FLUORINE AND ITS RELATION TO DENTAL CARIES

By

Kathleen King Dow

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Kathleen King Dow

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HISTORICAL BACKGROUND

The purpose of this thesis is to review the literature that has been published on the effects of the use of non-toxic doses of fluorine in relation to the problem of dental caries. The problem is not a new one. Archaeological studies show that the disease existed as far back as the Danish Stone Age, (87) but with our change in mode of living and increased consumption of carbohydrates, the need for control is more demanding. Selective Service Records for 1941 show that of 2,000,000 men examined, 900,000 were rejected for physical and mental disabilities, the major cause being dental defects. 188,000 or approximately 1/5 of the men, did not meet the standards set up by the organization which called for only 12 serviceable teeth. Great efforts have been made through general health education (99) programs to attack the problem by means of reduced carbohydrate diet. (88, 90) The American public will not accept it. Nor can this dental disease be controlled by dental practitioners, who can at best reach only a small percentage of the population. (104) The use of fluorine has been suggested as the best means of controlling the enigma.

The origin of the study dates back to 1908 when the Colorado Springs Dental Society started a survey to determine the cause of mottled enamel, which they thought to be a condition peculiar to that locality. Investigation that was made at that time pointed conclusively to the fact that the tooth defect was influenced by some unknown substance in the domestic water supply. Although samples of water from endemic areas were analyzed, it was not until 1928, when the deep-well water from Bauxite, Arkansas was put to spectographic as well as chemical analysis, that fluorine, heretofore foreign constituent of water,

was found. Like analyses of waters from non-endemic as well as endemic areas proved the hypothesis set forth.(6C)

Experimental work done on rats by Margaret Smith(8) paralleled the conclusions drawn. People native to the community of St. David, Arizona showed almost 100% affection. That drinking water was the cause was proved by feeding rats a residue from the water supply of that community. The resulting condition was identical with the fluorosis produced by feeding rats a ration containing sodium fluoride. McClure and Mitchell(7) about the same time showed the relationship of increased amounts of fluorine to increased metabolism of calcium in albino rats.

As early in their investigations as 1916 McKay and Black(2) noted that caries incidence was low in the Rocky Mountain Region where mottled enamel was prevalent. They also observed that the teeth of children in that locality compared favorably with the teeth of children where endemic mottling was unknown, but when the teeth did decay, the frail condition of the enamel made it impossible to make effective fillings. Therefore, many extractions were necessary, although carious lesions were small and few.

A study made by Bunting, Crowley, Hard and Keller(4) in Minonk, Illinois (1928) is the first published data on survey attempting to establish the relationship between dental caries and mottled enamel. They discovered that although caries occurred, they existed only as small pits or fissures and usually did not extend beyond that stage. Although the causative factor for mottled enamel had not been established at that time, they suspected that it was some principle in the

drinking water.

McKay [60] in 1929 published his conclusions that individuals living in communities which had no mottling of teeth had more caries than did those with mottled enamel, and also that when mottling did occur in either the mottled or the normal teeth of people living in endemic areas, it was limited almost exclusively to the molars.

These reports, substantiated by the clinical research done by others, [7,8] were the impetous for the widespread studies that followed.

DENTAL FLUOROSIS, A WATER-BORNE DISEASE

Chronic endemic dental fluorosis is described by Clawson et al (105) as "endemic hypoplasia of the permanent teeth, known variously as "denti di teeth", "le darmous" and "schmelzflecke", which is a water-borne disease associated with the ingestion of toxic amounts of fluorides in water used for cooking or drinking during the period of calcification of the affected teeth." The enamel may have a "paper-white", opaque appearance which has none of the translucency of normal enamel. If only spots on the tooth are affected and the rest of the enamel is normal a "mottled" appearance willbe produced. The markings on the teeth are present at eruption. With age the lesion will discolor to every conceivable shade of light yellow, brown or even black.

Dr. Eager (1) reported the condition, under the Italian name of "denti di chiae", as being endemic in Naples, Italy. Upon examination it was found to exist in areas with well-defined boundaries throughout the world. A 1941 report by Dean (69) sets the known number of endemic areas in the United States at approximately 400, ranging throughout 28 states.

The West Texas-Panhandle region, according to a report by Dean, (69) constitutes the largest known region of endemicity in the United States, the district affected being approximately the size of the State of Pennsylvania. Twenty-six West Texas counties were found to be endemic. Such large cities as Amarillo, Lubbock and Plainview are affected. Of 53 communities surveyed in 37 counties, only six could be classified as borderline.

In endeavoring to determine the minimal threshold of the dental

sign of chronic dental fluoroses, Dean and Elvove (32) examined the water supplies of four cities.

City	F. p.p.m.	Mottled enamel index
Colorado Springs, Colorado	2.5	slight
Monmouth, Illinois	1.7	slight
Galesburg, Illinois	1.8	slight
Pueblo, Colorado	0.6	negative

Margaret Smith (8) reported her findings on relationship of water supplies to mottled enamel for territory in Arizona.

F. p.p.m.	Mottled enamel index
0 - 0.8	no effect
0.9	very mild
1.0 - 2.0	mild
2.0 - 3.0	moderately severe
more than 6.0	severe pitting and chipping

High-fluoride and low-floride waters were often found in the same parts of the valley.

STUDIES MADE OF THE FLUORINE-CARIES HYPOTHESIS.

Although many surveys have been published on the relationship of fluorine content of water to dental caries, Dean's [32] work in correlating statistical evidence has been conspicuous. The epidemiological studies he has made point conclusively to the fact that there is an inverse ratio between fluorine concentration in water and caries incidence. He recommended as early as 1938 the control of dental caries by control of water supply at a minimum threshold of one part per million (p.p.m.) of fluorine.

A most interesting series of surveys has been made of Oakley, Idaho and Bauxite, Arkansas. In 1925 McKay [5] in making a study of the 100% endemic mottled enamel condition in Oakley, noted that one family living near the edge of the town and not drawing from the communal water supply was not affected. He convinced the people that a change from the warm spring water commonly used to the cold spring water used by the one family was advisable. In re-examining the community eight years later, it was found that no new cases of dental fluoroses had occurred. Later chemical analyses of the water supplies showed the newly adopted water supply to contain 0.5 p.p.m. fluorine, as compared to 6 p.p.m. in the old.

About the same time Bauxite, Arkansas decided to change its water supply. [3] They had been using water from wells. Those who had used it during the time of tooth calcification showed 100% dental fluoroses. Benton, a neighboring community, derived its water from the Saline River and showed no affection. With that to guide them, Bauxite voted to use the Saline River as their source of water supply. It was determined

that the abandoned well water contained 14 p.p.m. fluorine. Saline River water is fluorine-free.(33)

Twelve years later Dean (38) and associates made another dental caries survey involving the high school children, ages 14 to 22, from Bauxite and Benton. The teeth of the 50 Bauxite children were still mottled due to the fact that they had been exposed to high concentrations of fluorine during the time of calcification. The caries rate of the Bauxite group after using fluorine-free water for twelve years, was less than half that of the Benton students.

Dean, Jay, Arnold, McClure and Elvove (1939) made a survey of four cities in Illinois.(36) Pertinent findings are tabulated:

	Galesburg - Monmouth		Macomb - Quincy	
Concentration F. in p.p.m.	1.8	1.7	0.2	0.2
Caries incidence per 100 teeth	201	205	401	638
Lesions per 100 tooth surfaces	0.67	0.38	7.2	9.3

In Galesburg the L. Acidophilus counts of 30,000 or over were 15% and in Quincy 52%. 76 of the children of Galesburg were born elsewhere but entered the community prior to the age of six, before the permanent teeth had erupted. Hence the oral environment was identical with that of Galesburg children except in pre-eruptive history. The number of caries in the whole group of 31[illegible] children minus those of 243 children born in Galesburg showed 229 cavities per 100 children. 129 children

whose teeth were normal or the mottling of which was questionable showed 1.6 cavities per 100. This indicates that it was not drinking of fluorine-containing water that was protection, but that their teeth were resistant because of the structure of enamel.

