Effect of Natural Fluorides On Caries Incidence In Three Georgia Cities

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DENTAL HEALTH services of the Georgia Department of Public Health and of the Public Health Service in Region IV were requested by the dental society, chamber of commerce, and health department of Savannah, Ga., to make a detailed study of the prevalence of dental caries in the children of Savannah in relation to the fluoride content of its water supply. The natural fluoride content of Savannah's water supply was approximately one-half the concentration recommended by the State health department. The question was: How much additional reduction in the caries attack rate would be derived from the adjustment of this concentration to the approved range?

A dental survey was planned for Savannah and two geographically comparable communities having known concentrations of natural fluoride in their public water system. It was estimated that Savannah had from 0.3 ppm to about 0.5 ppm fluoride concentration. The Georgia cities of Macon and Moultrie were chosen as controls, for, according to the water control laboratory of the State health department, the natural fluoride content of Macon's water supply was 0.11 ppm and Moultrie's was about 0.75 ppm. These concentrations were determined from water samples collected during a 3-year period, 1954–56. (Macon obtains its water from the Ocmulgee River, Savannah, from 11 deep wells and the Savannah River, and Moultrie from 3 deep wells.) Forty samples tested for Macon showed a range of 0.0 to 0.5 ppm fluoride in the water supply. Moultrie's range was 0.3 to 1.4 ppm in 52 water samples tested.

Macon would serve as the baseline while Moultrie would indicate the caries attack rates present at the lowest fluoride level recommended by the State health department. The optimum fluoride concentration as determined by the formula relating fluid intake to mean maximum temperature (*1*) approximates the natural fluoride concentration present in the Moultrie water system. The mean maximum temperature according to the U. S. Weather Bureau station in Atlanta and Athens, Ga., was 76.6° F. for Savannah, 77.6° F. for Macon, and 80° F. for Moultrie, over a period of 82, 57, and 24 years respectively.

Over the years, Savannah has continually expanded, outreaching and overtaxing the public water system. To meet the increased demands, new wells were added directly to the water system at the point of greatest need. Today there are 11 independent deep wells and a surface supply with 2 separate pumps. Between March and October 1956, 138 samples from all water sources showed a range in fluoride of 0.0 to 0.8 ppm. The average fluoride concentration for each well ranged from approximately 0.31 ppm to 0.53 ppm, while the surface supply averaged about 0.06 ppm. This resulted in an overall numerical average of about 0.37 ppm fluoride concentration (table 1). Since records have been kept only in recent years on the fluoride concentration in the water system, the assumption was that the samples taken in 1956 would be indicative of the fluoride concentration in the water system for the entire life of the children examined.

The pumpage rate of each well fluctuated, depending upon the needs of the system, and since there was no common reservoir, there was no distribution constant. During 1956, the pumpage rate of individual wells varied from approximately 28 million to 1.4 billion gallons of water, and the surface source supplied about 35 million gallons. The inconstant pumpage rate and variation in the fluoride concentration necessitated the determination of a weighted average fluoride concentration in the water system for the year. By dividing the total

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Table 1. Average fluoride concentration in water supply, Savannah, Ga., 1956

Well No.	Gallons of water pumped	Number test samples	Fluoride range (ppm)	Average fluoride concentration (ppm)
1	220, 794, 332	11	0. 4–0. 8	0. 53
2	317, 192, 899	11	. 3– . 7	. 47
3	28, 474, 120	4	. 3– . 5	. 42
4	1, 059, 072, 217	11	. 3– . 5	. 45
5	1, 389, 495, 413	14	. 3– . 5	. 34
6	407, 671, 408	14	. 2– . 4	. 31
7	404, 160, 621	10	. 2– . 7	. 35
8	1, 112, 522, 738	9	. 3– . 4	. 32
9	788, 729, 221	13	. 3– . 5	. 39
10	596, 650, 207	10	. 3– . 5	. 38
11	179, 933, 182	7	. 3– . 5	. 41
12 and 13 [1]	37, 398, 000	24	. 0– . 3	. 06
Total	6, 542, 094, 358	138	. 0– . 8	. 37

[1] Surface water supply.

parts fluoride from each well by the total number of gallons pumped, a concentration of 0.38 ppm was calculated.

Materials and Methods

A survey technique to obtain the required data was decided upon early in the planning stage (*2*). Participation in the dental survey was limited to white school children 6–15 years of age who were continuous residents, had used only the public water supply since birth, and had parental consent.

