

A preliminary report of a longitudinal study begun in 1952 on the epidemiology of oral health in children, covering periodontal and systemic conditions, as well as caries.

Oral Health Study in Children of Suburban Washington, D. C.

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THIS is a preliminary report on a study of oral health in a population of children as the population becomes progressively less susceptible to dental caries following fluoridation of its community water. The study is not designed as a test of the fluoride-dental caries relationship; the study plan assumes that this relationship is fully established and that a progressive inhibition of dental caries will, in fact, occur. The study's broad and long-term objectives are to augment the descriptive epidemiology of dental caries and to lay a foundation for a descriptive epidemiology of periodontal disease as it first appears in relatively young persons. In addition the study group has been and will be utilized, as a population of known status and background, for short-term observation of pertinent phenomena. Two such reports, based in part upon this population, have already been published (1, 2).

The present report is limited to observations on dental caries. It describes the study population, criteria and methods of examination, and the status of the group at the time of first examination in 1952 and includes summary data

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from examinations in 1953 and 1954. Evidence is presented to support other findings that an inhibition of dental caries in children will follow use of a fluoridated domestic water. The continuing study is being conducted by the National Institute of Dental Research, Public Health Service, in Prince Georges and Montgomery Counties, Md., two counties adjacent to the District of Columbia.

The Study Situation

The population of Montgomery County in 1950 numbered 164,401 persons of whom 93.6 percent were white. The population of Prince Georges County was 194,182 persons, 88.2 percent of whom were white.

Both counties are predominantly urban. Only 6.4 percent and 5.9 percent of the residents of the respective counties lived on farms in 1950. The median number of school years completed by persons 25 years of age or older was 12.6 in Montgomery County and 12.0 in Prince Georges County. Median family income was \$4,532 in the one county and \$3,634 in the other (3a). The median value of one-family homes was \$16,136 in Montgomery County and \$11,696 in Prince Georges County (3b). Principal sources of income were Federal employment, wholesale and retail trade, construction, and service occupations. Only about 10 percent of

the population were employed in manufacturing (4).

Compared with the United States as a whole, residents of the two counties had completed more schooling, had earned higher incomes, and had lived in more expensive homes. For the entire Nation, the median number of school years completed in 1950, by persons 25 years of age or older, was 9.3 years (5a). Median incomes were \$2,970 for urban families, and \$2,186 for rural nonfarm families, respectively (5b). And the median value of a one-family home, in urban and rural nonfarm areas, was \$7,354 (5c).

About 5,000 elementary and junior high school pupils have been examined annually since the oral health study began. The Montgomery County group is taken from an area centering around the Takoma Park Junior High School, adjacent to the District of Columbia across its northeast border. The Prince Georges County group lives in the general vicinity of the Maryland Park and Suitland Junior High Schools, near the southeast border of the District. These areas were chosen as representative of suburban Washington from the socioeconomic standpoint and because their residents have been relatively nonmigratory.

Detailed data concerning the number of topical sodium fluoride treatments were obtained for each child through a schedule completed and returned by his parents. The proportion of treated children was so high in one Montgomery County neighborhood that it seemed prudent to exclude this entire group in computing caries and eruption expectancy tables.

Data for eight schools were analyzed separately by age, sex, and school. Though the proportion of filled teeth to total caries experience was uniformly higher in Montgomery than in Prince Georges County children, all children in the study seemed to have been drawn from the same universe as regards total caries experience in deciduous and permanent teeth and in eruption of permanent teeth and, hence, were combined into one single group for study.

Children in the study group are furnished a fluoridated water by the Washington Suburban Sanitary Commission although at the outset of the study one small group in Prince Georges County used water from wells. Raw water is taken from the Patuxent River and from the

northwest branch of the Anacostia River. The two watersheds drain about 105 square miles to the north and east of the District of Columbia. The raw water receives similar treatment in two processing plants. Treatment includes aeration, prechlorination, flocculation, rapid sand filtration, adjustment of alkalinity with hydrated lime, postchlorination, and the addition of fluoride as sodium fluosilicate by means of dry feeders. With the exception of fluoridation these procedures have been uniform throughout the lives of the children under study. Tap water prior to 1952 was essentially fluoride free.

