Aurora-Rockford, Illinois, Study III

Effects of Naturally Fluoridated Water on Dental Caries in Adults

HAROLD R. ENGLANDER, D.D.S., and DONALD A. WALLACE, Ph.D.

THERE has been but one study in the United States, that conducted by Russell and Elvove (*1*), in which the dental caries experience of adult natives of a city with a naturally fluoridated water supply was compared with that of adult native residents of a nearby fluoride-deficient city. Russell compared 385 adult natives, aged 18–44 years, of Colorado Springs, Colo., where domestic water contains approximately 2.5 ppm of fluoride, with a similar group of 155 adult natives of nearby Boulder which has fluoride-free water. All subjects used the local water supply almost continuously during calcification and eruption of their permanent teeth, and thereafter had consumed the water for more than half their lives. There were about two-thirds fewer decayed, missing, or filled teeth for each age group in Colorado Springs.

Deatherage (*2,3*) found less decay in selective servicemen, average age about 25 years, whose residence was traceable to fluoride communities than in those from fluoride-deficient communities. The least decay was noted in men who had been lifetime residents of fluoride areas. Some benefit was noted in those exposed to fluoridated water for shorter periods. Many of the subjects were from areas having more than 1 ppm of fluoride in the water. McKay (*4*) observed low dental caries experience and tooth loss in adults with dental fluorosis traceable to water in Colorado Springs, Colo. His conclusions were based on comparisons of the Colorado Springs data with dental caries rates found in a separate investigation in Madison, Wis. (fluoride free), and with published standard rates for tooth loss.

Russell and Elvove (*1*) cited a report by Adler from Hungary that provided further evidence of the effectiveness of fluoride on adults. Adler found that female natives, aged 21–45, of a fluoride city had lower caries rates than newcomers to that city or comparable natives of a nearby city who had consumed water low in fluoride.

In contrast to the foregoing studies, Weaver in England (*5*) concluded that little difference existed between the average number of decayed, missing, or filled teeth of mothers, up to about 40 years of age, attending maternal and child welfare centers in fluoride and nonfluoride cities. He suggested that fluoride has a caries postponing, rather than a caries preventing, effect. However, he based his conclusions on small numbers in each age group, and the water supply of his fluoride city passes through limestone strata, frequently causing wide fluctuations in fluoride concentrations from optimum to suboptimum levels.

A review of the literature cited evidenced a need for a survey to compare the dental caries experience of a large sample of adults who had lived almost continuously from birth in a city having approximately 1 ppm of fluoride in its domestic water with that of a similar sample

The authors are with the division of preventive dentistry and public health, University of Illinois, College of Dentistry, Chicago. *This paper is based on a presentation at the 40th General Meeting of the International Association for Dental Research at St. Louis, Mo., March 16, 1962. The study was supported in part by Public Health Service grant D–984.*

of adults who consumed water low in fluoride in a nearby city. The data reported here are from Aurora, Ill., which has about 1.2 ppm of fluoride in the communal water and Rockford, Ill., which is relatively fluoride-free. The investigation was conducted in 1960–61 as one aspect of a survey of periodontal disease.

Subjects and Methods

Because this was part of a study on periodontal disease, only persons with at least 10 natural teeth present were examined. In each city, local workers telephoned native residents and asked them to volunteer for examination. Newspaper, television, and radio were used to solicit cooperation of all persons who met the residence criteria of the study. Almost everyone in Aurora and more than half the population of Rockford were contacted. A careful review of information received by telephone showed that of all persons over 20 years old contacted, about 14 percent were edentulous in Rockford, and less than 2 percent were edentulous in Aurora. No edentulous persons or those with fewer than 10 natural teeth were asked to report for examination.

Appropriate descriptions of the cities of Aurora and Rockford and of the population groups examined appear in another report (*6*). The communal water of Aurora has contained approximately 1.2 ppm fluoride since 1890, and the water of Rockford has been fluoride-deficient (approximately 0.1 ppm fluoride) during the same period.