In a survey of nine-year old children in cities of Kansan, Colorado and Illinois (1938) Dean (31) found the occurrence of caries was lower for both deciduous and permanent teeth in mottled enamel areas than was the case in other places. 4% of the children who used water containing fluorine 0.6 to 1.5 p.p.m. were caries free compared to 22% of the children who used water containing 1.7 to 2.5 p.p.m. fluorine. The caries incidence in mottled and normal teeth was not significantly different. Dean concluded that "the limited immunity-producing factor is operative whether or not the tooth is affected by mottled enamel."

In order to determine the lowest concentration at which fluorine is effective in reducing the incidence of dental caries. Dean, Jay, Arnold and Elvove (52) selected eight Chicago suburbs for their observations. They took care to exclude any known variable factors. It could be expected that there would be homogeniety in diet and climatologic l conditions in those suburbs.

	p.p.m.F.	Children examined	Number caries	DMF	Percent No caries
Elmhurst	1.8	154	42	361	27.3
Maywood	1.2	139	39	352	28.1
Aurora	1.2	340	85	957	25.0
Joliet	1.3	233	42	765	18.0
Elgin	0.5	250	27	1,113	10.8
Evanston	0.0	308	8	1,399	3.8

	p.p.m. F.	Children examined	Number caries	DMF	Percent No caries
Oak Park	0.0	208	6	1,508	2.9
Waukegan	0.0	227	6	1,891	2.6

Bull (1936) studied a group of children 12 to 14 years of age in Green Bay, Wisconsin, (99) with the purpose of determining the severity of mottled enamel in that community where the people derived their water supply, which contained and average of 2.1 p.p.m. fluorine from five wells ranging from 804 to 955 feet deep. 75% of the people showed mottling, ranging from very mild to severe. In 1943 Bull published his findings on the incidence of caries existing in Green Bay as compared to that existing in Sheboygan, Wisconsin, a city 65 miles distant. The two cities are of comparative size. Sheboygan secures its water from Lake Michigan, the fluorine determination of which is 0.05 p.p.m. The decayed, missing, filled (DMF) experience of the children, determined by adding the number of decayed, missing and filled teeth by the number of children examined, in the two cities is summarized in the following table:

Area	Number of children	Teeth carious	Teeth filled	Teeth extracted	DMF
Green Bay	1,647	1,343	2,729	236	2.62
Outside Green Bay	521	732	1,472	187	4.49
Total Green Bay	2,168	2,075	4,201	423	3.06
Sheboygan	1,877	2,754	11,993	1,287	8.54

(106)

The Dane County Dental Society Fluorine Committee, under the direction of Frisch, recently completed a survey of the dental caries experience of the children in two Wisconsin communities, namely Union Grove with a fluorine concentration of 1 p.p.m. in the public water supply, and Madison, with 0.05 p.p.m. concentration. The findings of some 20 dental practitioners, and passed on by the local organizations are tabulated:

SUMMARY OF COMPARATIVE DENTAL SURVEY
PERMANENT AND DECIDUOUS TEETH

Union Grove - Madison

Ages 6 to 17 inclusive

	Union Grove 1.0 Fluorine P.P.M.	Madison 0.5 Fluorine P.P.M.
Number of children examined	109	545
Cavities Filled Units	199	4161
Cavities Unfilled Units	165	1689
Upper Anteriors Filled or Carious Units	12	512
Teeth Extracted or Need Extraction	11	441
First Molars Units Decayed	210	2955
AVERAGE NUMBER DECAYED UNITS PER CHILD	3.64	13.16

GENERAL SUMMARY OF RESULTS

1. Permanent teeth of Madison children began to show loss by extraction at age 7.
2. Permanent teeth of Union Grove children began to show loss by extraction at age 15.
3. Madison children have more than 4 times as many fillings.
4. Madison children have more than 2 times as many cavities.
5. Madison children have almost 9 times as much decay of the upper anteriors.
6. Madison children have about 8 times as many teeth lost by extraction.
7. Madison children have about 3 times as much decay of the first molars.
8. Madison females had .09% more decay than the males; Union Grove males had .09% more decay than females.
9. Madison children have almost twice as much irregularity of teeth of the type that presumably was caused by early loss of decidious or permanent teeth and loss of space by decay.
10. Union Grove children had an over all dental decay experience of only 27% as much as Madison children.

THE ORIGIN OF DENTAL CARIES.

Dental decay is on the increase. Frisch (99) cites the fact that Illinois army selectees, ages 21 to 37, show a dental caries experience (DMF) of 10.7, which is less than the caries rate of Waukegan, Oak Park and Aurora children, ages 12 to 14 with a DMF rate of 12.3 and 14.6.

Cox (67) offers the following theory of the origin of dental caries. "First, inadequacy in the diet - fluorine being one factor - results in caries-susceptible enamel. Second, through trauma, a crevice is developed in the enamel and an incipient lesion results. Third, by chance invasion of that lesion, or lesions, by aciduric organisms, with a plentiful supply of proper food, caries result."

That Lactobacillus acidophilus in the saliva play a major role in the breakdown of teeth has been demonstrated by Jay and by Harrison (75). Jay showed that the L. acidophilus count in the mouths of people living in endemic mottled enamel areas was low in contrast to those residing in communities where the water supply was free of fluorides. Hine examined the material from the base of 41 caries. In all cases he found a mixed flora, which supports the idea that oral bacteria in quantities appreciable to produce acid is capable of capable in causing decay.

Volker (42) sought to find the effect of fluorine on the solubility of enamel and dentin. Powdered enamel and dentin were treated with a solution of sodium fluoride in concentrations 1/25 and 1/10,000. The powder material showed decreased acid-solubility in proportion to the strength of the solution used. In a later publication he suggested the fluorine must act either by weakening attacking forces that cause the breakdown of teeth or by enhancing the power of teeth to withstand the attack. If the initial lesion of dental caries is a decalcification

of enamel by acids produced by bacterial fermentation of food, fluorine, he contends, must "have the ability to affect the in vitro growth and acid production of the oral bacteria.

Gottlieb (100) describes the acid-dissolving action of enamel as the "old" caries concept and offers the explanation that "carious lesions are produced by microorganisms along organic roads".

That surface changes in the enamel cause a protective layer to form over the teeth, making them less susceptible to caries, is the theory advanced by Bibby. (27)

Although the reason for dental decay has not been agreed upon, all of the aforementioned investigators of the problem do agree that fluorine, in some manner, plays a definite role in reduction of caries.

The other theory, widely supported, and based upon the natural means of acquisition, is that fluorine should be added to public water supplies that are below the generally accepted optimum concentration of 1 p.p.m. Ast (87) points out that the level would have to be adjusted to climatic conditions; that is, less fluorine should be added to water in hot, dry areas where more water would normally be imbibed. (87)

Although several writers (43, 67, 82) temper their recommendation for raising levels of fluorine in water by artificial means by advocating more clinical investigations and surveys of the problem, Dean (30,32) who has lead the work in epidemiological studies, and many others, feel that universal adjustment cannot but be of benefit to all. Methods of extraction of fluorides from waters containing too high a ratio have been developed in detail. (94,98) The cost of adding the soluble fluorides would be nominal.

Toxic effects such as lenthening of incisor teeth, changes in endocrine gland and kidney functions have been demonstrated experimentally and reported in the literature.[10, 11, 12, 13, 15, 16, 18, 19] 21

In all cases large doses of fluorine have brought about these changes. The dystrophy of mottled enamel is the only demonstrated indication of toxicity with lower levels of fluorine.

