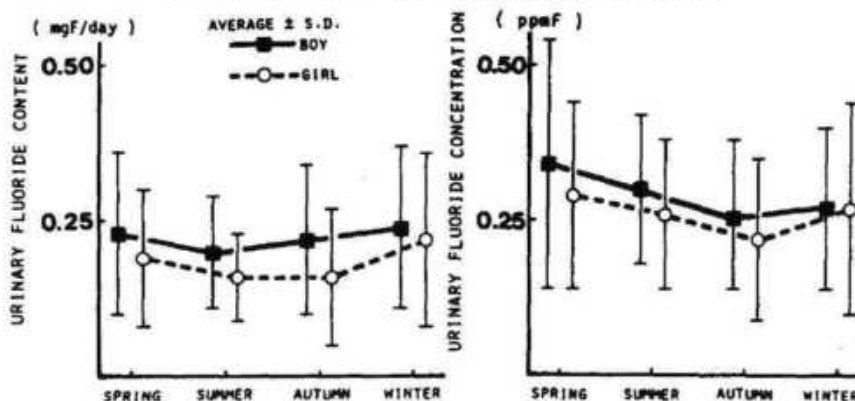
Urinary Fluoride Excretion in Fluoride-Exposed Populations:

a) The 24-hour fluoride excretion was measured in 289 male workers exposed to airborne fluoride at two aluminum smelters and a phosphate fertilizer plant. These workers were divided into the following six groups according to plant and year of investigation: Group 1 (1965) and Group 2 (1977) consisted of workers in aluminum smelter A; Group 3 (1975) Group 4 (1976), and Group 5 (1977) in aluminum smelter B; and Group 6 (1977) consisted of phosphate fertilizer workers. All had been drinking water containing less than 0.1 ppm F⁻.

Table 3

F⁻ Levels in the 24-Hour Urine of Workers Exposed to Airborne F⁻ at Their Work Place

| Industry	F⁻ in Air (mgF/m³)	No. of Subjects	Urinary F⁻ Excretion (mgF/day) Mean±S.D.
Aluminum smelter			
Gr. 1 (1965) Plant A	1,0 - 2.1	28	3.68 ± 1.56
Gr. 2 (1967)	0.3 - 1.0	42	1.32 ± 0.52
Gr. 3 (1975) Plant B	0.1 - 1.3	46	1.36 ± 1.03
Gr. 4 (1976	0.1 - 0.6	20	1.09 ± 0.36
Gr. 5 (1977)	<0.1 - 0.6	43	1.08 ± 0.4ε
Phosphate fertilizer			
Plant			
Gr. 6 (1977)	<0.1 - 0.7	110	1.07±0.65

Numbers in parentheses = year of investigation.

As shown in Table 3, the mean 24-hour urinary fluoride values of each group were higher than normal for Japanese male adults and the differences were statistically significant at the 0.1 level. Especially in Group 1, of 28 aluminum potmen with an atmospheric exposure level of 1.0-2.1 mgF/m³, the urinary fluoride excretion averaged 2.02 ± 1.02 mgF/day (Mean ± S.D.), significantly higher than those of the other five groups, but no osteosclerosis was found on x-ray examination.

b) Urinary fluoride levels of subjects drinking natural fluoride water (0.34 - 3.21 ppm): The 24-hr urinary fluoride excretion of 72

children aged 10-12 and 78 adults aged 40-49 residing in Itayanagi-cho in Aomori Prefecture, a natural fluoride area, was examined.

The subjects were divided into three groups according to the fluoride concentration in drinking water, as shown in Table 4. In all three groups the mean urinary fluoride values were significantly higher than the normal values (p < 0.01). Urinary fluoride excretion increased in relation to the level of fluoride in drinking water; the fluoride levels in 24-hour urine and their concentration in drinking water were directly related. No osteosclerosis was recognized in adult subjects but, in children, the incidence of dental fluorosis was 92% in Group A and 49% in Group B.

Table 4

F⁻ Levels in 24-Hour Urine of Residents in Areas
with High Natural F⁻ Content in Water

Group	F⁻ in Water (ppm)	Male Adult n	Male Adult M ± S.D.	Female Adult n	Female Adult M ± S.D.	Boy n	Boy M ± S.D.	Girl n	Girl M ± S.D.
A	3.07-3.21	12	4.35±1.22	12	4.30±1.08	13	3.15±0.92	8	2.03±0.65
B	1.02-1.56	11	2.50±1.32	17	1.75±0.51	15	1.17±0.34	14	1.06±0.38
C	0.34-0.64	11	2.06±1.02	15	1.05±0.39	14	0.60±0.22	8	0.45±0.20

n: number of subjects
M ± S.D.: Arithmetic mean with standard deviation

c) Urinary fluoride levels of subjects residing in fluoride-emitting industries: Urinary fluoride excretion of persons residing within 1 km of the fluoride-emitting aluminum smelter or phosphate fertilizer plants was measured. The subjects consisted of children aged 10-12 and adults aged 40-49 living in four different areas.

Table 5

F⁻ Levels in 24-Hour Urine of Residents in the
Vicinity of F⁻ Emitting Industries

Industry	F⁻ Levels in Air ($\mu g F/m^3$)	Urinary Fluoride Male Adult n	Male Adult M ± S.D.	Female Adult n	Female Adult M ± S.D.	Excretion (mgF/day) Boy n	Boy M ± S.D.	Girl n	Girl M ± S.D.
Aluminum smelter									
Plant A	5.2-14.0	13	2.02±1.08**	17	1.77±0.75**	-	-----	-	-----
Plant B	1.0- 4.0	177	1.15±0.61**	315	0.77±0.40**	39	0.25±0.11	37	0.25±0.11
Phosphate fertilizer									
Plant A	0.5-1.5	26	1.03±0.69*	22	0.74±0.31*	24	0.27±0.13	31	0.23±0.11
Plant B	0.3-0.5	52	0.82±0.53	74	0.50±0.30	73	0.19±0.11	51	0.17±0.08

n: Number of subjects; M±S.D.: Arithmetic mean with standard deviation; **: Mean is significantly greater than the normal value at the 0.01 level. *: Mean is significantly greater than the normal value at the 0.05 level.

Visible symptoms of fluoride injury and accumulation of fluoride on certain vegetation occurred in those areas (7). Atmospheric fluoride differed as shown in Table 5, but drinking water contained less than 0.1 ppm F-. The mean urinary fluoride values of each adult group in the air-polluted districts were significantly higher than the normal values except in the group of phosphate fertilizer plant B. The urinary fluoride levels of these subjects were far higher than what would have been expected from inhalation of airborne fluoride. However, in all groups of children the levels were not significantly different from normal values. No abnormal findings or disorders such as dental and skeletal fluorosis were apparent due to fluoride exposure in these subjects.

Urinary Fluoride Excretion as a Biologic Indicator for Monitoring a Fluoride Exposed Population: To prevent hazards to the population due to industrial fluoride pollution, measurement of urinary fluoride may be useful.
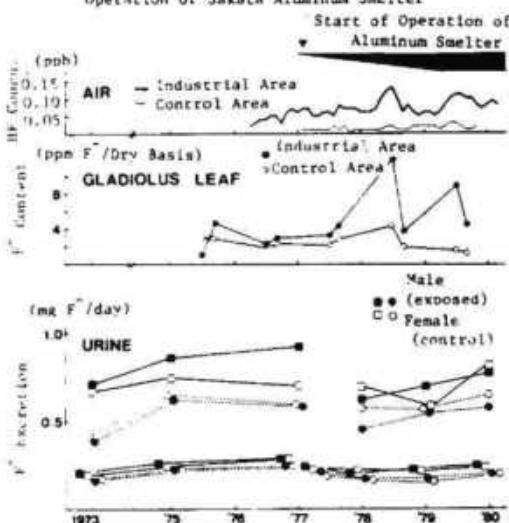
The authors have been carrying out follow-up studies on the health, and environmental monitoring and control in the Sakata new industrial development districts since 1973. This study was started 4 years before the operation of an aluminum smelter in this district began and has continued for 4 years during the operation.

As shown in Figure 6, after the aluminum smelter was operating, HF concentration in air measured by autometer and fluoride content of gladiolus leaves (1/3 upper part) at the industrial area were sometimes slightly higher than those in the control area. However, their fluoride levels were much lower than those of other polluted areas in Japan. Urinary fluoride levels in exposed population groups did not differ significantly before and after the factory was operating and urinary fluoride levels in exposed groups compared with those of control groups showed no significant differences. The general health of both the exposed and control population groups was apparently unaffected.

The authors believe that environmental pollution control in these districts has been successful.

The urinary fluoride excretion is closely related to the amount of fluoride absorbed. Con-

Figure 6

F⁻ in Air, Indicator Plant and Urine Before and After Operation of Sakata Aluminum Smelter

sequently, 24-hour urinary fluoride excretion has been utilized as an index of fluoride exposure. However, in order to establish normal values of urinary fluoride excretion, it is necessary to exclude individuals who have been exposed to high fluoride concentrations at work and where they reside. Moreover, persons with kidney diseases or pregnant women were eliminated because their urinary fluoride excretion is usually reduced(9).

Normal urinary fluoride values of Japanese subjects reported in this paper seem to reflect the daily dietary fluoride, rather than that from air and water, since our subjects are residing where ambient fluoride levels are low, both in drinking water and in air. From the fluoride content of 120 principal foods in Japan, determined in 1972 (10), daily dietary intake for Japanese subjects living in a non-polluted environment was estimated: Fluoride intake from food by male adults was 1.34 ± 0.34 mg/day; that for females 1.12 ± 0.35 mg/day. The estimates are about twice as high as normal 24-hr urinary fluoride.

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ECOLOGICAL STUDY OF DERMATOGLYPHIC DIVERSITY
IN FLUOROSIS BELT OF PUNJAB, INDIA

by

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SUMMARY: The present study is based on an ecological
sample of finger ball dermatoglyphic patterns of 170
subjects (82 males and 88 females) collected from the
Punjab fluorosis belt. For comparison, data on 200
subjects (100 males and 100 females) were collected
from the nonfluorosis area. Finger ball patterns of
all subjects were analyzed for various subtypes, ma-
jor types, indices, symmetry, monomorphism and pleio-
tropism. In the fluorosis belt series, the results
of the two sexes were compared; in the fluorosis vs.
nonfluorosis series comparison pertained to dermato-
glyphic variables.