Subjects for the study consisted of 896 white natives in Aurora and 935 white natives in Rockford, aged 18–59 years. The percentage of persons over 40 years of age examined in Aurora, 32.5 percent, was slightly greater than the percentage examined in Rockford, 26.7 percent. However, the mean ages of the Aurora and Rockford subjects were almost equal, and the overall ages were 33.6 and 33.1 years respectively. For each age group, the percentage of women in the cities was similar, 61 percent of the total sample in Aurora and 63 percent in Rockford.

With the exception of a few weeks' absence during any calendar year, all subjects from Aurora had consumed water containing approximately 1.2 ppm fluoride continuously from birth until 18 years old. Persons with a history of absence for a total of more than 5 years after 18 years of age were excluded from the study. The average total years of exposure was 32.6 for Aurorans. None of the natives of Rockford studied had consumed water containing optimum concentrations of fluoride except during brief visits to fluoridated communities. Their residence histories were almost identical to those of the Aurora sample. The average total years of exposure to fluoride-deficient Rockford water was 32.0 years. Table 1 shows the number of subjects examined in each age group, their mean ages, and total years of exposure to Aurora and Rockford communal water supplies.

Samples in both cities were distributed in a similar fashion with respect to income, educa-

Table 1. Distribution by age and by average exposure to fluoridated or fluoride-deficient water of 1,831 native residents examined for dental caries experience in Aurora and Rockford, Ill.

Age group (years)	Aurora (1.2 ppm fluoride)			Rockford (0.1 ppm fluoride)		
	Number examined	Mean age (years)	Mean total years' consumption of Aurora water	Number examined	Mean age (years)	Mean total years' consumption of Rockford water
18–19	162	18. 2	18. 2	120	18. 2	18. 2
20–29	188	24. 1	22. 9	223	24. 5	23. 3
30–39	255	34. 7	33. 6	342	34. 7	33. 1
40–49	205	44. 0	42. 9	191	43. 4	42. 2
50–59	86	55. 3	53. 0	59	53. 8	53. 1
All ages	896	33. 6	32. 6	935	33. 1	32. 0

tion, and dietary habits. Although persons in Rockford brushed their teeth slightly more frequently than those in Aurora, amounts of oral debris and calculus were about the same. Both cities had a proportionately high level of dental care.

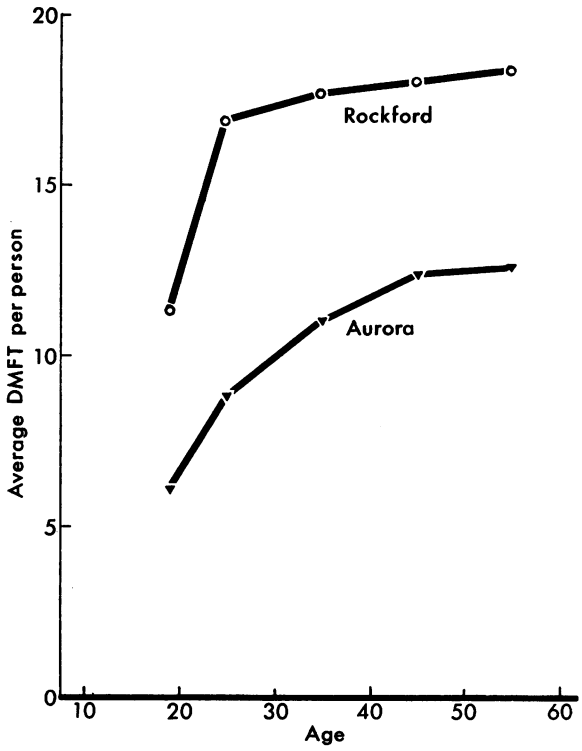
All subjects were examined clinically by Dr. Englander, by means of mouth mirror and explorer with a Castle light. Only frank lesions were counted as caries; catches in deep pits and fissures in the absence of other indications of caries were not counted. Sixteen radiographs were taken on each person, and results with radiographs will be reported in another paper.