ADMINISTRATION OF FLUORINE

One means of administering fluorine, now being widely tested clinically, is topical application. Armstrong,[64] by analyses of human sound and carious teeth has determined that the enamel of the former contain 0.0155 to 0.0163% fluorine and the dentin, 0.0200 to 0.0207%. Carious teeth show lower fluorine content in enamel, but not in the dentin.[26] By topical application of strong solutions of luorine, the concentration in tooth enamel is raised.

In treating powdered enamel and dentin with varying strength solutions of sodium fluoride, Volker[42] found that the acid-resistance quality of the teeth increased in direct proportion to the strength of the solution used. His belief is that fluorine attacks bacteria which produce the acid attributed to decalcify enamel.[62,84]

Bibby[27,45,93] believes that factors operating after tooth development are more important than during formation, and bases his beliefs on the fact that incisor teeth apparently benefit more from fluorine than do the molar teeth, though they both form at the same time. He recommends topical application as the best means of therapy so that all teeth will be treated and equally benefited.

According to Gottlieb,[100] fluorising the organic matter of the teeth with mouth washes makes the teeth extract calcium from the saliva and produces and additional obstruction to proteolytic enzymes, which cause tooth decay.

Norvold[57] suggests fluorine as the most practical and safest means of acquiring fluorine. After immersing teeth, that had been selected at random, in a strong solution of sodium fluoride, he determined that they contained 15.9% more fluorine than the control

teeth.

Specific formulas have been recommended and used. Twenty people used water containing 5 p.p.m. sodium fluoride (which is equivalent to 2.26 parts of fluorine) as a dentifrice. Atkins (44) reports a reduction in caries incidence.

A dental student and his wife are reported to have used a mouth wash 1:1,000 sodium fluoride in water, for five minutes a week over a period of six months. There were no deleterious effects except for slight sensitivity. No new carious lesions appeared. (97)

CONCLUSIONS

Early investigations in the fluorine study were carried out to determine the cause of mottled enamel. Once fluorine was found conclusively to be the causitive factor, the problem was to find what concentrations of fluorine constituted toxic doses and to eliminate excessive amounts from water supplies.

The low caries rate found in endemic communities opened up a new field of research. Epidemiologic, chemical and bacteriological studies indicate that the inhibiting effect of fluorine may provide dentists and public health agents with most effective caries control procedure thus far discovered.

The problem now under study is to test the practibility of adding limited and controlled amounts of fluorine to public water supplies found to be deficient in this element in the interest of universal caries control.

BIBLIOGRAPHY

(1)
Bager, J.M. 1901

Denti di chiais.

Pub. Health Rept., v. 16, p. 2576.

On examination of emigrants from Naples, he noted a peculiar dental condition which the people described as "denti di chiaie".

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(2)
Black, G.V. and McKay, F. 1916

Mottled enamel - and endemic development imperfection heretofore unknown in the literature of dentistry.

Dent. Cosmos, v. 58, p. 129.

Caries incidence is reduced in endemic areas. Teeth of children compared favorably with those of children in non-endemic areas. More people lost their teeth early because the frail condition of the enamel made it difficult to make effective fillings.

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(3)
McCollum, E.V., Simmonds, N., Becker, J.E. and Bunting, R.W. 1925

Effect of addition of fluorine to diet of rat on quality of teeth.

Journ. Biol. Chem., v. 43, p. 553.

Sodium fluoride to the extent of 0.0226% (0.0001% F) was included in the otherwise normal diet of rats. The rats developed incisors, abnormal in color and lacking characteristic orange tint. There was a change in the shape of the teeth. The upper incisors grew backward into a circle, while the lower teeth were correspondingly shortened.

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(4)
Bunting, R.W., Crowley, M., Hard, D. and Keller, M. 1928

The relation of Bacillus acidophilus to dental caries.

Dent. Cosmos, v. 70, p. 1002.

Caries are remarkably limited in the mouths of children residing in Minonk, Illinois, where mottled enamel is endemic. Caries exist as small pits or fissures. Although the cause of mottled enamel is unknown, it would seem to have its source in drinking water.

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(5)
McKay, F.S. 1930

Geographical Distribution of Mottled Enamel.

Journ. Dent. Res., v. 10, p. 561.

First summary of geographical distribution of mottled enamel. Nine state in the United States are listed as known endemic areas.

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(6)
Churchill, H.V. 1931

Occurrence of fluorides in some waters in the United States.

Ind. and Eng. Chem., v. 23, p. 996.

Fluorine was found to be present in the drinking water of communities in which mottled enamel was endemic.

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(7)
McClure, F.J. and Mitchell, H.H. 1931

Effect of fluorine on calcium metabolism in albino rats.

Journ. Biol. Chem., v. 90, p. 297.

Fluorine, especially soluble sodium fluoride, at levels of 0.0313 and 0.0623% of fluorine, caused increase in ash content other than calcium fluoride. Growth was inhibited. Although there was little effect with dosages of 0.0313% fluorine, there was a marked effect with 0.0623%.

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(8)
Smith, M.C. 1931

The cause of mottled enamel.

Science, v. 74, p. 244.

List of known mottled enamel areas throughout the world given.

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(9)
Ainsworth, N.J. 1933

Mottled enamel.

Brit. Dent. Journ., v. 55, p. 233.

A group of 200 children, 5 to 15 years, were examined in England. Those who lived in an area using water containing fluorine showed a caries incidence of 7.9% in permanent teeth and 12% in deciduous teeth. Those living in a community using fluorine-free water a caries incidence of 13.14% in permanent teeth and 43.3% in deciduous teeth.

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(10)
Hauck, H.M., Steenback, H. and Parsons, H.T. 1933

Is effect of fluorine on teeth produces through parathyroid gland?

Am. Journ. Physiol., v. 103, p. 480.

The parathyroid glands in the rat undergo no consistent significant change with the administration of toxic doses of fluorine.

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(11)
McClure, F.J. 1933

Fluorine and its physiological effects.

Physiol. Rev., v. 13, p. 277.

Regardless of their fluorine content, teeth are influenced structurally and presumably chemically by the presence of extremely small amounts of fluorine in the diet. Mere traces of fluorine exert a potent influence on the reaction of certain enzymes.

With dogs, rabbits, cats and guinea pigs as clinical subjects, sodium fluoride was administered in doses of 0.5 Gm. per 100 Gm. body weight internally or 0.15 Gm. by injection subcutaneously, with the following results observed:

1. Drowsiness and weakness resulting from paralysis of vaso-motor centers.

2. Cramps, epileptic in character, of a single organ or the entire body.

3. Paralysis of vaso motor centers.

4. Acceleration and deepening of breathing.

5. Vomiting.

6. Secretion of salivary and tear glands.

7. Early rigor following death.

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(12)
Phillips, P.H., Hart, E.B. and Bohstedt, G. 1933

Fluorine in the nutrition of rats.

Am. Journ. Physiol., v. 106, p. 350.

Growth in rats in inhibited by the addition of fluorine to the diet.

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(13)
Phillips. P.H., Hart, E.B. and Bohstedt, G. 1933

Fluorine - its effect on reproduction of rats.

Am. Journ. Physiol., v. 106, p. 356.

Chronic fluorine poisoning does not inhibit reproduction in rats, but does suppress lactation if given in large doses.

—

(14)
Sebrel, W.H., Dean, H.T., Elvove, E. and Breaux, R.P. 1933

Changes in teeth produced by water from mottled enamel area.

U.S. Pub. Health Rept., v. 48, p. 437.

Conway, South Carolina drinking water concentrated to one-tenth its volume, produced whitish incisors in white rats followed by the appearance of brown striations. Synthetic water containing 150 p.p.m. sodium fluoride gave similar results. At 500 p.p.m. sodium fluoride, the water was exceedingly toxic to young white rats. Chalky-white, brittle teeth were produced in those surviving the acute toxic effect.