KEY WORDS: Dermatoglyphics; Punjab; Fluorosis

Introduction

The term dermatoglyphics includes the analysis of the ridge patterns
of the skin of the fingers, palms, soles and toes (1). Epidermal ridges
develop during the sixth to seventh week of fetal life and thereafter re-
main unchanged throughout the life of an individual.   Dermatoglyphic
prints are useful on account of their permanency, individuality, herita-
bility, population variability, their role in medicolegal cases as well
as in constitution and diseases. Individual, bimanual, sexual, and popu-
lation variations occur in dermatoglyphic patterns both qualitatively and
quantitatively. Population variations pertaining to dermatoglyphics from
Punjab, India, have been reported by Bector (2), Rampal (3), Bal (4),
Phull (5), Sidhu et al. (6), Bhatnagar (7), Batish (8), and Kansal (9).

The present study aims to determine the dermatoglyphic diversity in
the Punjab fluorosis belt of India, where fluoride levels are high in the
drinking water.

Material and Methods

Based upon an ecological sample of finger ball dermatoglyphics of
170 subjects (82 males, 88 females) collected from the Punjab endemic flu-
orosis belt, data were collected from the village Khara, Tehsil Mansa,
District Bhatinda of Punjab where the fluoride content of the water has
been reported to be 9.95 ppm (Fig. 1). For comparison, data on nonfluo-
rotic area subjects were collected from Patiala based on 200 subjects

Figure 1

Punjab Areas of Endemic Fluorosis

(100 male and 100 females). Finger ball prints were obtained by ordinary printing ink on white sheets. The interpretation and formulation of finger ball dermatoglyphics was made in accordance with Henry's classification (9). Patterns which could not be identified due to various reasons, are not included in the present analysis.

Results and Discussion

The results have been discussed under the following headings:

I. Sex differences: Data obtained from the fluorosis belt have been compared for the two sexes pertaining to various subtypes, major types, indices, symmetry, monomorphism and pleitropism (Tables 1-6). In all parameters, statistically insignificant differences of same magnitude could be observed (Probability .1>P>.05) and hence the data of two sexes were merged for further investigation.

Table 1

Dermatoglyphic Subtypes in Subjects of Fluorosis Belt (FB) and Nonfluorosis Area (NFA)

Group	Sex		A	TA	L	L	CPL	LF	TL	WSS	WDS	WCC	ACC	Total	x^2	D.F.	P
FB	M	n	49	2	430	47	38	18	22	131	30	17	9	793	17.0889	10	.1>p>.05
		%	6.18	0.25	54.22	5.92	4.79	2.27	2.77	16.52	3.78	2.14	1.13				
	F	n	32	1	448	47	32	7	12	140	26	11	3	759			
		%	4.22	0.13	59.03	6.19	4.22	0.92	1.58	18.44	3.43	1.45	0.40				
Combined NFA	c	n	81	3	878	94	70	25	34	271	56	28	12	1552	69.5794	10	<0.01
		%	5.22	0.19	56.57	6.06	4.5	1.61	2.17	17.46	3.61	1.80	0.77				
	c	n	61	27	1016	40	88	47	71	376	45	112	9	1892			
		%	3.22	1.43	53.70	2.11	4.65	2.48	3.75	19.87	2.38	5.92	0.48				

A = Arch, TA = Tented arch, L^U = Loop ulnar, L^F = Loop radials, CPL = Central pocket loop, LR = Lateral pocket, TL = Twin loop, Wss = Whorl single spiral, Wds = Whorl double spiral, Wcc = Whorl concentric, Acc = Accidental.

II. Ecological Variation: The results on dermatoglyphic variables have been compared in the two ecological areas – fluorosis versus nonfluorosis – pertaining to the following parameters:

1. Dermatoglyphic subtypes: Table 1 presents results on the distribution of various subtypes in two ecological areas. In the fluorosis area, the incidence of plain arches, loops, whorls, double spiral and accidentals, was more frequent than in individuals living in the nonfluorosis area. The distribution of these pattern types was statistically significant (probability <0.01).

2. Major pattern types: When the results of major pattern types in two ecological situations were compared (Table 2), it was observed that the incidence of loops is more frequent in the fluorosis area, whereas whorls were more frequent in the nonfluorosis area. The incidence of arches in the two groups was almost equal. But the distribution, on the whole, was statistically significant (<0.01).

Table 2

Major Pattern Types

Group	Sex		Pattern Types			Total	Test of Significance		
			Arches	Loops	Whorls		X^2	D.F.	P
FB	M	n	51	477	265	793	5.8082	2	.1>P>.05
		%	6.43	60.15	33.42				
	F	n	33	495	231				
		%	4.35	65.22	30.43	759			
NFA	c	n	84	972	496	1552	21.2592	2	<.01
		%	5.41	62.63	31.96				
	c	n	88	1056	748	1892			
		%	4.65	55.81	39.54				

3. Indices: Three indices, pattern intensity index, Dankmeijer's (10) index and Furuhata's (11) index have been calculated (Table 3) to determine the relationship between various major types in the two ecological areas. Dankmeijer's index is more valuable in the fluorosis belt compared to the nonfluorosis area, indicating thereby a higher relationship between arches and whorls. Furuhata's index relating whorls and loops, is less valuable in the fluorosis belt.

4. Symmetry: Table 4 indicates the incidence of digital couplet bearing a similar pattern. The frequencies observed in the two ecological groups were almost the same and the results were statistically insignificant (probability .3>P>.2).

Table 3

Indices

Group	Sex	Pattern Intensity Index	Dankmeijer Index	Furuhata Index
FB	M	12.70	19.24	55.56
	F	12.61	14.29	46.67
NFA	c	12.65	16.94	51.03
	c	13.49	11.76	70.83

5. Monomorphism: When an individual has the same major pattern on finger balls of all digits of a hand, it is known as monomorphism of the hand.   The frequency (Table 5) of

Table 4

Digital Couplet Bearing Similar Pattern

Group	Sex		Symmetry	Asymmetry	Total	x^2	D.F.	P
FB	M	n	279	177	396	2.9421	1	.1 >p> .05
		%	70.45	29.55				
	F	n	281	89	370			
		%	75.95	24.05				
NFA	c	n	560	206	766	1.6138	1	.3> p >.2
		%	73.11	26.89				
	c	n	699	223	922			
		%	75.81	24.19				

monomorphic hands is almost the same in the two samples (probability .8>P>.7). It is of interest to note that not a single case of arch type monomorphic hand was recorded in either of the samples.

Table 5

Monomorphism

Group	Sex		Arches	Loops	Whorls	Total	x^2	D.F.	P
FB	M	n	-	30	6	36	3.5508	1	.1>p>.05
		%		83.33	16.67				
	F	n	-	32	17	49			
		%		65.31	34.69				
NFA	c	n	-	62	23	85	0.0673	1	.8>p>.7
		%		72.94	27.06				
	c	n	-	82	33	115			
		%		71.30	28.70				

6. Pleiotropism: When an individual has the same major pattern on finger balls of all digits of both hands, it is known as pleiotropism. The frequency distribution of pleiotropism of major types in the two groups was almost the same (probability .5>P>.3) (Table 6).

Table 6

Pleiotropism

Group	Sex		Arches	Loops	Whorls	Total	x^2	D.F.	P
FB	M	n	-	5	4	9	3.1322	1	.1>p>.05
		%		55.55	44.45				
	F	n	-	14	2	16			
		%		87.50	12.50				
HPA	c	n	-	19	6	25	0.5739	1	.5>p>.3
		%		76.00	24.00				
	c	n	-	17	3	20			
		%		85.00	15.00				

Since dermatoglyphic variables are genetical markers, from the above discussion one can conclude that genetical diversities are appearing due to ecological variations in the fluoride level of water.

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CIRCADIAN RHYTHM OF URINARY FLUORIDE EXCRETION
IN A HUMAN ADULT CONSUMING SPACE FOOD

by

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SUMMARY: This study was designed to detect the pre-
sence of a possible circadian rhythm of urinary flu-
oride excretion in healthy individuals. A healthy
male adult was fed space food for a period of 5 days.
Urinary excretion of F^-, Na, K, Cl, Ca, and Mg was
determined at 2-hour intervals throughout four days,
and the results were analyzed in time series. Based
on auto-correlation analysis, urinary F^- excretion
exhibited a persistent 24-hour rhythm. Na, K, Cl,
Ca, and Mg excretions showed a similar periodicity.

KEY WORDS: Circadian rhythm; Urinary fluoride; Space food

Introduction

Because of the ease with which sampling and analysis can done, urin-
ary fluoride has been widely used by many workers in studying the physio-
logical and biochemical effects of F^- on animals and humans (1-4).   In
such studies, spot urine samples are often taken for analysis due to prob-
lems associated with labor control or difficulty in storing samples.   In
previous communications, we compared urinary excretions of F, Ca, Mg, Na,
K, and Cl of a healthy adult on a normal diet with excretions of an indi-
vidual under fasting conditions (5). In this report, urinary F^- excretion
by a healthy male adult consuming space food was compared with excretion
of various other mineral elements.

Materials and Methods

To control dietary intake, a healthy male adult, aged 36, was given
space food manufactured by Oregon Freeze Dry Foods, Inc., U.S.A. The food
was provided three times daily, namely at 8:30 A.M., 12:30 P.M., and 6:30
P.M.; water 3 times daily at separate times. Total daily water intake of
1000 ml, included the water used for restoring the freeze-dried food sam-
ples.

The subject continued his routine 8-hour desk work, together with a
walk of about 20 minutes duration. The entire experiment, which lasted
for 5 days, was conducted in an environment where the average temperature
was about 24°C.

Urine samples were collected every 2 hours for 4 days, after intake

of experimental food. Urinary F⁻ content was determined by the fluoride
ion meter as described previously (6). Analysis of Na, K, or Cl was done
in a flame spectrophotometer, whereas Ca was determined spectrophotomet-
rically by the o-cresolphthalein complexon method and Mg in the same way
following treatment with xylidyl blue I reagent (Wako Pure Chem., Inc. LTD).