In tabulating decayed, missing, or filled (DMF) teeth, if a tooth was both filled and had one or more unfilled carious lesions, it was counted as filled. For decayed, missing, or filled tooth surfaces, surfaces which contained both fillings and open lesions were recorded as filled. Missing teeth were scored as four missing tooth surfaces. A separate tally was made for the number of discrete open lesions on each tooth regardless of filled status. Third molars were excluded in this analysis; therefore, 28 was the maximum number of teeth tabulated for any subject.

Results

Dental caries experience was significantly less for adult natives of Aurora than for natives of Rockford regardless of the method of estimation. For each age group, the average number of DMF teeth per person was lower in Aurora

Figure 1. Mean dental caries experience, DMF teeth, according to age, for 1,831 adult natives of Aurora and Rockford, Ill.



(table 2 and fig. 1). For all ages, there were about 10 DMF teeth for Aurorans and 17 for natives of Rockford. This difference was statistically significant at less than the 1 percent level of confidence. Overall reduction in DMF teeth for Aurorans over natives of Rockford was 40 percent, ranging from a high of 48 percent for those aged 20–29 years to 31 percent for

Table 2. Age-specific average numbers of decayed, missing, and filled teeth per person for 1,831 adult native residents of Aurora and Rockford, Ill., 1960–61

Age group (years)	Numbers of teeth per person							
	Aurora (1.2 ppm fluoride)				Rockford (0.1 ppm fluoride)			
	Decayed	Missing	Filled	DMF	Decayed	Missing	Filled	DMF
18–19	0. 40	0. 11	5. 54	6. 05	0. 84	0. 52	9. 91	11. 27
20–29	. 30	. 43	8. 05	8. 78	. 74	1. 80	14. 38	16. 92
30–39	. 36	1. 44	9. 23	11. 03	. 35	2. 77	14. 53	17. 65
40–49	. 37	2. 69	9. 35	12. 41	. 51	3. 65	13. 84	18. 00
50–59	. 17	3. 14	9. 27	12. 58	. 46	4. 66	13. 22	18. 34
All ages	. 34	1. 44	8. 35	10. 13	. 55	2. 55	13. 68	16. 78

those aged 50–59 years. Eighty-two percent of the DMF teeth index in Aurora was accounted for by filled teeth compared with 81 percent for Rockford. While an appreciable reduction still exists in the older age groups, it was thought that the decreasing trend is probably due to the elimination of edentulous persons and those with fewer than 10 teeth. Since about 14 percent of all persons over 20 years old contacted were edentulous in Rockford compared with 2 percent in Aurora, the overall average of DMF teeth was recalculated by adding 14 edentulous persons to every 86 persons examined in Rockford and 2 edentulous persons to every 98 examined in Aurora. This raised the average DMF teeth scores slightly, and resulted in a reduction of 43 percent. Thus, there was little change in the magnitude of the difference between the cities.

Because the percentage of persons over 40 years old was slightly greater in Aurora than in Rockford, the crude age-specific DMF teeth scores in Aurora were adjusted according to the age distribution of the population in Rockford. There was little difference between the crude and age-adjusted DMF teeth rates in Aurora.

Differences in dental caries experience were more striking when evaluated by means of DMF tooth surfaces. For all ages, the average numbers of DMF surfaces found per person in Aurora and in Rockford were about 22 and 43 respectively (table 3 and fig. 2). This 49 percent difference was statistically significant ($P<0.01$). Reductions for Aurora varied from a high of 62 percent for the 20- to 29-year-old group to a low of 36 percent for those aged 50–59 years. Approximately 70 percent of all DMF surfaces of subjects in each city were filled.

Figure 2. Mean dental caries experience, DMF surfaces, according to age, for 1,831 natives of Aurora and Rockford, Ill.