(15)
Phillips, P.H., Hart, E.B. and Bohstedt, G. 1934

Influence of fluorine ingestion on the nutritional qualities of milk.

Journ. Biol. Chem., v. 105, p. 123.

The content of fluorine in normal milk is 0.05 to 0.22 mg. per liter. Fluorine in milk from cows fed 0.2 to 3.0 Gm. of fluorine as rock phosphate per day had only slightly higher or the same fluorine content. Rats fed the two kinds of milk for 140 days showed no differences. There was no toxicity for animals that had a fluorine intake of 0.132 mg. of fluorine per day.

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(16)
Phillips, P.H., and Lamb, A.R. 1934

Histology of certain organs and teeth in chronic toxicoses due to fluorine.

Arch. Path., v. 17, p. 169.

Including fluorine in the diet of rats, in concentration of 20 to 30 mg. per kg. of body weight per day, in the form of sodium salt or rock phosphate, produces changes in kidneys, incisor teeth and thyroid glands.

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(17)
Bowes, J. and Murray, M. 1935

Estimation of fluorine content of the teeth.

Biochem. Journ., v. 29, p. 102.

In a study to determine the composition of teeth of good structure, so as to determine the relationship between chemical constitution and hypoplasia, it was found that human enamel of London area contained 0.02% fluorine.

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(18)
Phillips, P.H. and Hart, E.B. 1935

Effect of organic diet on fluorine toxicoses.

Journ. Biol. Chem., v. 109, p. 657.

A diet high in fat and low in carbohydrate used on experimental animals did not lessen the toxicity of fluorine. The addition of lactates, glycerol or lactic acid to the ration did not increase tolerance to fluorine. This is interpreted to mean that chronic fluorine poisoning involves more than a mechanism responsible for carbohydrate metabolism. The mode of action of fluorine is systemic in character. Its reaction is produced by its rather general inhibition of enzymic systems.

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(19)
Schour, I. and Smith, M.C. 1935

Mottled teeth.

Journ. Am. Dent. Assoc., v. 22, p. 796.

Mottled enamel was produced in albino rats by the administration of sodium fluoride. Mottled enamel has been found on deciduous teeth of several children whose supply of drinking water contained 12 to 18 parts per million of fluorine.

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(20)
Bowes, J.H. and Murray, M.M. 1936

Mottled teeth from Maldon.

Br. Dent. Journ., v. 60, p. 556.

Fluorine determinations made on mildly mottled enamel of subjects from the endemic area of Maldon, Essex showed enamel to contain 0.035% fluorine and the dentin 0.07%. The degree of abnormality suggested by the chemical analysis was considerably less than that based on examination of the surface structure, which showed a slightly hypoplastic condition.

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(21)
DeEds, F. 1936

Fluorine in relation to bone and tooth development.

Journ. Am. Dent. Assoc., v. 23, p. 568.

In the first mile of the earth's crust, fluorine ranks twentieth among the elements. It is also found in vegetable tissue, bones and teeth of man and lower animals. The low solubility of calcium fluoride

accounts for its accumulation in teeth and bones. The toxic effects of fluorine on enzymes suggest the possibility of interference with metabolism and with enzymic processes associated with normal bone and tooth formation.

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(22)
Machle, W.F. 1936

Normal uninary fluorine secretion and the problem of mottled enamel.

Dent. Cosmos, v. 78, p. 612.

The urine of 101 normal subjects and 38 women and children (hospital patients), none of whom had been subjected to geographical or occupational exposure of fluorine compounds, contained 0.5 to 2.8 mg. of fluorine per liter. Foods as well as water must be considered a source.

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(23)
Murray, M.M. 1936

Maternal transference of fluorine.

Journ. Physiol., v. 87, p. 388.

In experiments on rats, a mother was fed 0.05% sodium fluoride. The newborn rats had 0.0004% fluorine in their bones, which was 30 times as much as that in the bones of the control animals. It is suggested that the mottling of temporary teeth in young children may come from prenatal maternal fluorosis. Milk from regions where fluorine occurs in water, contains fluorine in amounts that may be effective.

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(24)
Smith, M.C. 1936

Dietary factors in relation to fluorine.

Journ. Dent. Res., v. 15, p. 281.

Experiments on approximately 1500 rats demonstrated that:

1. Mottled enamel does not result from deficiency of any known dietary essential.

2. Suboptimal intake or dietary improvement of protein, calcium, phosphorous and vitamins A, C, and D has no effect.

3. The fluorine intake is the deciding factor.

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(25)
Smith, M.C. and Reed, R. 1936

Five year study in fluorine-free water district.

Journ. Am. Dent. Assoc., v. 23, p. 1725.

Fluorine compounds enter the system from sources other than water supply.

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(26)
Armstrong, W.D. and Brekhus, B.A. 1937

Enamel and dentin, principal components.

Journ. Am. Dent. Assoc., v. 24, p. 99.

Microgram analyses on mixed human sound teeth showed enamel to contain 0.0155 to 0.0163% fluorine and the dentin of the same teeth 0.0200 to 0.0207%. The analyses of carious teeth made to date indicate a lower fluorine content in the enamel, but not in the dentin.

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(27)
Bibby, B.G. 1937

Protective action of enamel surface.

Journ. Am. Dent. Assoc., v. 24, p. 97.

As a result of surface changes on the enamel, a protective layer is formed on the teeth, which may make them less susceptible to dental decay. The natural self-protective capacity of teeth explains why dirty teeth do not always decay and why decay becomes less active as teeth grow older. If this protective process can be brought about by artificial means, the prevention of much dental decay should be possible.

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(28)
Hine, M.K. 1937

Bacteria and dental caries.

Journ. Am. Dent. Assoc., v. 24, p. 97.

The possibility of microorganisms as a cause of dental caries has been considered since the introduction of the germ theory of disease. Many bacterial species found in the mouth are capable of producing acid strong enough to decalcify tooth structure. Material from the very base of 41 cavities was examined. In all cases mixed flora was found. This supports the idea that any species of oral bacteria that can produce acid in appreciable quantities is capable of causing dental decay.

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(29)
Armstrong, W.D. and Brekhus, P.J. 1938

Possible relationship between the fluorine content of enamel and resistance to dental caries.

Journ. Dent. Res., v. 17, p. 393.

Enamel of non-carious teeth contain 0.0111% fluorine as contrasted with 0.0069% fluorine in carious teeth.

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(30)
Clark, J.D. and Mann, E.H. 1938

Occurrence of luorine in the drinking water of New Mexico and the menace of fluorine to health.

University New Mex. Bull. Chem. Ser. 2, No. 5, p. 23.

A home method for the extraction of fluorine is given. If bone ash is added to the water obtained from the wells, and the mixture is boiled, the precipitate that settles out will carry with it the excess fluorine.

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(31)
Dean, H.T. 1938

Endemic fluoroses and its relationship to dental caries.

U.S. Public Health Repts., v. 53, p. 1443.

In a survey made of nine year old children in cities of Kansas, Colorado and Illinois, it was found that with water 0.6 to 1.5 p.p.m. fluorine concentration, 4% of the children were caries-free; with water 1.7 to 2.5 p.p.m. fluorine concentration, 22% were caries-free.

(32)
Dean, H.T. and Elvove, E. 1936

Facts about fluorides.

Eng. News record, v. 120, p. 591.

Dental fluoroses is caused by drinking water in excess of 1 p.p.m. during the years from birth to eight years. 351 areas of endemicity are known or have been reported on. The relationship of dental fluoroses to fluorine containing water has been confirmed in 260 cases of the areas. Removal of the excess fluorine by use of magnesium oxide is suggested.