For food analysis, the food sample was ground in mortar and pestle and
the powdered sample was passed through a No. 24 mesh filter. Determination
of fluoride was carried out with a molecular absorption spectrometer by the
method of Itai et al. (7).

Results and Discussion

The levels of F, Na, K, Cl, Mg, and Ca found in urine samples are
shown in Fig. 1 (a) through (f). As seen in Fig. 1 (a), F⁻ excretion ex-
hibited persistent rise in the morning that lasted until about noon, fol-
lowed by a decline in the evening. Excretion of F⁻ appeared to be en-
hanced by ingestion of food. The average F⁻ excretion was 18.2 μg per hr.
and the average daily excretion was about 440 μg. Urinary excretion of
Na, K, and Cl resembled the pattern exhibited by F⁻, namely a rise from

Figure 1

Daily Urinary Excretion of Minerals in an Adult
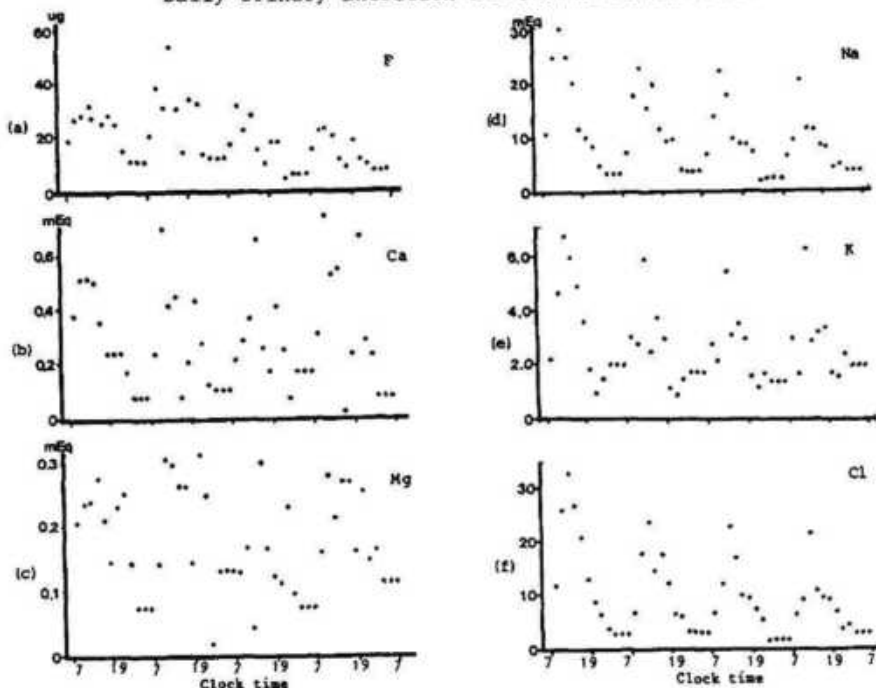
morning till noon, diminishing in the afternoon, and low in the evening
(Fig. 1 (b)–(f). Unlike F⁻, excretion of these three elements was not af-
fected by food consumption. The average daily excretion of Na, K, and Cl
was about 2.34, 1.24 and 4.42 g, respectively. Their average content per
hour was 113.9, 51.7 and 166.9 mg respectively. Corresponding values for
Ca and Mg were 140.4 and 48.1 mg for daily excretion and 5.8, 2.0 mg for
average content per hour, respectively.

Fig. 2 shows changes in excretion of F⁻ and various other minerals on
a 24-hour basis. Although the data show excretion of each type of mineral
at 2-hour intervals for 24 hours, the values actually represent the aver-
age of the combined values obtained from 4 consecutive days. A rise in
urinary F⁻, Ca and Mg excretion was often observed about 1–4 hours follow-
ing food intake (Fig. 2-A). Minerals, whose excretion is influenced by
food ingestion, were termed "food-dependent." In contrast, excretion of
Na, K, and Cl was not influenced by food intake (Fig. 2-B). These miner-
als may be termed "food independent."

Figure 2

24-Hour Urinary Excretion of Minerals in an Adult


(A)   (B)
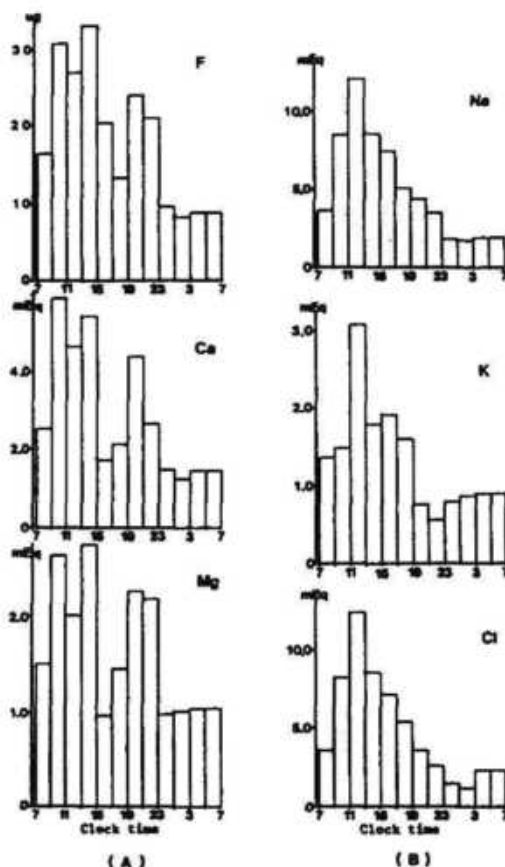
To examine the periodicity of excretion of these mineral elements, a
time-serial analysis was run and from the data, the auto-correlation co-
efficient was determined.   As shown in Fig. 3, for Na, K, and Cl the auto-
correlation coefficient approached the value of 1 for every 12 hours, ex-
hibiting a periodicity of 24 hours.   These observations confirmed an ear-
ly report by Mills and Stanbury (8), who demonstrated rhythmical excretion
of Na, K, and Cl in humans.   The coefficient of F^-, unlike those of Na, K,
and Cl was far from 1 in the 12 hour base, whereas the coefficients   of
these four mineral elements displayed a 24-hour periodicity.   A similar
pattern to that of F^- was observed with both Ca and Mg, thereby suggesting
the presence of periodicity.

Thus, but auto-correlogram analysis, a circadian rhythm in the urin-
ary excretion of F^-, Ca, Mg, Na, K, and Cl in an human adult has been dem-
onstrated.   Whitford et al. (9), showed that plasma F^- exhibited a   dis-
tinct circadian rhythm (24-hour) in dogs.   Furthermore, there was a dis-
similarity with which these minerals were excreted into the urine. Where-
as, in our experiments, both Ca and Mg exhibited the same excretion   pat-
tern as that of F^-, the remaining three minerals, namely, Na, K, and Cl
showed a dissimilar pattern.   In other words, they may be divided   into
two groups "food-dependent type" and "food-independent type" respectively.

Figure 3
Autocorrelation Coefficients of Urinary Minerals
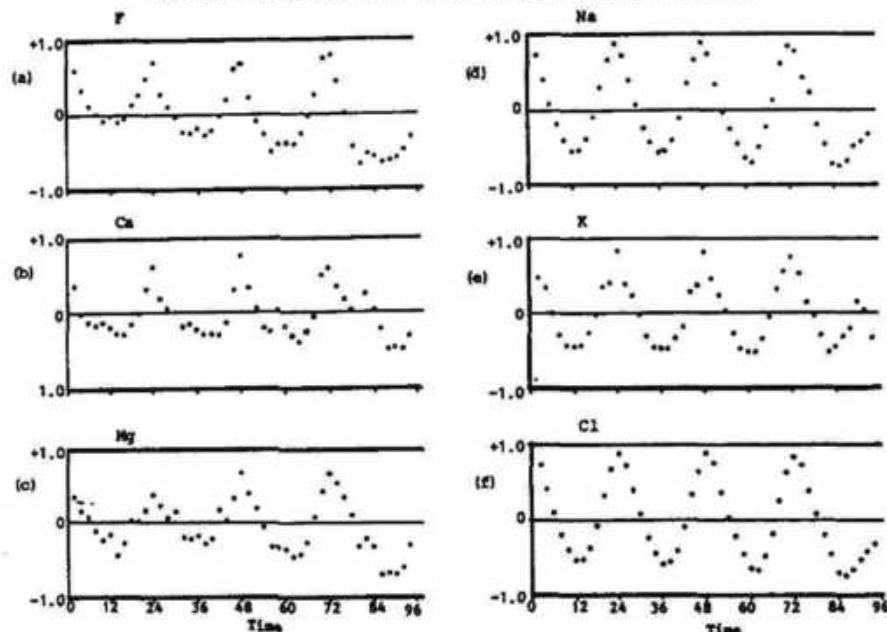
Urinary F⁻ excretion may be influenced, not only by the mechanism involved in Na, K, and Cl excretion, but also by movement of Ca and Mg in the body. In addition, the influence of the latter two minerals may be greater than that of the former. Knowledge about the presence of such periodicity may be important when spot urine samples are to be taken for analysis.

Conclusion

Urinary F⁻ excretion, of a healthy human adult, exhibited a persistent 24-hour rhythm. A similar periodicity was observed with Na, K, Cl, Ca, and Mg excretion. Whereas urinary excretion of F⁻, Ca, and Mg was affected by food consumption, that of Na, K, and Cl was unaffected. Thus these minerals may be termed "food-dependent" and "food-independent" respectively.

Acknowledgement

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ALTERATION IN GASTRIC SECRETION OF RATS ADMINISTERED NaF

by

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SUMMARY: In vivo effect of oral administration of 25 mg
NaF/kg body weight/day on gastric secretion in male al-
bino rats,100 gm average body weight,was observed for a
period of sixty days. A time-dependent secretagogue ef-
fect accompanied by an increase in free acidity and pep-
tic activity was noted. A possible role of adenosine
3':5'-monophosphate (c-AMP) is discussed.