Careful dental examinations were conducted by two dentists, Hubert H. Martin from the Georgia Department of Public Health and Ernest C. Leatherwood from Region IV, Public Health Service. A tooth surface was considered carious if the end of the dental explorer penetrated the soft, yielding tooth structure; if, in the case of pits and fissures, the explorer caught, supported its own weight, and met resistance when it was withdrawn; or if the surface had a carious lesion which was clinically obvious. The observations of the two examining dentists were recorded in code on the patient's chart (*3*) along with the following data:

1. Number of teeth erupted.
2. Number of permanent teeth extracted and

Table 2. Percentage of caries-free permanent teeth in children, by age, in Macon, Savannah, and Moultrie, Ga., 1956–57

Age (years)	Number of children examined			Percent children caries-free		
	Macon	Savannah	Moultrie	Macon	Savannah	Moultrie
6	371	554	71	48. 2	49. 3	76. 1
7	419	622	80	40. 3	42. 1	58. 8
8	413	652	61	25. 7	29. 4	50. 8
9	442	638	64	18. 8	23. 7	40. 6
10	402	478	64	10. 0	16. 9	46. 9
11	280	440	40	10. 0	13. 9	27. 5
12	300	417	37	6. 3	9. 4	32. 4
13	432	374	47	5. 1	9. 6	27. 7
14	450	397	52	3. 1	5. 5	21. 2
15	381	299	24	1. 8	6. 0	16. 7
Total	3, 890	4, 871	540	17. 1	23. 3	44. 3

reason for extractions: orthodontic purposes, trauma, or otherwise.

3. Number of primary and permanent teeth needing extraction.

4. Number of unfilled carious teeth and number of surfaces involved.

5. Number of filled teeth and number of surfaces restored.

Findings

A total of 9,301 school children participated in this dental survey, 3,890 from Macon, 4,871 from Savannah, and 540 from Moultrie. Even though the number of children in Moultrie was relatively small, when the data from all three communities on caries-free children and on decayed, missing, and filled (DMF) teeth were subjected to the chi-square test, they were found to be statistically significant (*4*).

Table 2 shows the number of children examined as well as the percentage with caries-free permanent teeth. The total for all ages shows that for permanent teeth, 17.1 percent of the children in Macon are caries-free, while 23.3 percent of Savannah's children are caries-free, and 44.3 percent of Moultrie's children are caries-free.

The percentage difference in the total DMF rates, as shown in the last three columns of table 3, indicates that the children of Savannah have 35.6 percent fewer caries than those of Macon. Moultrie shows 60.8 percent less dental decay than Macon and 39.1 percent less than Savannah.

The difference in the decayed, missing, or filled rate per child at each age in the three cities is shown in the chart.

Decayed, missing, or filled permanent teeth per child by age, Macon, Savannah, and Moultrie, Ga., 1956–57.

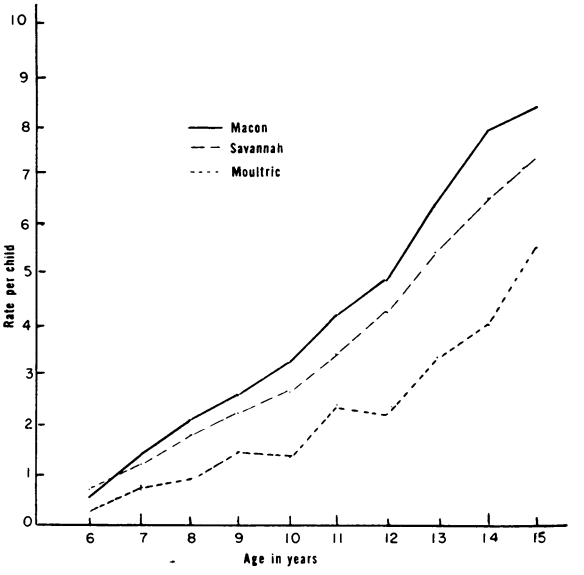

Table 3. Decayed, missing, or filled (DMF) permanent teeth, DMF rate per child, and percentage difference in DMF rate per child, by age, Macon, Savannah, and Moultrie, Ga., 1956–57

Age (years)	Number permanent teeth DMF[1]			DMF rate per child			Percent difference in DMF rate		
	Macon	Savannah	Moultrie	Macon	Savannah	Moultrie	Savannah over Macon	Moultrie over Savannah	Moultrie over Macon
6	197	365	16	0.53	0.66	0.23	+24.5	−65.2	−56.6
7	581	733	70	1.39	1.18	.88	−15.1	−25.4	−36.7
8	837	1,125	59	2.03	1.73	.97	−14.8	−43.9	−52.2
9	1,127	1,356	91	2.55	2.13	1.42	−16.5	−33.3	−44.3
10	1,264	1,236	83	3.14	2.59	1.30	−17.5	−49.8	−58.6
11	1,158	1,440	91	4.14	3.27	2.28	−21.0	−30.3	−44.9
12	1,451	1,733	80	4.84	4.16	2.16	−14.0	−48.1	−55.4
13	2,663	1,981	154	6.16	5.30	3.28	−14.0	−38.1	−46.8
14	3,597	2,464	208	7.99	6.21	4.00	−22.3	−35.6	−49.9
15	3,182	2,149	131	8.35	7.19	5.46	−13.9	−24.1	−34.6
Total	16,057	14,582	983	4.64	2.99	1.82	−35.6	−39.1	−60.8

[1] Exclusive of third molars.