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(33)
Dean, H.T., McKay, F.S. and Elvove, E. 1938

Mottled enamel survey of Bauxite, Arkansas.

U.S. Pub. Health Rpts., v. 53, p. 1736.

The production of dental fluoroses was stopped within ten years after the change of water supply from one with excess fluorine content.

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(34)
Cox, G.J. 1939

New Knowledge of flourine in relation to dental caries.

Journ. Am. Water Works Assoc., v. 31, p. 1926.

It is noted that mottled enamel does not cause increase in dental caries.

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(35)
Cox, G.J. 1939

Flourine beneficial to health.

Dental Observer, v. 6, p. 1.

Flourine administered to pregnant rats caused decrease in dental caries in young. Sir James Crichton Browne advises adequate supply of flourine in the diet of women to insure stronger teeth in next generation.

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(36)
Dean, H.T., Jay, P. and Arnold, F.A. 1939

Domestic water and dental caries.

U.S. Pub. Health Rept., v. 54, p. 862.

A comparison was made between children who were born in Galesburg, Illinois and those who were born elsewhere and moved to that city prior to six years of age. A comparison of cavities showed 229 per 100 children born elsewhere and 186 per 100 born in Galesburg. The results indicated that it was not drinking fluorine-containing water that made the difference but the formation of resistent enamel during the pre-eruptive period.

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(37)
Dean, H.T., Elvove, E. and Paston, R.F. 1939

Enamel in South Dakota.

U.S. Pub. Health Rept., v. 54, p. 212.

A survey made of dental fluorosis in South Dakota showed that the endemicity was centralized in rural and smaller communities where the source of domestic water supply was from South Dakota sandstone areas.

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(38)
Dean, H.T. and McKay, F.S. 1939

Production in mottled enamel halted by a change in common water supply.

Am. Journ. Pub. Health, v. 29, p. 590.

Oakley, Idaho and Bauxite, Arkansas were the first communities to change their common water supplies from those which caused mottled enamel due to high fluorine content to the accepted fluorine level of 1 p.p.m. Reports from the areas show that with the change, mottled enamel was stopped.

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(39)
Fahey, J.J. 1939

Colorimetric determination of fluorine with ferron.

Ind. Eng. Chem. Anal. Ed., v. 11, p. 362.

90 cc of ferron (7-iodo-8-hydroxy-quinoline-5-sulfonic acid) and 10 cc of an aqueous solution of 2N HCl - 0.1 N $FeCl_3$ in 100 cc distilled water assumes a yellow color in the presence of fluorine in concentration as low as 1 p.p.m. By matching with solution of known concentration, determination of fluorine content in water may be made.

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(40)
Hodge, H.C. 1939

Fluorosis in rats due to contamination with fluorine of commercial casein.

Journ. Nutrition, v. 17, p. 333.

Rats, fed for three generations on a fluorine-contaminated diet, showed the following marked signs of dental fluorosis.

(1) Lengthening of upper incisors.
(2) Fracturing of lower incisors.
(3) Decreased eruption rate.
(4) Marked diminution of color as compared to normal.

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(41)
Schuck, C. 1939

Study of influence of magnesium and sodium on the activity of fluorides.

Journ. Dent. Res., v. 17, p. 387.

The toxicity of fluorine is not enhanced by the addition of magnesium to water used in the diet of rats. Addition of sodium carbonate does not increase dental fluorosis.

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(42)
Volker, J. 1939

Effect of fluoride on solubility of enamel and dentin.

Journ. Proc. Soc. Exper. Biol. and Med., v. 42, p. 725.

Powdered enamel and dentin, treated for one hour with aqueous solutions of sodium fluoride of concentrations 1/25 to 1/10,000, were found to show decreased acid solubility. The more concentrated the solution, the more resistant the teeth become. It is suggested that decreased caries incidence of people in endemic areas is due to adsorption of fluorine on the dental surface.

(43)
Anthony, L. P. 1940

Editorial.

Journ. Am. Dent. Assoc., v. 27, p. 3.

The works of McKay, Black and Cox are discussed. The statement is made that until much more work is done, the use of fluorine, either by topical application or by addition to water supplies, does not meet with the approval of the dental profession.

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(44)
Adkins, P.A. 1940

Fluorine as a dentifrice.

Journ. Am. Dent. Assoc., v. 27, p. 1109.

In 20 cases in which water containing 5 p.p.m. sodium fluoride (which is equivalent to 2.26 parts of fluorine) was used on the tooth brush as a dentifrice, there was a marked reduction in dental caries.

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(45)
Bibby, B.G. 1940

Use of Fluorine compounds to prevent caries.

Time, v. 35, p. 40.

Bibby notes that mottling effect occurs only in second teeth, and that controlled intake of fluorine after ten years of age will not cause mottling. The toxicity of fluorine makes it unsafe as a dentifrice.

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(46)
Bibby, B.G. and Van Kesteren, M. 1940

The effect of fluorine on mouth bacteria.

Journ. Dent. Res., v. 19, p. 391.

Fluorine in concentration of less than 1 p.p.m. limit allows production of acid by bacteria; concentrations of more than 250 p.p.m. were needed to inhibit bacterial growth. Limitation was in direct proportion to concentration of fluorine. Fluorosed dental enamel will

also reduce acid production.

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(47)
Cheyne, V.D.

Effect of selective salivary gland extirpation on dental caries.

Proc. Soc. Exp. Biol. and Medicine, v. 43, p. 58.

In the absence of oral secretion there was a great increase in dental caries, but the number of caries was reduced by one-fifth by the administration of fluorine.

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(48)
Cheyne, V.D. 1940

Inhibition of experimental dental caries by fluorine in the absence of saliva.

Journ. Dent. Res., v. 19, p. 280.

Animals were fed fluorine in quantity sufficient to cause mottling and desalivated. When these animals, which presumably had increased fluorine content in enamel, were placed on a caries-producing diet, there was no significant reduction in caries. The observation is made that fluorine must be continuously used to be effective. Saliva is not necessary as a vehicle.

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(49)
Cox, G.J. 1940

Fluorine in relation to dental caries.

Journ. Am. Dent. Assoc., v. 27, p. 1107.

In 1805 Gay-Lussac showed the presence of fluorine in dental enamel, after the discovery of the halogen in fossil enamel by Morichini in 1802. Observations are made that fluorine not only causes mottled enamel, but reduces dental caries and inhibits bacterial action either through drinking water or in the saliva.

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(50)
Day, C.D.

Chronic endemic fluorosis in northern India.

Brit. Dent. Journ., v. 68, p. 409.

Fluorine in concentration of 1.2 to 6.4 p.p.m. was present in water supplies. Although young and old were almost universally affected and showed dental fluorosis, incidence of caries was low. 41.89% of the children in the mottled enamel area were free from caries, while only 5.95% in the non-endemic area were free.

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(51)
Schour, I. and Massler, M. 1940

Studies in tooth development; the growth pattern of human teeth.

Journ. Am. Dent. Assoc., v. 27, p. 1918.

The conditions that show in teeth at adolescent age are a direct cause of the factors prevalent at early childhood.

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(52)
Smith, M.C. and Smith, H.V. 1940

Observations on the durability of mottled teeth.

Am. Journ. Pub. Health, v. 30, p. 1050.

A survey of children, ages 12 to 14 years, and adults was made in St. David, Arizona, where community water supplies ranged from 1.6 to 4.0 p.p.m. fluorine. It showed that 33% of the children had carious lesions and that beyond 21 years of age few people were free of caries. The observation is made that caries, once started, spread rapidly and steps to repair cavities are unsuccessful. The authors recommend that fluorine not be added to city water supplies where intake cannot be controlled.

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(53)
Finn, S.B. and Hodge, H.C. 1941

Reduction in rat caries by fluorine.