KEY WORDS: Rats, gastric acidity; NaF, cyclic-AMP; Secretagogue

Introduction

Acute and subacute gastric symptoms due to fluoride in drinking wa-
ter in inhabitants of endemic areas as well as in individual workmen ex-
posed to fluoride-contaminated air are reported (1,2). Fluoride is known
to alter the permeability of oxyntic cells of the gastric wall to H^+ ions
(3). Alterations in the mobilization of other physiologically important
ions, such as Na^+, K^+, Ca^{++}, and related enzyme activities on fluoride ad-
ministration have also been observed (4).

Introduction of NaF into the gastric cavity of cats has been shown
to produce a marked decrease in the output of H^+ ion secretion (5,6), al-
though the effect was localized and reversible. The occurrence of acute
and subacute gastric symptoms in inhabitants of endemic fluorosis areas
and in workmen exposed to fluoride-polluted air stimulated us to test the
effect of fluoride on gastric secretion in rats, under in vivo conditions,
by exposing them to fluoride for relatively longer periods.

Materials and Methods

Forty-eight male albino rats, 100 gm average body weight, from Indus-
trial Toxicology Research Centre, were fed ad libitum a pellet diet (Hind
Lever Laboratory Feeds, India) and maintained under standard laboratory
conditions. The rats were divided into two groups: Group I, 24 experi-
mental animals, received 25 mg NaF per kg body weight per day with water
for sixty days; Group II, 24 controls, were given normal saline in an
identical manner. Experimental and control animals were placed in separate
cages.

Six rats from each group were sacrificed after 7, 15, 30 and 60 days
of fluoride administration. To obtain food-free stomachs, the animals
were subjected to overnight fasting prior to sacrifice. Stomachs were
dissected out after ligating oesophageal and duodenal openings. Gastric

juice was collected and volume noted. Gastric juice, after centrifuga-
tion to remove suspended food particles, was analyzed for free and total
acidity using Topffer's reagent as pH indicator (7). Peptic activity was
determined according to the Anson method (8). The results were expressed
as mEq/litre of acidity and in terms of pepsin units, respectively.

Results

Table 1 shows alterations in the gastric volume of rats after fluo-
ride administration. The groups of rats sacrificed after 7 and 15 days
of fluoride administration did not show any significant alterations in
gastric volume. However, gastric volume increased 2 and 3 fold after 30
and 60 days of fluoride exposure, respectively.

Table 1

Alterations in Gastric Volume (ml)
on Exposure to NaF in Rats

Experi-mental	Normal	Experi-mental	Normal	Experi-mental	Normal	Experi-mental	Normal
0.33	0.3	0.43	0.43	0.7	0.3	1.0	0.33
(.2-.5)*	(.2-.4)	(.2-.7)	(.2-1.0)	(.2-1.0)	(0-.5)	(.6-2)	(0-.6)

Values are the average of six rats.
* Range of values are expressed in parenthesis.

Table 2 gives mEqs of free and total acidity per litre of gastric
juice in normal and treated animals after 7, 15, 30 and 60 days of fluo-
ride administration. Free acidity increase was not significant after 7

Table 2

Alterations in Gastric Acidity on Exposure to NaF in Rats
(mEq Acidity per liter)

Period of F⁻ Exposure	Category of Rats	Free Acidity (with range)	Total Acidity (with range)	% Increase in Free Acidity
7 days	Experimental	28 (0-70)	91 (20-100)	16
	Normal	23 (0-40)	76 (90-110)	
15 days	Experimental	30 (10-80)	93 (40-180)	6
	Normal	28 (0-60)	81 (50-120)	
30 days	Experimental	60 (20-140)	128 (70-220)	500
	Normal	10 (0-30)	65 (50-85)	
60 days	Experimental	46 (10-110)	156 (90-220)	211
	Normal	15 (0-30)	103 (70-150)	

Values are the average of 6 rats.

and 15 days, whereas rats sacrificed after 30 and 60 days showed six and three fold increase in free acidity, respectively. The increase in total acidity of these respective groups was mainly due to increase in free acidity. Peptic activity of treated rats increased in all four groups (Table 3). However, after 30 and 60 days of fluoride administration, the change was more prominant (73% and 67% respectively).

Table 3

Alterations in Peptic Activity on Exposure to NaF in Rats

Period of F⁻ Exposure	Category of Rats	Pepsin unit/ml	% Activation
7 days	Experimental	228.33 (120–290)*	21
	Normal	188.33 (160–230)	
15 days	Experimental	233.33 (180–280)	17
	Normal	200.00 (160–240)	
30 days	Experimental	275.00 (240–330)	73
	Normal	105.00 (120–300)	
45 days	Experimental	276.66 (200–320)	67
	Normal	160.00 (100–200)	

*Range of values are expressed in parenthesis.
Values are average of six rats.

Discussion

In the present experiment on oral administration of NaF to rats, the secretagogue effect was time-dependent. The current finding, under in vivo conditions, agrees with recently published data that NaF caused dose-related stimulation of H^+ ion secretion and did not interfere in histamine induced H^+ ion secretion from isolated distended mouse stomach under in vitro conditions (9). However, according to earlier reports, NaF produces inhibition of gastric acid secretion under in situ conditions (3,5). Reed and Smy (6) have also shown that fluoride exerts an inhibitory effect on histamine induced H^+ ion output; however this NaF effect was localized and reversible. Variations in experimental conditions such as, the difference between in vitro (isolated stomachs), in situ (ligated stomach under anesthesia) and in vivo (intact animal) preparations, the site of NaF action and the species used, could have caused the discrepancy.

The secretagogue effect, produced by prolonged fluoride exposure in rats, can be explained on the basis of the recent concept of H^+ ion secretion from the gastric wall. It is generally accepted that most of the secretagogues such as histamine , choleratoxins, pentagastrin, etc. exert their effect via involvement of cyclic-AMP (10-14). Since NaF increases cyclic AMP levels in the intact cells (15, 16) by stimulating adenylate cyclase, it is possible that fluoride increases H^+ ion secretion by elevating cyclic-AMP levels in the intact stomach of exposed rats. The in-

hibitory effect observed under in situ conditions, as reported earlier, could be related to higher concentrations of NaF available per se in the gastric mucosa which, instead of stimulating adenylate cyclase, inhibits it. Fluoride is reported to produce a biphasic effect on adenylate cyclase activity, i.e. stimulation at lower concentrations and inhibition at higher concentrations (17). Furthermore, it is known that NaF causes histamine release from isolated rat mast cells (18). It is, therefore, possible that fluoride further elevated levels of c-AMP by enhancing the release of histamine from rat stomach mast cells, which could in turn stimulate H^+ ion secretion.

Increase in peptic activity on fluoride exposure has been reported earlier (3). Zymogenic cells are known to supply pepsinogen to both blood (endocrine function) and gastric juice (exocrine function). Increase in peptic activity, observed in the present experiment, may be related to increased output of this enzyme into gastric juice and activation of zymogenic form to the active pepsin at low pH.

Figure 1

Established and Postulated Mechanism of Regulation of F^- and H^+ Transport Across Gastric Mucosa
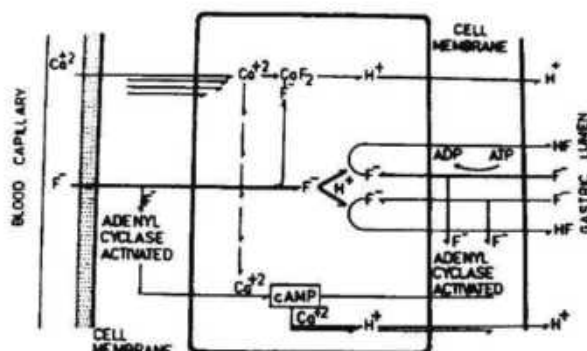
At present our data are insufficient to analyze the nature of fluoride action at the receptor level of gastric cells. However, our finding suggests that elevation of cyclic-AMP levels by fluoride in the rat stomach causes stimulation of H^+ ion output; it explains the acute and subacute gastric symptoms observed in inhabitants of endemic fluorosis areas and by individual workmen exposed to fluoride air pollution.

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FLUORIDE LEVELS IN SERA AND HARD TISSUES OF RATS
CONSUMING F⁻ VIA DRINKING WATER

by

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SUMMARY: The effect of different fluoride intakes
(5, 10, 25, 50 ppm) via drinking water for four
weeks on body weight gain, food and water consump-
tion, fluoride level in serum, lower incisor enam-
el and femur of young rats was examined.   In F_5,
F_{10}, F_{25} groups compared to control, no signifi-
cant differences were observed in body weight
gain, food and water consumption. In the F_{50}
group, however, body weight gain and food consump-
tion were diminished. After the fourth week of
treatment, elevated serum fluoride levels in the
F⁻ groups were associated with a higher fluoride
content of lower incisor enamel and femur.   The
results suggest that this animal model may be
suitable for the study of in vivo effects of flu-
oride treatment as well as for the investigation
of the effect of fluoride supply on the salivary
glands which have high metabolic activity.

KEY WORDS: Fluoride consumption via drinking water; Fluoride in sera, fe-
mur, incisor enamel.

Introduction

Studies in recent years have been carried out to determine the role
and significance of salivary fluoride in the cariostatic action of this
ion (1-14). However, data respecting the effect of fluoride on salivary
gland function, enzymes and morphology (15-20)are sparse. The purpose
of the present investigation was to study the alterations in some basic
parameters (body weight, food and water consumption, fluoride concentra-
tions in sera, mandibular incisors and femurs) of rats with various flu-
oride levels for four weeks via drinking water.

Materials and Methods

Female Wistar rats, (average body weight of 75 grams) were divided
into five groups and fed on standard food pellet (LATI, Hungary) with a
mean fluoride concentration of 48±5.2 ppm. They received fluoride in
drinking water with 0, 5, 10, 25 or 50 ppm. Food and water were provi-
ded ad libitum. Five rats killed just prior to starting the experiment

served as controls (C_o).

Experimental Procedure: After 16-hour starvation, under sodium pen-
tobarbital anesthesia the rats were bled through the femoral vein. Body
weight, food and water consumption were controlled during the entire pe-
riod of the experiment. Serum samples were obtained from the femoral
vein and the serum fluoride levels were determined in groups C_o, control
(C) and in groups F_5, F_{10}, F_{25} and F_{50} after the first, second, third
weeks and at the end of the experiment. The lower incisors were careful-
ly removed from the alveolar bone and cleaned of debris. The teeth were
covered with fluoride-free varnish with the exception of enamel surfaces.
The femur from each animal was mechanically cleaned, weighed and dried.
The incisor enamel and the femur samples were analyzed in the zero con-
trol group and in the other five groups only after the fourth week of
fluoride treatment.