Table 4. Number of primary teeth decayed or filled (df) and df rate for ages 6–11 years, Macon, Savannah, and Moultrie, Ga., 1956–57

Age (years)	Number of children examined			Number of df primary teeth			df rate		
	Macon	Savannah	Moultrie	Macon	Savannah	Moultrie	Macon	Savannah	Moultrie
6	371	554	71	1, 770	2, 253	260	4. 77	4. 07	3. 66
7	419	622	80	2, 004	2, 455	299	4. 78	3. 95	3. 74
8	413	652	61	1, 890	2, 437	214	4. 58	3. 74	3. 51
9	442	638	64	1, 587	1, 941	157	3. 59	3. 04	2. 45
10	402	478	64	1, 029	960	116	2. 56	2. 01	1. 81
11	280	440	40	301	486	23	1. 08	1. 10	0. 58
Total	2, 327	3, 384	380	8, 581	10, 532	1, 069	3. 69	3. 11	2. 81

An analysis of the decayed-filled (df) rate in primary teeth is presented for these cities in table 4. Moultrie has the lowest df rate for the children examined.

Discussion

From the findings, it is obvious that an inverse relationship exists between the caries attack rates and the concentration of fluorides in the water system of these three communities. Approximately one-fourth of the permanent teeth of the children examined in Macon were decayed, missing, or filled, one-fifth in Savannah, and one-ninth in Moultrie.

The DMF rates of the 12–14-year-old groups in Macon, Savannah, and Moultrie can be plotted upon Dean's graph of dental caries experience in 21 cities (*5*). The pattern is similar even though these rates occur in cities with a warm climate.

The DMF percentage difference between Savannah and Moultrie demonstrates decisively the additional protection against dental decay that could be achieved in Savannah by increasing the fluoride concentration of the water system from 0.38 ppm to at least 0.75 ppm (but no more than 1.0 ppm).

Conclusion

Savannah, with a natural fluoride content of about 0.38 ppm in the water system, is providing its children with 35.6 percent protection against dental decay. An additional 39.1 percent reduction in caries would be expected if Savannah were to increase the fluoride concentration to equal Moultrie's (0.75 ppm). Macon, with only a trace of fluoride in its water system, would expect to reduce dental caries in its children by at least 60.8 percent with adequate fluoridation.

Summary

A dental survey of 9,301 continuously resident, white school children between the ages of 6 and 15 years was conducted in the cities of Macon, Savannah, and Moultrie, Ga., in order to determine the effect of different concentrations of natural fluoride in the water systems upon the rate of dental decay.

The natural fluoride concentration was approximately 0.11 ppm for Macon, 0.38 ppm for Savannah, and 0.75 ppm for Moultrie. The mean maximum annual temperature for these cities was 77.6° F., 76.6° F., and 80.0° F. respectively.

On a percentage basis, Moultrie had about twice as many caries-free children as Savannah and more than two and one-half times as many as Macon.

The decayed, missing, or filled (DMF) rate for permanent teeth per child was 4.64 in Macon, 2.99 in Savannah, and 1.82 in Moultrie.

Moultrie's DMF rate was 60.8 percent lower than Macon's and 39.1 percent lower than Savannah's; Savannah's was 35.6 percent lower than Macon's.

The decayed-filled rates for primary teeth were slightly lower in Moultrie than in the other two communities.

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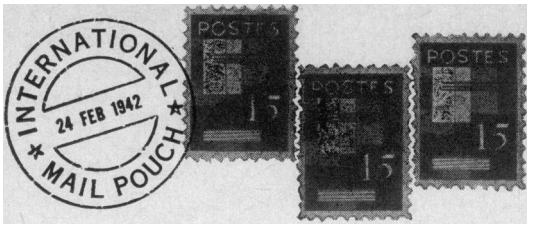
Epidemiological Note

Smallpox

The recent occurrence of smallpox in Germany, which was introduced by a traveler from India, prompted the application of rigid requirements for vaccination of persons entering the United States from Western Europe. There was need for making the requirement apply to persons traveling from more areas than the one where the index case eventually was hospitalized. He had symptoms of the disease while traveling by plane from the Far East, and fellow travelers destined for various parts of Europe were exposed to infection. He also stopped in Switzerland before going to Germany. Secondary cases and one death have been reported, all of them from the area of Germany where the index case was found.