Journ. Nutrition, v. 32, p. 255.

By adding fluorine to the diet of rats the incidence of dental caries was reduced appreciably.

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(54)
Lawrenz, M. and Mitchell, H.H. 1941

Effect of dietary calcium and phosphorous on the assimilation of dietary fluorine.

Journ. Nutrition, v. 22, p. 91.

Two groups of rats were put on diets with small amounts of fluorine. Group A was given increased calcium, from 0.23 to 0.73%, with phosphorous constant. It was noted that this change in diet depressed the total retention of fluorine from 10 to 13% and to a greater extent the deposition of luorine in teeth and soft tissue. In Group B the phosphorous was increased from 0.14 to 0.71% with calcium remaining constant. This change did not modify the total retention of fluorine nor the distribution of retained fluorine among bones, teeth, and soft tissue. It was decided from the report that calcium can protect the body against dietary fluorine by impairing its assimilation.

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(55)
Lukomsky, E.H. 1941

Fluorine therapy for exposed dentin and alveolar atrophy.

Journ. Dent. Res., v. 20, p. 649.

Sodium fluoride was successfully used for hardening carious dentin, anesthetizing dentin, for disinfecting root canals and for treating sensitivity at the gingival area. The sodium fluoride is applied as and isotonic solution (0.7%) or as a paste made from white clay with 0.7% sodium fluoride.

A hypertonic solution or a paste made with glycerine, 31 to 37% strength, may also be used. Care should be taken to apply only to the tooth surface. All excess should be carefully wiped away.

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(56)
McClure, F.J. 1941

Domestic water and dental caries.

Am. Journ. Diseases of Children, v. 62, p. 512.

By collecting samples of saliva from subjects in Washington, D.C. where fluorine concentration is low in drinking water and from subjects in Amarillo, Texas, which is high, it was determined that there is very little relationship between the effect of the level of fluor-

ine in drinking water on the fluorine content of human saliva. Figures for Washington show saliva content of fluorine to be 0.1 p.p.m. while that of Amarillo is only slightly above that concentration.

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(57)
Norvold, R.W., Inglis, J.H. and Armstrong, W.D. 1941

External acquisition of fluorine by enamel.

Journ. Dent. Res., v. 20, p. 232.

Topical application of fluorine is suggested as the safest and most practical means of acquiring fluorine. That the halogen is taken up by the tooth enamel was proved by experiment. Teeth selected at random and immersed in a strong solution of luorine for a given length of time contained 15.9% more fluorine than the control group of teeth.

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(58)
Ockerse, T. 1941

Endemic fluoroses in the Bretoria District (S. Africa).

In Pretoria there are 15 known endemic fluoroses areas, in ten of which the fluorine content of water is from 1.43 to 13.9 p.p.m. Advanced cases of fluorosis show all degrees of stiffness of the joints and limbs. Increased density of the bone showed, as did curvature of the spine, ossification of the vertebrae and osteophytic growths along the ribs. The incidence of dental caries was low.

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(59)
Sognnaes, R.F. 1941

Fluorine in tooth enamel.

Journ. Dent. Res., v. 20, p. 503.

The people of the Island of Tristan de Cunha were found to have dental fluorosis in 15.8% of 3907 permanent teeth and 10% of deciduous teeth although the water contained only 0.2 p.p.m. fluorine. The source of the trouble, it was decided, was fish that made up a large percent of the diet of the natives.

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(60)
Sognnaes, R.F. and Armstrong, W.D. 1941

Condition suggestive of dental fluorosis observed in Tristan da Cunha.

Journ. Dent. Res., v. 20, p. 315.

On the island of Tristan da Cunha it was determined that the average fluorine content of enamel was 0.014% in the dentin, 0.0270% in permanent teeth and 0.0196 in deciduous teeth. Compared to sound human teeth from Minnesota where no condition of fluorosis existed, these values are 27 to 60% higher.

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(61)
Sognnaes, R.F. 1941

Effect of topical fluorine application on experimental rat caries.

Brit. Dent. Res., v. 70, p. 433.

Rats fed on a caries-producing diet showed 50% reduction in incidence of decay when treated with potassium fluoride solution (3 mg. per 0.05 ml.)

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(62)
Volker, J.F. and Bibby, B.G. 1941

Action of fluorine in limiting dental caries.

Medicine, v. 20, p. 211.

Studies made in the occurrence of dental caries show that reduction is a result of the intake of fluorine. It must act either by attacking forces that break down teeth or by enhancing the power of the teeth to withstand attack. The former is likely true. Fluorine attacks bacteria which, by fermentation of food, produce the acid that decalcifies enamel. The authors suggest local application as the best means of fluorine intake.

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(63)
Wilson, D.C. 1941

Fluorine and dental caries.

Lancet, v. 1, p. 375.

Two groups of children in Somerset were studied. It was noted that those with mottled enamel had no more dental caries than those from the same community who did not have dental fluoroses. The observation was also made that intake of fluorine before teeth were completely calcified reduced the number of carious teeth.

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(64)
Armstrong, W.D. 1942

Fluorine as it relates to caries.

North-West Dent. v. 24, p. 211.

Because water intake of individuals varies, topical application of fairly strong fluorine solutions is recommended. It has not been proved that fluorine introduced in this way lowers caries incidence, but the concentration in tooth enamel is raised by the treatment.

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(65)
Armstrong, W.D. 1942

Review of the dental fluorosis studies at the University of Minnesota.

Am. Assoc. Adv. of Science, Wash. D.C., Pub. No. 19, p. 50.

Analysis of sound teeth, carious teeth, and mottled teeth were made to determine the constituents. Determinations of the effect of extra fluorine on incidence of rat molar caries are discussed.

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(66)
Arnold, F.A., Dean, H.T. and Elvove, E. 1942

Domestic water and dental caries.

Pub. Health Repts., v. 57, p. 773.

A study made on children who had been exposed for two years to a water supply which had been increased in fluorine content from 0.1 to 0.7 p.p.m. showed the incidence of caries to be similar to that of children who had never been exposed to fluorine in water supply. Neither was there any noticeable difference in L. acidophilus count in the two groups.

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(67) 1942
Cox, G.J. and Levin, M.M.

Resume of the fluorine-caries relationship.

Am. Assoc. Adv. of Science, Wash., D.C., Pub. No. 19, p. 68.

The authors concluded from their studies that fluorine is definitely a factor in the development of caries-free teeth in the preeruptive stage.

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(68) 1942
Cheyne, V.D.

Graded mottling in molar teeth by feeding sodium fluoride.

Journ. Dent. Res., v. 21, p. 145.

Young albino rats were fed varying doses of potassium fluoride. Mild mottling was produced with doses of 150 p.p.m., mild uniform mottling with 300 p.p.m. and macroscopic hypoplasia, pitting and corrosion with concentrations of 350 to 550 p.p.m. With the high dosages the enamel showed softening. Sex did not influence degree of susceptibility to these effects.

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(69) 1942
Dean, H.T.

Geographical distribution of endemic dental fluorosis.

Am. Assoc. Adv. of Science, Wash., D.C., Pub. No. 19, p. 6.

A report of surveys showing the geographical distribution of mottled enamel made in 1930, 1937 and 1941, with descriptive maps.

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(70) 1942
Dean, H.T.

The investigation of physiological effects by the epidemiological method.

Am. Assoc. Adv. of Science, Wash., D.C., Pub. No. 19, p. 23.

Endemic dental fluorosis study by epidemiological methods, is presented. The dental characteristics of 5824 white children of 22 cities in 10 states closely associated with fluorine are discussed.

(71)
Dean, H.T., Jay, P., Arnold, F.A. and Elvove, E. 1942

Domestic water and dental caries.

U.S. Pub. Health Rept., v. 56, p. 365.