Serum Fluoride Analysis: The blood was centrifuged and 100 μl ali-
quots of sera were assayed for ionized fluoride content using a fluoride
sensitive microcapillary electrode (RADELKIS OP-262, Hungary). The Moody
and Thomas technique was employed (21) with slight modification.

Enamel and Bone Tissue Analysis: To remove enamel for fluoride anal-
ysis, it was exposed to 50 μl of 1 M perchloric acid for 45 sec. An ali-
quot of each acid solution was diluted with 1 M sodium acetate to 150 μl
(final pH: 4.6) and fluoride was determined by direct potentiometry in
hanging drop with the fluoride selective ion electrode (RADELKIS OP-F
7112, Hungary). Two μl of acid solution was subjected to calcium analy-
sis by atomic absorption spectrophotometry (22). The weight of enamel
removed during acid immersion was calculated assuming that the rat tooth
enamel contains 34% calcium (23). The femurs were ashed for five hours
at 500°C in quartz crucibles. The ash was weighed and about 20 mg of
ashed bone powder was dissolved in 1 ml of 1 M perchloric acid for 2 min.
At this point, 4 ml of 1 M sodium acetate buffer saturated with EDTA was
added to 1 ml of acidic solution. Each sample was analyzed for calcium
by atomic absorption spectrophotometry and for fluoride as mentioned ear-
lier.

Results

1. Effects of fluoride-containing drinking water on the body weight
and food consumption: As seen in Figures 1 and 2, rats in all F⁻ groups
consuming fluoride with the drinking water exhibited a tendency to retard-
ed body weight gain and decreased food consumption depending on the fluo-
ride level in drinking water and duration of treatment; the differences
were significant solely in the F_{50} group. The rate of body weight gain
and food consumption (expressed in mg food per rat per day) in the F_{50}
group was much lower than in control rats drinking deionized water. These
differences could be detected even after the first week of fluoride treat-
ment.

2. Daily water consumption and daily fluoride intake: Regarding the
mean daily water consumption per rat (Fig. 3), differences between the
control and the F⁻ groups were not statistically significant. Fig. 4
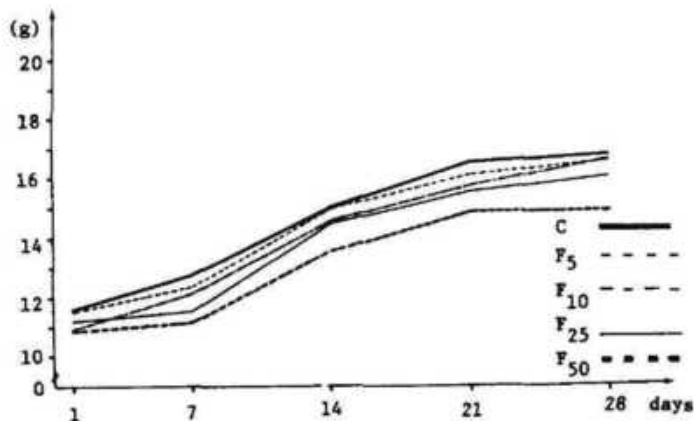
Figure 1

Mean Body Weight of Young Rats Consuming F⁻ in Drinking Water for Four Weeks
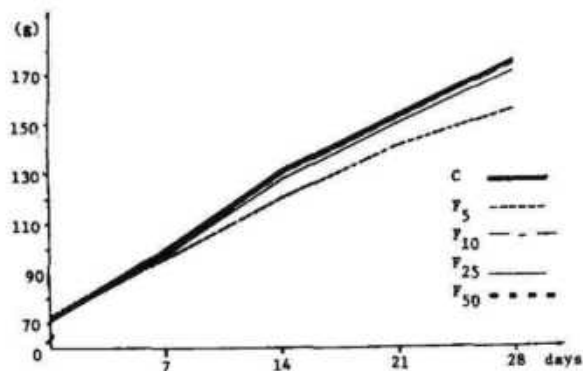
Groups: C=control (deionized water); F_5=5 ppm NaF in drinking water; F_{10}=10 ppm F⁻; F_{25}=25 ppm F⁻; F_{50}=50 ppm F⁻
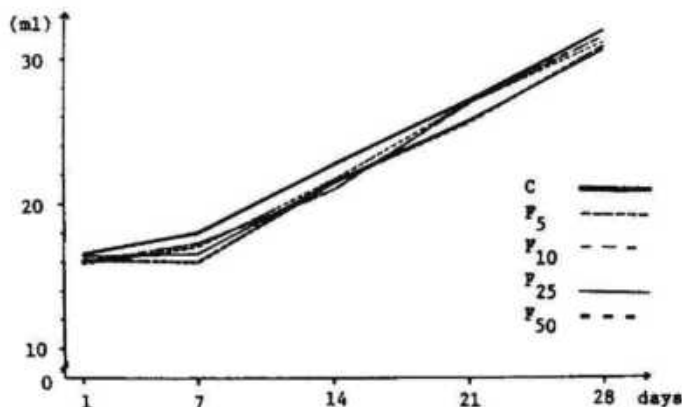
Figure 2

### Food Intake (Grams/day/rat) of Young Rats Consuming F⁻ in Drinking Water for Four Weeks

shows the daily fluoride intake of rats expressed in mg F⁻ per rat per day calculated from mean water and food consumption during the first, second, third and fourth week of treatment. In all of the F⁻ groups, fluoride intake was continuously increasing; the extent of fluoride intake depended primarily on the concentration of fluoride in water.

Figure 3

Water Intake (ml/day/rat) of Young Rats Consuming
F⁻ in Drinking Water for Four Weeks

Figure 4

Total Daily F⁻ Intake (mgF⁻/rat) of Young Rats Consuming
F⁻ in Drinking Water for Four Weeks
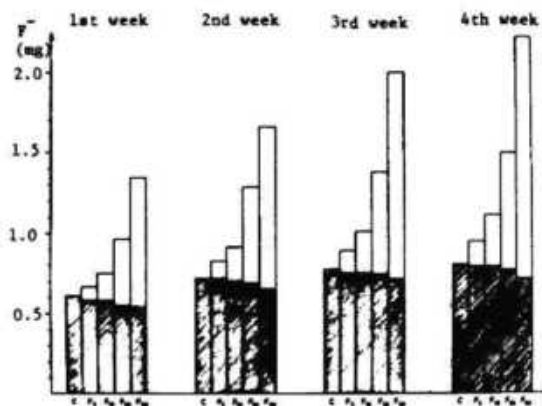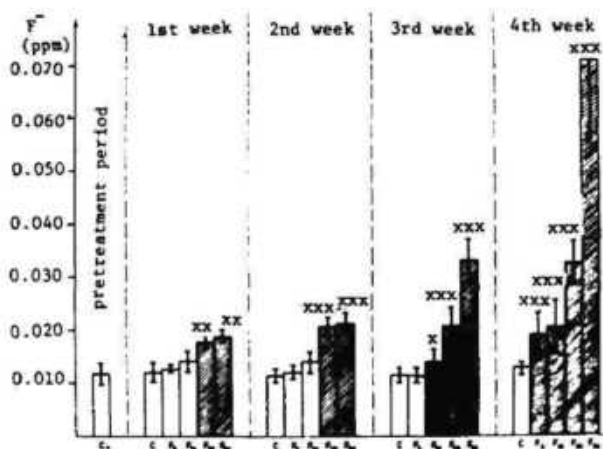

: F⁻ intake from the diet.   : F⁻ intake via drinking water. Groups left to right: Column 1 C= control (deionized water); Column 2 F_5 = 5 ppm F⁻; Column 3 F_{10} = 10 ppm F⁻; Column 4 F_{25} = 25 ppm F⁻; Column 5 F_{50} = 50 ppm F⁻.

Figure 5

F^- Serum Levels in Rats Consuming F^- Via
Drinking Water for Four Weeks

Groups: C_0 = control (pretreatment); C = control (deionized water); F_5 = 5 ppm F^-; F_{10} = 10 ppm F^-; F_{25} = 25 ppm F^-; F_{50} = 50 ppm F^-. Data are means ± S.D. ☐ = NS (not significant; ▨ = S (significance, x: $p < 0.05$; xx: $p < 0.01$; xxx: $p < 0.001$).

3. Serum ionized fluoride levels after the first, second, third and fourth week of fluoride dosage: Analysis of rats' sera (Fig. 5) revealed a marked elevation of serum fluoride levels in all F^- groups when four-week samples were compared to controls. A statistically significant increase in serum fluoride level was detected in F_{25} and F_{50} group even after the first week. In the F_{10} group, increase in serum fluoride concentration was considerable only after the third week of treatment. By extending the period of fluoride treatment to four weeks, the serum fluoride level will be elevated even in F_5 group, with the lowest fluoride intake.

4. Fluoride content of hard tissues after fourth week of fluoride treatment: Fig. 6 illustrates the fluoride content in femurs. In accordance with the serum fluoride level, the fluoride uptake of bone was significantly higher in groups F_5, F_{10}, F_{25} and F_{50} compared to controls. However, an elevated fluoride level was also detected in the control group in comparison to the so-called zero control group indicating that during the period of 28 days some fluoride uptake of femur may have been derived from the laboratory pellet. Fig. 7 shows the fluoride content of the lower incisor enamel. In accordance with bone fluoride levels, a strong correlation was also observed between the fluoride concentration in drinking water and the amount of fluoride in the incisor enamel.