Failure to recognize the possibility of smallpox in persons traveling from infected areas has been followed by several localized outbreaks in Europe in the past decade. In each instance, it has been necessary to apply rigid vaccination requirements for travelers from these epidemic areas before entrance into the United States.

The United States has not been immune to the introduction of the infection from other countries. In one instance in 1946, a soldier returning from Japan developed smallpox en route to Seattle. In spite of isolation, the disease spread, and there was a final total of 28 cases with 8 deaths. In 1947 a man traveling from Mexico City by bus presumably developed first symptoms of the infection en route to New York City. This case was not recognized as smallpox except in retrospect. In this outbreak, there were 9 cases with 2 deaths including the first case. These two outbreaks show very clearly what may happen if the infection is introduced and why rigid requirements for vaccination of persons subject to possible exposure are justified. Vaccination is required for protection not only of the traveler but also of the public.—Dr. Carl C. Dauer, *medical adviser, National Office of Vital Statistics, Public Health Service.*



Water Hunter

Experience in ground water exploration sometimes pays off. After 2 months of exploratory work, contract technicians reported that no water was available for a certain small town in Brazil. An experienced engineer and a crew from Serviço Especial Saúde Pública located a 4-meter stratum of good, water-bearing sand 10 hours after they arrived in the area.

—E. Ross Jenney, M.D., *chief, Health and Sanitation Division, U. S. Operations Mission, Brazil.*

26 Million Tails

With all the returns counted in its nationwide campaign, the Ministry of Health and Social Welfare of the Republic of Korea has collected 26,994,758 rat tails. The 2-month eradication effort was to combat foci of typhoid fever. However, a second wave of the disease hit Pusan, where 97 cases including 8 deaths were reported, 3 months after the campaign ended.

—Alfred S. Lazarus, Ph.D., *chief public health adviser, U. S. Operations Mission, Korea.*

Teamwork

International teamwork helped Thailand combat a cholera epidemic in May and June 1958. Following news of the outbreak, 500,000 cc. of vaccine from the Serum and Vaccine Laboratories of the Philippines Government and an equal amount from reserve supplies in the United States were flown to Thailand. UNICEF sent equipment to produce the vaccine, and a United States Navy medical research team from Taiwan went to Bangkok to give bacteriological and epidemiological assistance.

The first cases were reported in Bangkok May 23, and the outbreak reached a peak 15 days later when 230 cases were reported. Twenty provinces reported cholera, and by the end of June, Thailand had nearly 6,000 cases with 868 deaths. The fatality rate, at first over 15 percent, dropped below 10 percent as treatment facilities improved and intensive vaccination and health information campaigns gained momentum.

After a few cases occurred in neighboring Cambodia, mass inoculation began and preventive measures were publicized. Part of the vaccine used in Cambodia was produced at the Pasteur Institute in Phnom Penh, using equipment provided several years ago by the Agriculture Division of the U. S. Overseas Mission.

—Andrew P. Haynal, M.D., *chief, Public Health Division, U. S. Operations Mission, Thailand, and* Carleton B. White, M.D., *chief, Public Health Division, U. S. Operations Mission, Cambodia.*

Droit du Seigneur

In 1954, during one of my visits to the village training institute at Rahimyar Khan, West Pakistan, I showed a motion picture on constructing an earth privy. About 2 weeks later when I returned, I was met at the train by the institute's principal, several instructors, and many of the trainees. Their salaams were hasty and they seemed excited as they escorted me to a jeep and whisked me off to the institute, instead of to the resthouse, the usual first stop to unpack, bathe, and breakfast.

At the institute, as the trainees lined up, did a military right face and marched forward, the principal indicated I was to follow. The line of march halted 75 yards away in a corner of the campus. There, guided by the motion picture, the trainees had constructed an earth privy, complete with superstructure, the first ever built at the institute, and probably the first in the state of Bahawalpur.

A red ribbon was strung across the entrance, and the trainees indicated that I, their "uncle," a term young Pakistanis use to show respect to an older man, was to officiate at the opening. The students cheered and camera shutters clicked while I cut the ribbon. I repeated the act so that all the photographers could get their pictures.

I complimented the trainees and turned to go, but excited voices told me my ceremonial duties were not ended. Their American "uncle" was also to be the structure's first guest.

—Alexander A. Robertson, *health and sanitation adviser, U. S. Operations Mission, Thailand, formerly a member of U. S. Operations Mission, Pakistan.*