A survey of reports was made on Bauxite, Arkansas. In 1928 the community, showing almost 100% affection, changed its water supply from one containing 14 p.p.m. fluorine to one free of fluorides. The 1938 survey showed that children who had used the deep-well water showed severe mottling, while children born subsequent to the change were practically free from fluorosis. The 1940 examination revealed that children with severe mottled enamel, who had been exposed to fluorine-free water for 12 years, still showed markedly few dental caries. The youngest age group showed the highest caries experience although they had been exposed the shortest period of time.

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(72)
Deatherage, C.F. 1942

Mottled enamel from the standpoint of the public health dentist.

Am. Assn. Adv. of Science, Wash., D.C., Pub. No. 19, p. 81.

An extensive report covering the mottled enamel problem in some 70 communities is Illinois. The methods used in sampling, classifying defects, and recording and reporting data in the examination of school children of that state are given in detail.

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(73)
East, B.R. 1942

Tooth decay among naval recruits.

Am. Journ. Pub. Health, v. 32, p. 1242.

The same dentist examined 4.602 white men. Men of the North showed more signs of decay than those of the South. The state with the highest rate, 12.54 decayed, missing, or filled teeth per man was Connecticut. Arkansas had the lowest rate. It also had the lowest rejection rate for defective and deficient teeth in 1918. The New England states as a whole showed 11.48 DMF per man, as compared to the states of Arkansas, Louisiana, and Mississippi with 3.5 DMF per man.

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(74)
Jay, P. 1942

Tooth decay still a riddle.

Science News Letter, v. 41, p. 7.

2100 children were examined. The number of caries-producing bacteria was found to be low where drinking water contained fluorine. This indicated that the caries-inhibiting action of fluorine may be due to bacteriostatic effect.

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(75)
Jay, P. 1942

Fluorine and dental caries with special reference to L. acido-philus.

Am. Assoc. Adv. of Science, Wash., D.C., Pub. No. 19, p. 63.

A review of the surveys made with a special view to the bacterial counts found in the mouths of children in endemic and non-endemic areas.

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(76)
Machle, W. and Largent, E.J. 1942

Fluorine accumulates like lead in body.

Science News Letter, v. 41, p. 262.

About 1 mg. of fluorine is the intake daily of people on a normal food and drink diet. This amount is passed off in the urine. In concentrations above that level about one-half of the intake is absorbed and stored. If more than 2 mg. is taken daily, the chemical accumulates particularly in the bones.

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(77)
McClendon, J.F., Foster, W.C. and Supplee, G.C. 1942

The inverse ration between fluorine in food and drink and dental caries.

Arch. of Biochem., v. 1, p. 51.

The enamel of the teeth is probably 20% fluorpatite. A test was made for the action of fluorine found in cow's milk by dividing the country into parallels of latitude. The conclusions made were that

dental caries in city school children varies inversely with the fluorine content of the milk. The correlation coefficient is 0.37.

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(78)
McClure, F.J. 1942

Fluorine acquired by mature dog's teeth.

Science, v. 95, p. 256.

Sodium fluoride was fed to mature dogs. Teeth were extracted at various intervals. The dentin showed a steady increase in fluorine content, but the increase in enamel was not consistent.

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(79)
McClendon, J.F. and Foster, W.C. 1942

Effect of dietary fluorine in delaying dental caries.

Journ. Dent. Res., v. 21, p. 139.

A ration containing 0.3 p.p.m. fluorine, fed to 21 day old rats for 40 days, produced dental caries. The number of caries increased with continued feeding. Fortifying the diet with substances which added only 0.03 p.p.m. fluorine delayed the onset of caries.

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(80)
McKay, F.S. 1942

Mottled enamel: early history and its unique features.

Am. Assoc. Adv. of Science, Wash., D.C., Pub. 19, p. 1.

The events leading up to the changes in water supplies of the cities of Bauxite, Arkansas and Oakley, Idaho, where mottled enamel was endemic, and the subsequent uncovering of the causative factor are discussed in detail.

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(81)
Schour, I. and Smith, M.C. 1942

Experimental dental fluorosis.

Am. Assoc. Adv. of Science, Wash., D.C., Pub. No. 19, p. 32.

Changes brought about in the teeth of experimental animals by the addition of fluorine to the diet fed them, are compared to the manifestations of fluorosis in human teeth.

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(82)
Smith, H.V. 1942

The chemistry of fluorine as related to fluorosis.

Am. Assoc. Adv. of Science, Wash., D.C., Pub. No. 19, p. 12.

Natural sources of fluorine, effect of fluorine on experimental animals, methods of removing fluorine from water, and sources of fluorine other than water are discussed.

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(83)
Spira, L. 1942

Chronic fluorine poisoning signs and symptoms.

Edinburgh Med. Journ., v. 49, p. 707.

Survey made in England showed that 21.9% of the people suffered from dental fluoroses. There was occurrence of some signs and symptoms co-existent with mottled teeth.

	Incidence	%
Constipation	538	48.95
Paraesthesiae	380	34.59
Skin eruptions	323	29.39
Athletes foot	205	18.65
Brittle nails	185	16.83

In every case the patient had been using a water supply containing fluorine in excess of 1 p.p.m.

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(84)
Volker, J.F. 1942

Fluorosis studies at the University of Rochester.

Am. Assoc. Adv. of Science, Wash. D.C., Pub. No. 19, p. 74.

The author suggests a program of study be made to determine the results of treating tooth surfaces topically with applications of fluorine.

(85)
Younger, H.B.

Removing the stain from mottled enamel.

Am. Assoc. Adv. of Science, Wash. D.C., Pub. No. 19, p. 50.

The technique for bleaching the stains of mottled enamel with acid bleach solutions is discussed and displayed pictorially. The treatments may be given weekly or semi-weekly until the result is accomplished.

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(86)
Arnold, F.A. 1943

Role of fluorides in preventive dentistry.

Journ. Am. Dent. Assoc., v. 30, p. 499.

The addition of fluorine in concentration of 1 p.p.m. is advocated on the basis of the following observations. "Only a small amount of fluorine is necessary to assure the desired effects. A change in the dental caries experience would be expected to occur in the children born and reared in a community after such a water treatment was inaugurated. The mildest type of dental fluoroses that may occur is sporadic and inconsequential and there is an unlikelihood of any other toxic manifestations."

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(87)
Ast, D.B. 1943

The caries-fluorine hypothesis and a suggested study to test its application.

U.S. Pub. Health Rept., v. 58, p. 857.

A thesis which reviews the history of the problem and makes suggestions as to the means of adding fluorine to public water supplies. 91 references.

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(88)
Boyd, J.D. 1943

Prevention of dental caries in late childhood and adolescence.

Journ. Am. Dent. Assoc., v. 30, p. 670.

A study to show that caries can be prevented through dietary measures. The biologic worth of the diet, with carbohydrate content as of secondary importance, is discussed. The amount of fluorine present in local water supplies was accounted for.

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(89)
Dollar, M.L. 1943

The present and probable future roll of dentistry in American society.

Journ. Am. Dent. Assoc., v. 30, p. 1453.

There are approximately 70,000 dentists in the United States. In 1941 about $500,000,000 was spent for dental services.

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(90)
Krasnow, F., Oblott, E.B. and Friedson, S. 1943

Dental caries control within our reach.

Journ. Am. Dent. Assoc., v. 30, p. 1508.

A general program of diet and plan of healthful living is outlined in great detail, with the purpose of showing the necessities for curtail of dental caries.

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(91)
Largest, E.J., Machle, W. and Ferneau, F. 1943

Fluoride ingestion and bone changes in experimental animals.

Journ. Ind. Hyg. and Tox., Nov. 1943, v. 36, p. 316.