The fluoride feeders were started on December 28, 1951. During a period of preliminary adjustment, operation was not continuous. For this reason and because of the reservoir of fluoride-free water stored in the system of mains, a fully fluoridated water was not available at all taps throughout the distribution system until the last week of February in 1952. From that time onward, spot tap fluoride determinations carried out by the Washington Suburban Sanitary Commission have been faithful reflections of the daily fluoride levels in finished water at the filtration plants with the exception of a short period in mid-June 1952, when water in the Prince Georges County area was diluted with fluoride-free water obtained through a cross connection with the District of Columbia supply. During that period the fluoride level in the Suitland area dropped to 0.50 p.p.m. F. The District of Columbia supply has since been fluoridated. The average daily fluoride content of finished water at the Robert B. Morse filtration plant, serving generally the Montgomery County study children, was 0.98 p.p.m. F in 1952 and 0.94 p.p.m. F in 1953. The average daily fluoride content of finished water at the Patuxent filtration plant, serving generally the Prince Georges County study children, was 0.90 p.p.m. F over both years.

Methods and Criteria

All examinations have been carried out by dental officers of the National Institute of Dental Research. Mouth mirror and explorer are employed, with the child seated in a portable dental chair, under a portable examination

light. Examination results are dictated to a recorder in a code similar to that suggested by Klein and Palmer (6). Some changes have been made in the code to avoid phonetic confusion and to permit the separate notation of pit-and-fissure or smooth-surface carious lesions found on a single tooth surface. Examinations are scheduled so that each child is observed during the same calendar week on successive years.

All criteria are designed to assure the highest practicable degree of comparability among examiners:

None but positive lesions which admit the explorer point are recorded as carious.

Decalcified areas in the gingival third of the labial or buccal surfaces and opacities of marginal ridges which suggest a possible proximal lesion are recorded as questionable and tabulated as normal unless a definite enamel discontinuity is demonstrated with the explorer.

Deep pits and fissures are similarly recorded as questionable unless softened dentin is encountered by the explorer point or there is visible evidence of backward decay at the dentino-enamel junction.

A tooth is considered to be in eruption if any portion protrudes through the gum.

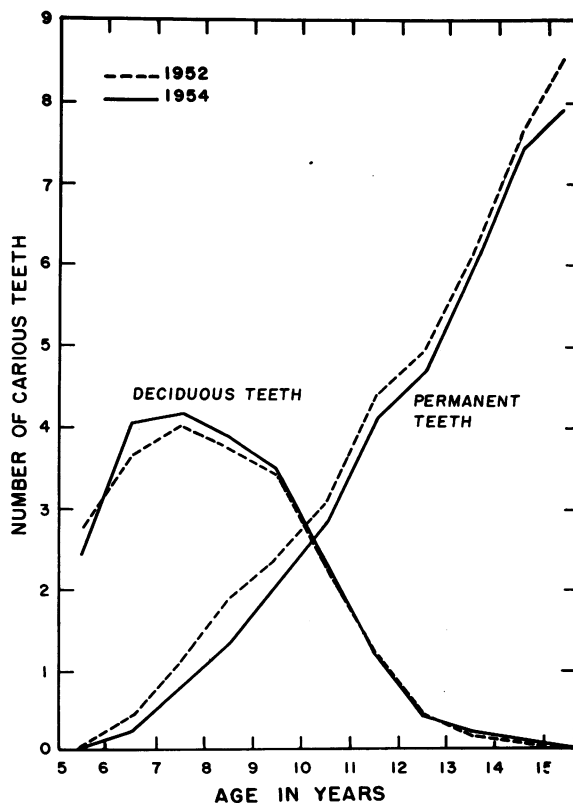
Criteria for the scoring of periodontal disease have been discussed in detail in an earlier report (7).

Initial Status

A total of 4,737 white children aged 5 through 15 years were examined between December 1951 and February 1952, coincident with the fluoridation of the water supply. The dental caries experience of this group of children is summarized in table 1.