Figure 6

F^- Concentrations in Young Rat Femur After
Drinking F^- Water for Four Weeks
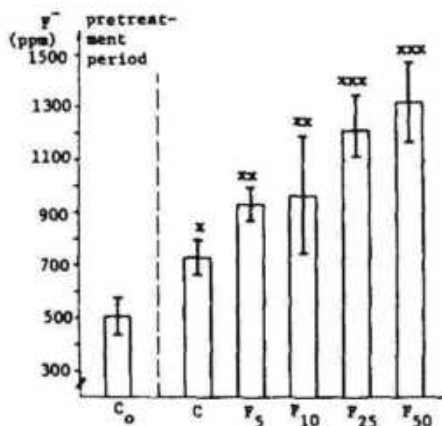
Comparisons: C vs C_o: x: $p < 0.05$; F_5 vs C: xx: $p < 0.02$;
F_{10} vs C: xx: $p < 0.02$; F_{25} vs C: xxx: $p < 0.001$; F_{50} vs
C: xxx: $p < 0.001$.

Discussion

Büttner et al. (24-28) have demonstrated that fluoride metabolism
(absorption, distribution, retention, mobilization and excretion) is ba-
sically similar in humans and rats. One ppm fluoride in drinking water
is considered caries preventive in humans, whereas 25-50 ppm affords 50%
caries reduction in rats. Fluoride doses applied did not lead to the
development of enamel fluorosis (29). In group F_{50} the highest serum
fluoride concentration was 3.6 µM at the end of the 4th week, a threshold
level which usually elicits minimal disturbance of mineralization with
long-term and continuous fluoride intake (30). However, several factors
can influence its manifestation such as individual differences in gene-
ral metabolism, the route, frequency and duration of intake, species,
age, type of fluoride compound and even acid-base status (31). At the
same time it is also known that fluoride tolerance in developing animals
is 2.5-fold higher than in young adult animals (32). This fact offers
an explanation for the lack of fluorosis in enamel as an early sign of
fluoride toxicosis in our study. Hodge (33) reported that 50 ppm fluo-
ride in drinking water is not noxious to rats. In contrast, we observed
an apparent decrease in body weight in group F_{50} caused by diminished
food consumption. Several authors have reported decreased food consump-
tion due to massive fluoride intake (34-37). Neither Allmann (38) nor
Singer (39) found reduced food consumption in rats given 100 ppm fluoride

Figure 7

F⁻ Concentrations in Lower Incisor Enamel of Young Rats
Drinking F⁻ Water for Four Weeks
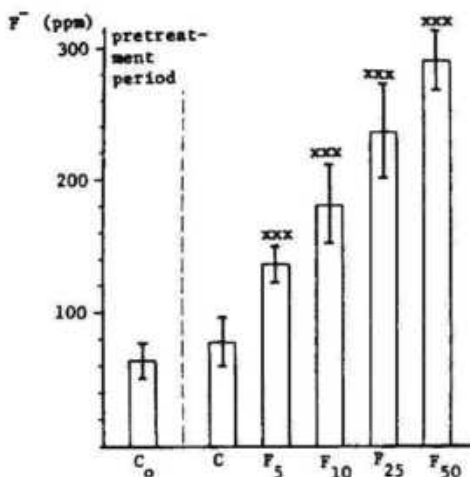
Comparisons: C vs C_o: not significant; F_5 vs C, F_{10} vs C,
F_{25} vs C, and F_{50} vs C: xxx: $p < 0.001$.

with the diet or 50 ppm in drinking water. Niver (40), however, observed
a decrease in body weight due to 50 or 100 ppm fluoride in drinking wa-
ter for 28 days. Kuo (41) reported a similar result. In our experiments.
control and fluoride-treated rats did not differ in water consumption.
This finding and unchanged food consumption of groups F_5, F_{10} and F_{25},
compared to controls, suggest that total daily fluoride intake changed
primarily as a function of fluoride content of drinking water.   Total
fluoride loads, calculated for mg F⁻/kg body weight on the 4th week of
treatment, were substantially lower than toxic doses for the rat (C:4.57;
F_5: 5.41; F_{10}: 6.38; F_{25}: 8.75; F_{50}: 14.26) (42). The rat is more resis-
tant to fluoride toxicity than sheep or rabbits (43). Data for serum ion-
ized fluoride concentrations over 4-weeks showed that serum fluoride con-
centrations rose in direct relation to fluoride intake through drinking
water. On the other hand, control serum fluoride concentrations were not
essentially affected. The time course of fluoride loading and the age of
rats are important factors influencing changes in serum fluoride levels.
For our groups F_{25} and F_{50}, serum fluoride values on day 28 agree with
the 24-day and 31-day plasma levels for rats which consumed 25 or 50 ppm
fluoride in water as reported by Ekstrand (44). As shown earlier, plas-
ma fluoride levels depend on dietary fluoride (45-51), skeletal fluoride
concentration (52), and lack of significant difference between serum and
plasma in concentration of ionic fluoride (53). Guy (54) reported ele-

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vation in human plasma fluoride associated with a rise in fluoride   con-
tent of drinking water. Our serum values support these findings. As pos-
tulated earlier, retention of fluoride in the skeleton of young rats is
greater (53%) compared to only 36% in mature rats (55). Wallace-Durbin
(56) concluded that the extent to which a bone will accumulate F^{18} seems
to depend on vascularity of the bone and its growing activity. Under pre-
sent experimental conditions, fluoride concentrations in the femur   of
rats consuming fluoride via drinking water were, in all groups, higher
on day 28 than in control rats the same age drinking deionized water.
This is explained by the rapid fluoride uptake of bones in young develop-
ing animals (57-59) and increased activity of osteoblasts due to fluoride
intake (60-61). The fluoride concentration was significantly   enhanced.
even in femurs of control rats as compared to values for 0-day pretreated
controls for which dietary fluoride may have been responsible.

   In regard to the rats' incisors, which are known to continuously
erupt throughout life, deposition of fluoride showed a linear correlation
with the level of fluoride added to drinking water. Since it is doubtful
that the concentration of fluoride in relationship with the permanent en-
amel maturation shows a decreasing tendency from the apical end in length
to the incisal edge of the enamel (62) and the erupted part of this ena-
mel which is exposed to the fluids of the oral cavity is about one-sixth
of the total surface,fluoride accumulated in experimental animals most
likely came from systemic circulation.   Comparing group C_0 to controls,
elevation was slight but insignificant in the fluoride content of the
analyzed total incisor enamel similar to that detected in serum fluoride
levels. However, growth of incisor teeth is rapid, taking approximately
30-50 days to renew completely (63); our four-week model seems,also,to
be good for investigation of fluoride incorporation into enamel depend-
ing on the cariostatic water fluoride levels.

   Finally, the results of our work indicate that the rat, under pre-
sent experimental conditions, may be suitable for the study of fluoride
effect not only on hard tissues but also for investigating the effect of
this ion on general metabolism.

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FLUORIDE AND ENVIRONMENT - SITUATION IN THE DISTRICT OF COTTBUS

by

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SUMMARY: Brown coal fired stations in the district of
Cottbus, which produce a total quantity of 29,000 t/h
steam, require 12,000 t of brown coal every hour. 75%
of the fluoride content of brown coal is emitted as hy-
drogen fluoride (HF). The glass and ceramics industry,
enamel and aluminum plants are additional fluoride emit-
ters.

The area of the district which was tested for flu-
oride emissions, by automatic and mobile measuring nets
for four years, produced the following results in indus-
trial polluted areas: An average for gaseous fluoride
(HF) ranged from 0.020 to 0.025 mg/m^3 up to 0.070 mg/m^3
(short time value); the fluoride rate of the dusts
ranged from 10 to 20 mg/m^2 within 30 days, up to 102
mg/m^2 within the same period.

In industrial areas, with low air pollution, gas-
eous fluoride ranged on average from 0 to 0.005 mg/m^3,
the fluoride rate of the dusts from 6 to 10 mg/m^2 with-
in 30 days. To the soil of the district, phosphate fer-
tilizer fluoride compound, 1880 t calculated as F$^-$, are
added every year. This sizeable quantity of fluoride
in our environment warrants research about the effect
of fluoride on the health status of the population.

KEY WORDS: Fluoride; Environment; Brown coal-fired stations

Introduction

Fluorides which occur in nature everywhere, are found naturally in
soil, in water and in insignificant amounts, in the air. Classic fluoride
emitters are plants for fertilizer and superphosphate production, glass
and ceramics industries, enamel and aluminum factories. In recent liter-
ature, brown coal power stations are described as important fluoride emit-
ters because fossil fuels contain fluoride compounds which are changed by
combustion into hydrogen fluoride and inorganic fluoride. Brown coal
power stations, which produce a total quantity of 29,000 t/h steam in the
district of Cottbus, require about 12,000 t of brown coal every hour. In
the future, these quantities of brown coal will increase due to building
additional brown coal-fired stations.

In samples of brown coal from opencasts of the East Elbe river, Das-

sler (1) described rates of fluoride from 6 to 50 ppm (dry weight). Hard
coal contains levels of fluoride from 15 to 210 ppm (2).   Fluid   energy
carriers contain low-grade amounts of fluoride and gaseous ones are with-
out fluoride.

In the Cottbus district, only small quantities of hard coal are need-
ed. For this reason, the total fluoride balance is calculated exclusive-
ly on the basis of brown coal use.

The following are fluoride levels in samples of brown coal obtained
from different brown coal power stations during two years (Table 1).

Table 1
Fluoride in Samples of Brown Coal

Opencast	Concentration ppm F⁻	Max. value ppm F⁻	Quantity of samples
Lohsa	15 - 50	204	19
Nochten	15 - 60	480	34
Barwalde	10 - 70	212	18
Spreetal	30 - 80	116	55
Bertsdorf	25 - 200	264	13

Our examinations show that 75% of the fluoride contained in the coal
leaves the chimney as hydrogen fluoride. Provided the smoke gas aspira-
tion is working correctly, 5% of the fluoride is emitted as solid fluo-
ride compounds. Glass plants of the district need an abundance of fluor-
spar, cryolite and sodiumsilicofluoride as fluxing and   etching   agents.
The rate of fluoride in the mixture ranges between 0.5 and 10%. Fifteen
to 35% of the fluoride used in the production of household glass and 70
to 90% used in production of industrial glass is emitted in exhaust gas.