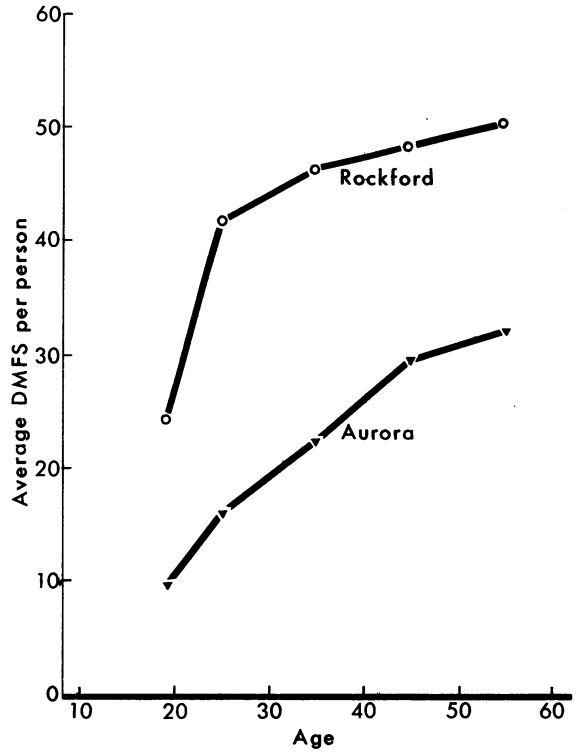


Table 4 shows the average numbers of surfaces per person with open carious lesions regardless of filled status. There were approx-

Table 3. Age-specific average numbers of decayed, missing, and filled tooth surfaces per person for 1,831 adult native residents of Aurora and Rockford, Ill., 1960–61

Age group (years)	Numbers of tooth surfaces per person							
	Aurora (1.2 ppm fluoride)				Rockford (0.1 ppm fluoride)			
	Decayed	Missing	Filled	DMF	Decayed	Missing	Filled	DMF
18–19	0. 48	0. 45	8. 67	9. 60	1. 46	2. 00	20. 79	24. 25
20–29	. 52	1. 70	13. 85	16. 07	1. 54	7. 43	32. 94	41. 91
30–39	. 56	5. 63	18. 02	22. 21	. 78	11. 08	34. 67	46. 53
40–49	. 44	10. 70	18. 46	29. 60	1. 12	14. 46	33. 02	48. 60
50–59	. 30	12. 56	19. 22	32. 08	1. 10	18. 64	30. 75	50. 49
All ages	. 48	5. 69	15. 67	21. 84	1. 14	10. 21	31. 89	43. 24

Table 4. Age-specific average numbers of tooth surfaces with open lesions for 1,831 adult native residents of Aurora and Rockford, Ill., 1960–61

Age group (years)	Average numbers of surfaces with open lesions per person	
	Aurora (1.2 ppm fluoride)	Rockford (0.1 ppm fluoride)
18–19	0. 52	1. 24
20–29	. 53	1. 29
30–39	. 46	. 79
40–49	. 37	1. 00
50–59	. 29	1. 03
All ages	. 45	1. 03

imately 2.3 times as many unrestored lesions for Rockford natives as for Aurorans.

The ratio of the number of filled tooth surfaces to the number of filled teeth was calculated for each age group in Aurora and Rockford (fig. 3). There were significantly fewer filled surfaces per filled tooth in Aurora than in Rockford.

In Rockford, only 1 individual was found free from dental caries experience, that is, without any evidence of decayed, missing, or filled teeth, whereas 37 caries-free persons were observed in Aurora. Almost three times as many persons in Aurora as in Rockford had no carious lesions or restorations in their six maxillary anterior teeth.

Discussion

It is apparent from the data that lower caries experience rates which have been reported for children in Aurora (*7*) remain low throughout adult life.

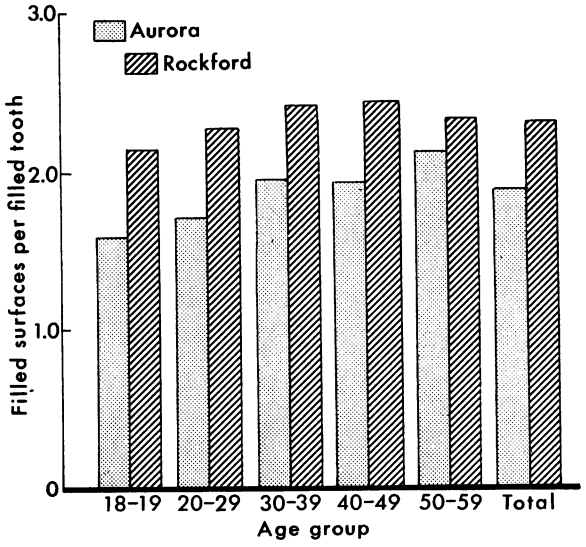
The mean ages of the two study groups were similar; however, a breakdown of the sample into percentages in each age group revealed that the Aurora sample contained a slightly greater proportion of persons 40 years of age or older than did the Rockford sample. This difference was probably due to the elimination of persons with few or no remaining natural teeth. It should be noted that the greater percentage of persons in the older age groups in Aurora was not responsible for any appreciable change in the age-adjusted DMF teeth rate for Aurora.