Female rabbits from the same litter were fed fluorine in concentrations from 245 to 2,980 p.p.m. The right forelegs of the rabbits were amputated to find the fluorine content in the bone. Macroscopic changes that showed were small areas of porous bone, ranging from less than 1 mm. in diameter to approximately 1 cm. The areas were also scattered through the vertebrae, over the cranium, zygoma, maxillae and surfaces of the bones of the nose and pharynx.

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(92)
Spira, L. 1943

Endemic fluoroses in Great Britain.

Edinburgh Med. Journ., v. 50, p. 237.

School children in Maldon, Essex developed mottled teeth from drinking, during period of calcination of enamel, water containing fluorine 1 p.p.m. which is equivalent to 1/120 of a grain per pint of water. Parathyroid deficiency was brought about by ingestion of toxic amounts of fluorine, with subsequent disturbance of the calcium metabolism of the body.

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(93)
Bibby, B.G. 1944

Fluoride in prevention of caries.

Journ. Am. Dent. Assoc., v. 31, p. 228.

Factors operating after tooth formation are more important than those during formation. This is evidenced by the fact that caries reduction in the first permanent molars is only about one-fourth of what it is in incisors despite the fact that the two are formed at the same time. Enamel and dentin are practically inert tissue. Fluorine does not concentrate in the tissue. Topical application is a superior means of acquiring fluorine, to insure reduction of caries in all teeth. At present the front teeth benefit more than the molars due to contact with water.

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(94)
Bowman, F.F. 1944

Fluorine and public health.

Journ. Wis. State Dent. Soc., v. 20, p. 174.

Mr. Bowman, Health Officer of Madison, Wisconsin, reviews the dental problem of that community. Of the 5,668 children examined in the first six grades of all public and parochial schools, 2,892 or 53%, were found to have defective teeth. Madison has fluorine in concentration of 0.05 p.p.m. The cost of the necessary sodium fluoride for a city the size of Madison would approximate $5,000. Adequate apparatus of not excessive cost is available. Recommendation is made that serious consideration be given to the idea of mass administration through the public water supply.

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(95)
Bruebbel, A.O. 1944

Post-war implications of fluorine and dental health from the viewpoint of public health dentistry.

Dentistry, v. 5, p. 29.

Dentistry should direct its energies toward a wider distribution of dental care in proportion to the dental disease problem and the improvement of technics in dental disease control after the war. Fluorine, ingested in the concentration of less than 1 p.p.m. does not produce harmful effects. Its use would seem to be the solution likely to bring into a more favorable ration the supply and demand of dental services.

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(96)
Dean, H.T. 1944

Post-war implications of fluorine and dental health - epidemiological aspects.

Dentistry, v. 4, p. 620.

Review of the studies that have been made on fluorine in relation to dental caries, with special emphasis on those that regarded sunshine, hardness of water and diet.

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(97)
Epstein, S. and Schamp, H.M. 1944

Sodium fluoride mouth rinse: Report of two cases.

Journ. Am. Dent. Assoc., v. 31, p. 1233.

Mouth rinse, 1:1,000 sodium fluoride used once a week for five minutes over a period of six months.

Case 1. Some hypersensitivity showed, but there was no alteration in bone structure.

Case 2. There was no arrest in caries, but no new carious lesions appeared after starting the prophylactic treatment.

Findings of the case were that gingivae were not affected adversely by contact with sodium fluoride five minutes per week.

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(98)
Faust, C.E. 1944

Post-war implications of fluorine and dental health.

Am. Journ. Pub. Health, v. 34, p. 320.

Addition of fluorine to water supplies would not be difficult nor expensive. Natural amount of fluorine must be known. To keep a constant check, colorimetric test could be made by plant operators with little or no technical knowledge. Application of fluorine in concentration of 1 p.p.m. to fluorine-free water supplies would require 20.5 pounds per 1,000,000 gallons of water per day. The total cost for a year would be $567. No additional labor would be needed, but supervisory control would be desirable.

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(99)
Frisch, J.G. 1944

Fluorine as an inhibitor of dental decay.

Journ. Wis. State Dent. Soc., v. 20, p. 177.

A summary of the literature covering the studies made on fluorine in regard to dental health, with charts and tables summarizing surveys made in Green Bay and Sheboygan, Aurora, Oak Park and Waukegan, and in towns in Illinois, Colorado and Ohio. A summary of the dental caries experience of 1003 Illinois selectees, age 21 to 27 is also given. The author recommends addition of fluorine to deficient water supplies.

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(100)
Gottlieb, B. 1944

The new caries concept.

Journ. Am. Dent. Assoc., v. 31, p. 1944.

The old caries concept supposed that acid dissolving enamel is the first step in dental caries. After testing extracted teeth with acid, organic structures remained intact and only entirely calcified parts of the enamel were dissolved. Carious lesions are produced by action of microorganisms along organic roads, the surrounding higher calcified parts resisting longer. Fluorising the organic matter of the teeth by fluorine mouth wash makes these structures attract calcium from the saliva and produces an additional obstruction to proteolytic action.

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(101)
Nichols, M.S. 1944

The relation of fluorine to health and fluoride content of Wisconsin municipal waters.

Bull. Wis. State Board of Health, Oct. 1944.

A review of reports of surveys made which advocate adding fluorine to public drinking water supplies. The author suggests that a diet containing proper amounts of calcium, phosphorus and vitamin D are necessary in conjunction with the fluoride if caries are to be controlled. Several diseases of the human body which have their origin in the "apical abscesses" of the teeth are cited. Fewer carious teeth would mean fewer of those diseases. A recommendation is made that fluorine be added to the water supplies to bring it to the level of 1 p.p.m., and a list of the fluoride content of Wisconsin municipal waters is given.

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(102)
Ockerse, T. 1944

Chemical composition of enamel and dentin in high and low caries areas in South Africa.

Dentistry, v. 4, p. 647.

High-caries area selected for investigation was Knysna district with a caries experience rate of 99%; the low-caries area was the Calvinia district with a caries experience of 40%. Diets in the two areas were similar, and result of the chemical analysis of the high- and low- caries areas showed no significant difference in the percentage of calcium, magnesium and phosphorous. The fluorine content, however, is considerably higher in the enamel and dentin in the low-caries area. Its origin is likely in the drinking water which contains 1.5 p.p.m. fluorine.

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(103)
Smith, R.R., Shaner, E.O.

Effects of buffered lethal doses of fluoride on guinea-pigs.

Journ. Am. Dent. Assoc., v. 31, p. 1483.

Guinea-pigs administered lethal doses of sodium or potassium fluoride died in forty to sixty minutes. Eighteen guinea-pigs administered double lethal doses of sodium or potassium fluoride buffered with calcium carbonate with or without magnesium oxide did not die.

These animals exhibited normal activity and resumed regular feeding within an hour and a half after administration of the fluorides. These favorable results of the use of the buffered fluorides indicate a drastic reduction of toxicity. These conclusions reflect the promising possibilities of using the fluorides in a dentifrice with a safe outcome even though it perhaps might be ingested in small quantities.

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(104)
Subcommittee on dental research of the American College of Dentists. 1944

A study of the occurrence and treatment of dental caries among school children aged 6 to 18 years in the United States.

Journ. Am. Dent. Assoc., v. 31, p. 322.

A dental plan for all school children is set up. It is stated that in normal peace time (1940) there were approximately 75,000 dentists, or one dentist to each 1,600 persons in the United States.

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(105)
Clawson, M.D., Khalifah, E.S. and Perks, M.C. 1944

Chronic endemic dental fluorosis.

Journ. Am. Dent. Assoc., v. 27, p. 1569.

A description of mottled enamel, with prevention and treatment is discussed.

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(106)
Fluorine Committee
Dane County Dental Society 1945

Unpublished report. Comparative dental survey of Union Grove, Wisconsin and Madison, Wisconsin.

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