Table 2
Fluoride Emissions into the Atmosphere t/a

Districts	Brown Coal Fired Station	Silicate	Freon	Other*	Total
Calau	370	25	8	0	18.8
Cottbus	20	13	21	0	2.5
Forst	8	25	6	0	1.8
Guben	15	0	6	1	1.0
Hoyerswerda	84	28	16	182	14.5
Senftenberg	154	54	21	3	10.9
Spremberg	450	57	6	2	24.1
Weißwasser	470	84	8	2	26.4
Total	1571	286	92	190	100
In %	73.4	13.4	4.3	8.9	100

* Emissions from aluminum and iron works.

Hydrogen fluoride concentrations ranged from 5 to 210 mg/m^3 and exhaust gas of etching baths from 5 to 130 mg/m^3. Additional fluoride emitters in our district are ceramic industries, enamel, and aluminum plants, and freon emissions from refrigeration factories. Total fluoride emissions into the atmosphere by the major emitters are presented in Table 2.

Further anthropogenic fluoride emission sources in our district are the phosphate fertilizers which possess considerable fluoride concentrations (Table 3).

Table 3

Fluoride in Phosphatic Fertilizers

Fertilizer	Content of F⁻ in %
Runaphos	3
Superphosphat	1
Alkalisinterphosphat	2
Magnesium phosphat	1.2
Pikaphosphat	0.8

124,257 t of phosphate fertilizers are added to the soil of our district every year from which we calculated the total fluoride to be 1880 t/a. Other sources of the soil's pollution by fluoride are sedimentation dusts and rainfall.

The most serious anthropogenic fluoride contamination of the ground and surface water in Cottbus is sewage from glass factories and fluoridation of drinking water supplies. On the basis of routine information from glass plants and from waterworks, the total annual fluoride addition to water is 255 t. Feed containing phosphates, wood protection agents, insecticides, etc. are additional fluoride emitters. The portion of fluoride from these agents is overlooked. Table 4 presents the total quantity of fluoride emitted into our environment.

Table 4

Total Volume of F⁻ in Environment in t/a

District Total	Air	Soil	Water	Feed
4398	2250	1880	225	13
In % 100	51.2	42.7	5.8	0.3

In other districts of the GDR, fertilizers are dominant. Normal values of environmental fluoride in the surroundings of the classic fluoride emitters, are presented in Table 5. For the district of Cottbus area which was tested during four years for atmospheric fluoride by automatic and mobile measuring nets, the levels obtained for high and low fluoride industrial areas are contained in Tables 6 and 7.

Table 5

Rural and Urban Normal F⁻ Values

Rural districts	$0.1 - 0.7$ µg/m^3
City districts	$1 - 5$ µg/m^3
City districts (medium industry)	ca .09 µg/m^3

Table 6

High Atmospheric Fluoride in Industrial Areas

Air Pollution	Short Term Value	Long Term Value
HF (mg/m^3)	0.016-0.070	0.004-0.006
Fluoride in dusts (mg/m^2)	- 10-20 102	. 30 days up to . 30 days

Table 7

Low Fluoride Pollution in Industrial Areas

Air Pollution	Short Term Value	Long Term Value
HF (mg/m^3)	0-0.005	0.002
F in dusts	6-10 mg/m^2	. 30 days

According to our preliminary investigations, the district of Cottbus is a high atmospheric fluoride area, mainly due to brown coal-fired stations and silicate factories. Total fluoride emitted into the air, in the east part of the Cottbus district, is 2.2 kt annually. The major part comes from brown coal power stations which use 40-45 million tons of soft brown coal annually. In the future, these amounts will increase by 20-25 million tons annually due to constructing additional large brown coal power stations. This enormous quanity of fluoride in our environment warrants a longterm comprehensive research program regarding the influence of fluoride on the health status of the population.

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Towarzystwo Biochemiczne i Szczecinskie Towarzystwo Naukowe. May 25-26,
1979, pp. 222.

At a symposium on fluoride metabolism the results of research on the
biochemical effects of fluoride in food, air, water, and soil, on various
tissues and functions in humans, animals and plants were discussed. Some
of the findings are briefly summarized in the following.

Humans

In humans, with varying degrees of susceptibility to caries, accord-
ing to the number of unfilled cavities, who were exposed to significantly
different levels of fluoride in drinking water, certain differences were
noted in the biochemical composition of saliva, in the activity of eno-
lase and lactate dehydrogenase levels of protein, inorganic phosphate and
magnesium.

Laboratory investigations carried out on employees at the "Police"
chemical factories, where workers were exposed to fluoride compounds in
the work environment, showed that fluoride excretion in urine and alka-
line phosphatase activity in the serum was increased, and the hydroxypro-
line level in blood serum was elevated, as was excretion of hydroxyproline
and glycosaminoglycans in urine. No inhibition in the progress of caries
was observed.

Experimental Animals

Observations dealing with experimental animals included those on Wis-
tar rats administered 10 or 20 mg NaF/kg body weight. The results were
compared with the findings in rats that received the same dose plus cal-
cium carbonate. In the first group, periosteal cells in iliac bone were
multiplied; in the second, periosteal reactions were not visible. Fatty
degeneration of hepatocytes in the group receiving 10 or 20 mg NaF/kg was
observed as well as histological changes in kidneys. Histochemical reac-
tions under the influence of NaF were altered. In other experiments, on
Wistar rats, hyperglycemia appeared about 1 hour after 20 to 100mg NaF/kg
body weight was administered intraperitoneally in a single dose. It was
statistically significant in comparison to control rats injected with dis-
tilled water or sodium chloride (p < 0.01).

In sheep living near the factory, more changes were found in the ac-
tivity of enzymes CPK, AspAT, ALAT, LDH, α-HBDH, AP and AcP than in sheep
from a more distant region and in controls.

Botanical Findings

In pot experiments on oats, white mustard and perko[*] supplementation
with 325 ppm or 5.0 g (F^- levels found in soils surrounding aluminum fac-
tories) was toxic. The straw crop was lower at 2.0 g NaF by 10.7% than

[*]perko - crossed fodder plant brought from Estonia.

in the control group. With increasing F⁻ rations, it decreased by 28.5%, 64.8% and 76.5% respectively. The yield of grain decreased more markedly.

The fluoride content of vegetable products cultivated within the F⁻ emission areas of the chemical factories of "Police" depends upon the distance of the garden plot from the emission source (particularly in the case of cultures located up to 2 km from the chemical factory). The fluoride content in vegetables was higher in the above-ground portions of plants than in underground portions.

Sodium fluoride in different doses (0.05% - 0.5%) inhibited the bacteria content of actinomycetes, fungi and lipolitic microorganisms in examined soils, as well as the growth of some selected strains of soil fungi and yeast.

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DENTAL FLUOROSIS IN CATTLE

by

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Dental fluorosis in cattle exposed to industrial fluoride pollution
can be classified in the following categories: 1) hypercementosis with
tooth ankylosis, cementum necrosis and cyst formation; 2) delayed erup-
tion of permanent incisor teeth; 3) necrosis of alveolar bone with re-
cession of bone and gingiva; 4) oblique eruption of permanent teeth, hy-
poplasia of teeth with diastemata; and 5) rapid progression of dental
lesions. Adherence to the standard established by the National Academy
of Sciences (NAS) has left severe cases of fluoride intoxication in cat-
tle undetected in field surveys.

Fluoride is toxic to the respective cells: ameloblasts, odontoblasts,
cementoblasts and cementocytes and to osteoblasts and osteocytes. Appre-
ciation of the pathogenesis in and pathologic anatomy of fluoride intox-
ication must rest on recognition of the fact that fluoride is toxic to
cells of both apposition and resorption. Fluoride does not stimulate the
apposition of any hard tissue. Hypercementosis results from decreased
cementum resorption, not from enhanced apposition.

Fluoride intoxication in cattle is characterized by osteosclerosis
of the metaphyses, which delays closure of the epiphyseal plates because
the primary and secondary spongiosa are not resorbed normally. Resorp-
tion of the roots of the deciduous teeth and formation and eruption of
permanent incisor teeth is very much delayed.

Root resorption of deciduous teeth, by osteoclasia of both cementum
and dentin, may be initiated by pressure from the advancing permanent
tooth.

By adherence to the NAS classification of dental fluorosis, a very
severe case of fluoride intoxication was not recognized; thus the au-
thors conclude that the NAS criteria of fluoride intoxication are super-
ficial and should be changed. Recession of alveolar bone and gingiva, a
very important and common manifestation of chronic fluoride intoxication
in cattle, exists with or without the fluoride-induced structural changes
in the enamel.

Furthermore, data from experimental fluorosis through one generation
have no relevance to a field situation with continuous exposure to indus-
trial fluoride pollution through several generations.

Fluoride is toxic to osteoblasts and osteocytes, and the cells with
the greatest metabolic activity suffer first. The clinical observation
of gingival recession and exposure of root surfaces should therefore be
considered signs of severe fluoride intoxication of alveolar bone. Very

Abstract

severe recession of alveolar bone has also been found in a field situation of fluoride intoxication by phosphate mineral supplements as well as moderate to severe recession in experimental fluoride poisoning.

Since fluoride is toxic to the odontoblasts and ameloblasts, hypoplastic and fan-shaped teeth should be expected in progressive fluoride intoxication. The rapid spread of brown discoloration in permanent teeth is explained by the rapid transport of ions. Intravenously injected isotopes ^{123}I, ^{32}P and others could be traced to the enamel within 5 minutes. Concentrations of the isotopes were greater in the external than in the internal layer of enamel. A correlation between ash fluoride concentrations and the degrees of fluoride toxicosis has been established from experimental fluoride intoxication in cattle.

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VALUTAZIONE DELL'ESPOSIZIONE A FLUORO IN UNA INDUSTRIAL PRODUTTRICE DI ALLUMINIO
(Evaluation of Fluoride Exposure in an Aluminum Production Plant)
(Electrolytic Process)

by

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Data from fixed samplers gave reliable information on environmental pollution in factories. However, real exposure, when compared to results obtained with personal samplers and the result of urinary fluoride determination was overestimated. Urinary determinations allow evaluation of real exposure in relation to the job, of the fluoride accumulation level in each individual, and of the likely trend of accumulation over the years. Furthermore, considering that the fluoride exposure level was not high, this environmental study failed to establish a correlation between dose of fluoride absorbed and urinary excretion in each individual subject.