The two study groups were balanced according to sex and other factors. Differences in dental caries experience could not be attributed to gross differences in dietary habits or levels of oral hygiene. Carbohydrate consumption was found to be similarly high in both cities. If anything, status of oral hygiene was slightly less favorable in Aurora.

None of the Aurorans examined had any objectionable enamel fluorosis. The very mild fluorosis occasionally detected in persons over 50 years old tended to confirm that Aurora city water had contained optimum concentrations of fluoride continuously through the years.

Only persons who had at least 10 natural teeth present were selected for this study. Records of telephone calls showed a much higher percentage of edentulous persons in Rockford than in Aurora. Such loss of teeth would be due to both dental caries and periodontal disease, but more likely would be from dental caries in the younger age groups. It is probable that if subjects could have been chosen in a completely random fashion, still greater differences in numbers of missing teeth would have been found between cities, because more edentulous persons and those with fewer than 10 natural teeth would have been included in

Figure 3. Mean number of filled surfaces per filled tooth for 1,831 natives of Aurora and Rockford, Ill.



the Rockford sample. The Aurora and Rockford DMF teeth scores were corrected for percentages of edentulous persons found. This corrected estimate made little difference in the magnitude of the difference between the cities and did not change our conclusion that dental caries experience was importantly less in Aurora than in Rockford.

In Aurora and Rockford, dentist-to-population ratio was about the same, and the proportion of DMF tooth surfaces filled (approximately 70 percent) was equally high, indicating that dentists in Rockford had to do more work to provide amounts of dental care equivalent to that found in Aurora. On the average, although more than 16 more decayed tooth surfaces had been filled in Rockford, more than twice as many lesions remained unrestored, and there was greater loss of teeth.

The data indicated that if an Auroran's tooth was filled, it was less likely to be a multisurface restoration. The ratio of filled surfaces to filled teeth was consistently lower. Since decay was more apt to be located in pits and fissures in Aurorans, there were fewer cavities of the type most difficult to detect and correct. A significantly greater percentage of adults in Aurora (52 percent) had caries-free maxillary anterior teeth than adults in Rockford (18 percent), thereby reducing the necessity for fillings that may be unsightly.

This study corroborates the work of Russell (*1*), McKay (*4*), and Deatherage (*2,3*) on adults. It should be recalled that Russell found for his fluoride group greater reductions in DMF teeth (about 60 percent) than those found for similar age groups in this study. Failure to duplicate Russell's percentage reduction found in Colorado Springs is probably due to various factors in the present study, such as the elimination of persons with fewer than 10 natural teeth, differences in examination technique, and the inclusion of persons over 45 years of age.

Summary and Conclusions

Dental caries experience, estimated by clinical means, for 896 white, continuous residents of Aurora, Ill., and 935 similar natives of Rockford, Ill., aged 18–59 years, was significantly less for Aurorans, who had consumed domestic water containing about 1.2 ppm of naturally occurring fluoride for an average total of 32.6 years. The Rockford subjects had consumed fluoride-deficient water for an average total of 32.0 years.

The average age was 33.6 years for Aurorans and 33.1 for natives of Rockford. None of the subjects was away from his respective city water for a total of more than 5 years after 18 years of age. Persons in both cities were distributed similarly according to sex, socioeconomic status, education, dietary practices, and quality of dental care.