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RENAL EXCRETION OF FLUORIDE DURING WATER DIURESIS
AND INDUCED URINARY pH-CHANGES IN MAN

by

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Urinary flow rate and urinary pH on renal handling of fluoride fol-
lowing intake of a definite dose of fluoride administered i.v. was in-
vestigated. Two volunteers, 1 male aged 24, and 1 female aged 22, were
studied on two different occasions under alkaline and acidic urinary con-
ditions, respectively. Water diuresis was induced by drinking water, in
an initial amount of 2% of the body weight, and subsequently, 0.5% of b.
w. every 30 min. for 3 hrs.

Renal function was measured during two control periods of 20 min.
and then 3 mg fluoride as NaF solution was infused at a constant rate
for 30 min. Fluoride excretion and renal function were measured during
3 consecutive 20 min. periods. Blood samples were taken at 10, 20, 30,
40 min. and at 1, 1.33, 2, 3, 4, 5, 6, 9 hrs. after the start of infu-
sion. All urine was collected during the same period of time.

The major finding of the present study is that an induced high wa-
ter diuresis results in rapid fluoride clearance. The predominant mech-
anism of renal excretion of fluoride is glomerular filtration followed
by net tubular reabsorption, since no evidence of tubular secretion was
seen. Maximum renal fluoride clearance seems to be most affectively
achieved at high water diuresis. Thus, it seems logical to recommend
that a high water intake should constitute an important part in treatment
of cases of acute fluoride intoxication.

KEY WORDS: Ions, fluoride; Kidney, function, nephrotoxicity, urine flow,
            urinary pH; Pharmacokinetics, renal fluoride clearance; Flu-
            oride intoxication.

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F⁻ CONTENT RELATED TO THE ELEMENTAL COMPOSITION, MINERAL
DENSITY AND STRENGTH OF BONE IN HEALTHY AND
CHRONICALLY DISEASED PERSONS

by

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The first objective of this study was to illustrate how bone fluo-
ride is related to age and sex, several cations, mineral density, and
compressive bone strength in 88 subjects who died suddenly and were not
victims of chronic or immobilizing diseases. The second objective was
to determine whether chronic immobilizing diseases affect bone fluoride
content or the relation of fluoride to certain cations. Bone fluoride
in 50 subjects,who died as a result of chronic immobilizing diseases,was
compared to that in the 88 subjects who had died suddenly as the result
of acute coronary disease or accident.

Fluoride was significantly and positively correlated with age, Mn,
and Zn in both groups. In addition, Cu and Sr were related to F⁻ with
positive coefficients for specimens from subjects who had died suddenly.
Compressive strength was inversely correlated with F⁻. In both groups
the concentration of F⁻ increased with advancing age.

Accumulation of F⁻ was not significantly higher in the chronic dis-
ease group than in the sudden-death group. In the chronic disease group,
F⁻ increased with age as Ca decreased. Thus correlation between F⁻ and
compressive strength in the sudden-death group was negative. In post-
menopausal women,who suffered from chronic diseases, both the decrease
in Ca with age and the negative correlation between F⁻ and Ca were great-
er than in women who had died suddenly.

The F⁻ concentrations observed do not produce any effect that would
clearly prevent bone loss in post-menopausal women with chronic diseases
compared to women in the sudden-death group. In neither group did the
relation between F⁻ concentration and compressive strength provide any
evidence that F⁻ in this range would increase compressive strength.

Both the correlation coefficients for product moment and the multi-
ple linear regression analysis indicated that the relation between Zn
and F⁻ concentrations is statistically significant; it was more signifi-
cant in subjects who had died suddenly than in those who had died from
chronic diseases. Use of fluoridated water does not change the mineral
density of bone. With fluoride supplementation,bone strength does not
increase; it either remains unchanged or decreases.

RESIDUAL FLUORIDE IN THE MOUTH FOLLOWING
THE USE OF A FLUORIDE MOUTH RINSE

by

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The safety of caries-prophylactic fluoride mouth rinse as well as the rinsing method itself was investigated. The amount of fluoride that remains in the mouth after use was determined. Eighty-six children in the sixth grade of primary school (41 boys and 45 girls) were instructed to rinse with 10 ml of the fluoride mouth-rinsing solution (containing 500 ppm of F^-:pH 5.0, phosphoric acid-acidified NaF solution) for 30 seconds. They were told to rinse the mouth subsequently with two 10 ml portions of distilled water for 10 seconds at a time. The fluoride content of the agent that remained in the rinsing cup, the amount of fluoride that was expectorated after use of the rinse, and the fluoride content of the rinsing distilled water were determined by means of an Orion Ionalyzer (model 901).

The sum of the fluoride content of the portion of the rinsing agent that remained in the rinsing cup and the amount of fluoride that was expectorated was 4.33 ± 0.12 mg in the boys and 4.28 ± 0.13 mg in the girls, which corresponds to 86.60% in the boys and 85.56% in the girls of the initial amount of fluoride. With the conventional rinsing method, the amount of fluoride retained in the mouth was 0.67 ± 0.13 (13.40%) in the boys and 0.72 ± 0.13 mg (14.44%) in the girls. When use of fluoride mouth rinse was followed by rinsing with water, the retention of fluoride was 0.46 ± 0.12 mg (9.22%) in the boys and 0.48 ± 0.12 mg (9.56%) in the girls. In 65 children, the retention of fluoride after use of the conventional fluoride mouth rinse was less than 0.8 mg.

The authors conclude that the fluoride concentration and volume of rinsing solution are safe provided the rinsing method is adequate.

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Abstract

FLUORIDE IN HUMAN MILK

by

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Stockholm, Sweden

This study was designed to determine the F^- content in human milk associated with different levels of F^- intake using a silicon-facilitated micro-diffusion technique capable of good accuracy and precision. The mean F^- concentration was 0.36 ± 0.02 µmol/l ($\pm$ SEM) for colostrum and 0.37 ± 0.04 µmol/l for mature milk in the 1 ppm fluoride water area. In the 0.2 ppm area the mean F^- concentration of colostrum was 0.28 ± 0.02 µmol/l. The difference between the samples from the two fluoride areas was not statistically significant.

In breastmilk, collected from 10 mothers at different times during a 24-hour period, no diurnal differences in F^- content were observed. In a subgroup, there were no differences in F^- concentration between the first, the mid and the last portion of the milk.

Previously, Ekstrand et al. observed that administration of 1.5 mg F^- to the mother, does not influence the F^- concentration of her breastmilk. On the other hand, Elsala et al. found higher F^- levels in human milk from a 1.7 ppm F^- area than in a control (0.2 ppm) area. Thus, chronic exposure to high fluoride water levels induces a slight increase.

In an infant of the same age, receiving water-diluted baby formula, F^- intake will be much higher because of the F^- content of the water. In the 0.2 ppm area, the daily intake will be about 160 µg whereas in the 1.0 ppm area it will be about 800 µg, about 30 and 160 fold the intake of the breast fed infant in the respective areas.

In conclusion, during early infancy when breastmilk is the predominant source of food, the infant will have a very low F^- intake, ranging between 5 to 10 µg per day.

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FLUORIDE: CAUTION AGAINST ABUSE

by

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    In a case of fatal ingestion of fluoride in 1974 at a dental clinic, a Brooklyn, New York, couple was granted $750,000.00 for the wrongful death of their son and for the pain and suffering he endured prior to death. A 3-year old male child with no caries was instructed to rinse his mouth with a 4% stannous fluoride solution. Approximately five min-utes later, the child vomited and had a convulsive seizure. The child had swallowed a one-half Lily cup of a 4% stannous fluoride solution. While in the intensive care unit, the child had cardio-respiratory ar-rest during a convulsive seizure and died approximately three hours af-ter the accidental ingestion of the stannous fluoride solution. At this age most children cannot master a mouthrinsing technique, or control, to a satisfactory degree, their swallowing reflex.

    A 4% stannous fluoride solution has a fluoride concentration of al-most 10,000 parts per million. If the child swallowed half of the con-tents of a small, three-ounce Lily cup (about 45 ml), he would have in-gested 435 mg of fluoride from the mouthrinse alone, an amount that ob-viously can be lethal for a human of his age (and probable weight).

    The author points out that the solution for topical application of a fluoride gel is relatively concentrated, and recommends extreme caution when any type of fluoride treatment is undertaken, especially when dele-gating this phase of treatment.

KEY WORDS: Caries prophylaxis; Fatality from stannous fluoride; Stannous
            fluoride mouth rinse

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Abstract

FLUORIDE STIMULATION OF MICROSOMAL
BENZENE METABOLISM

by

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Benzene metabolism was examined in hepatic microsomes from male Sprague-Dawley rats. In addition to phenol, a highly polar unidentified component was formed. No halide other than fluoride stimulated, in vitro, formation of both metabolites. Fluoride did not affect covalent binding of benzene metabolites to protein. Other mixed-function-oxidase reactions, and codeine and ethylmorphine demethylation and benzo[a]pyrene hydroxylation, were not affected by fluoride. The polar metabolite(s) was not retained on either a C-18 reverse-phase or a DEAE-Sephadex anion-exchange column. Thus, although highly polar, this component does not appear to be anionic. These results suggest that an enzyme with high specificity for benzene is responsible for microsomal benzene metabolism. Both phenol and the polar metabolite(s) appear to be formed through a common initial step, which is stimulated by fluoride.

KEY WORDS: Benzene metabolism; Hepatic microsomes

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Authors' Abstract

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EPIDEMIOLOGICAL INVESTIGATION ON ENDEMIC FLUOROSIS IN
SOME DISTRICTS OF SHANGDONG PROVINCE

A general survey on the distribution of fluoride content of drinking water in Shandong Province was carried out in 1978-1979. The following year, four of these counties were surveyed for dental and skeletal fluorosis. In 31 study areas, fluoride in water was relatively high and, in 8 controls areas, water fluoride was relatively low. At the same time, samples of soil, grain, vegetable, and air were collected and examined for fluoride content. The prevalence rate of dental and skeletal fluorosis increased with the fluoride content of drinking water. A positive linear correlation between the two was shown. The question concerning the pathogenesis of fluorosis and the definition of endemic area were discussed.

KEY WORDS: Endemic fluorosis; Shangdong Province; China

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