Subjects from Aurora had an approximate average of 10 decayed, missing, or filled teeth, and 22 decayed, missing, or filled tooth surfaces, while their Rockford counterparts had 17 DMF teeth and 43 DMF surfaces. Thus, the dental caries experience of Aurorans was roughly 40 to 50 percent less when evaluated by teeth and surfaces. These differences might have been greater if a random sample had been examined. Persons with fewer than 10 teeth were excluded from examination, and as a result, many more persons were eliminated in Rockford than in Aurora. About seven times as many edentulous persons were noted in Rockford as in Aurora. A quick estimate of the correction for this factor made little change in the magnitude of the difference in DMF teeth between the cities. Nonetheless, this was a factor that was difficult to estimate accurately for each age group.

Although approximately 70 percent of all DMF surfaces were filled for persons in each city, the Rockford subjects had an average of approximately 2.3 times as many unfilled carious lesions. Decay was more likely to be located in pits and fissures in the Aurorans. The maxillary anterior teeth were free from caries attack in a significantly greater percentage of the subjects in Aurora.

This study provides additional evidence that the low dental caries experience of children who consume water containing approximately 1 ppm of fluoride almost continuously from birth persists during adult life.

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Exhibits

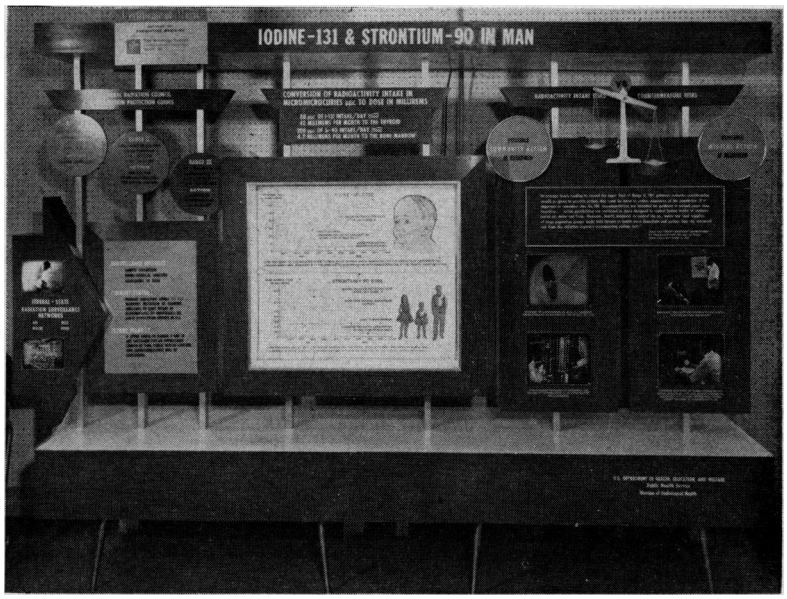
Iodine 131 and Strontium 90 in Man

An evaluation of data on radionuclides deposited in our environment as a result of the resumption of nuclear tests, first by the U.S.S.R. last fall and then by the United States this spring, is depicted in this exhibit. Results indicate that radiation through May 1962 did not require changes in American dietary patterns or other action to limit intake of radionuclides.

Calculated doses of radiation from iodine 131 and strontium 90 fallout for the period September 1961 through May 1962 are compared with calculated doses from natural background and equated against the Federal Radiation Council's radiation protection guides. The data are based on radiochemical analysis of air, water, milk, and food samples collected by the Federal-State Radiation Surveillance Networks.

The exhibit also features public health protective measures available for consideration if radiation reaches and remains for an appreciable time at levels where action is required, but radioactivity intake risk will have to be weighed against risks of the protective actions before such action is taken. Measures include placing infants on powdered or evaporated milk, placing dairy cattle on stored feed, decontamination of milk by ion-exchange techniques, and addition of stable iodine (KI) and stable calcium to offset effects of iodine 131 and strontium 90.

Further information about the exhibit, including arrangements for borrowing, can be obtained from the Division of Radiological Health, Public Health Service, Washington 25, D.C.



Specifications: A free-standing, three-panel exhibit, 7 feet high, 10 feet wide, and 2 feet deep; total weight 1,200 pounds including three packing crates. Four 110-watt outlets are required.