Subsequent study of history records supplied by parents disclosed that 1,950 of these children had been born in and had been continuous residents of the area, except for short vacation trips in some instances, and had not received any treatment designed to prevent dental caries. Findings for this group, designated hereafter as the baseline population, were accepted as representative for children in the general area in the absence of a known caries-

1952 and 1954 caries experience of continuous-residence children of Montgomery and Prince Georges Counties, Md., who had not received caries prevention treatments.



inhibitory factor and were utilized in the construction of a family of expectancy curves for caries increments in teeth and tooth surfaces, the eruption of permanent teeth, and the exuviation of deciduous teeth. Oral findings for these children are presented in broad outline in table 2.

The general caries experience in the baseline group is considerably lower than it was in children examined initially at Grand Rapids (8), and it was somewhat below the caries levels reported at the beginning of the Newburgh and Brantford studies (9, 10). Very similar findings were returned by Arnold and McClure (11) in a study of children aged 12 and 13 years in 1939 and 1940 in Arlington, Va., another suburb of Washington, D. C., and by the Southern Maryland District Dental Society, which examined about 15,000 other children in Montgomery and Prince Georges Counties early in 1952. The findings for this separate group of children are summarized in table 3.

On the basis of these comparisons, the mean number of decayed, missing, or filled (DMF) permanent teeth in baseline children aged 11 years appears to be somewhat high. If this is true, computations of yearly caries increment based on these data will overestimate the true increment between the ages of 10 and 11 years and will underestimate the true increment between the ages of 11 and 12 years.

Table 4 shows crude caries rates for children,

comparable with the baseline group, who were observed in 1952, 1953, and 1954. Findings for caries in permanent teeth in 1953, after 1 year of fluoridation, are in general slightly higher than the findings for the baseline year though the differences are well within the range of chance variation. This has been a common phenomenon in fluoridation studies where examinations are carried out with mirror and explorer. Reported DMF means were somewhat

Table 1. Oral status of 4,737 children in Montgomery and Prince Georges Counties, Md., 1952

Mean age (years)	Number of children	Mean number of permanent teeth		Mean number of deciduous teeth		Percent of caries-free children	
		In eruption	DMF ¹	Present	def ²	Permanent dentition	Deciduous dentition
5.44-----	186	1.08	0.03	19.19	2.15	97.3	47.3
6.47-----	416	5.34	.30	16.22	3.16	86.1	33.7
7.45-----	487	9.14	.96	13.30	3.50	56.7	28.1
8.49-----	475	11.73	1.74	11.17	3.56	36.2	21.1
9.48-----	499	14.21	2.46	8.80	3.45	22.6	20.6
10.47-----	394	17.99	2.94	5.58	2.35	19.0	34.0
11.51-----	420	22.26	4.01	2.74	1.27	11.7	54.8
12.53-----	601	25.45	4.88	1.05	.52	9.0	75.7
13.50-----	572	27.09	6.29	.35	.19	7.2	89.0
14.49-----	513	27.53	7.86	.14	.05	3.9	95.9
15.37-----	174	27.67	8.63	.02	.02	4.0	98.3
All children—10.64---	4,737	18.09	3.71	6.49	1.84	28.4	54.0

¹ Decayed, missing, or filled.

² Decayed, extraction indicated, or filled.

Table 2. Oral status of 1,950 continuous-residence children in Montgomery and Prince Georges Counties, Md., who, on initial examination in 1952, had not had topical fluoride or other caries-preventive treatments

Mean age (years)	Number of children	Mean number of permanent teeth		Mean number of deciduous teeth		Percent of caries-free children	
		In eruption	DMF ¹	Present	def ²	Permanent dentition	Deciduous dentition
5.44-----	60	1.40	0.03	19.10	2.77	98.3	36.7
6.46-----	171	5.63	.41	16.04	3.67	81.3	26.9
7.45-----	211	9.22	1.09	13.29	4.04	50.7	22.3
8.50-----	181	11.59	1.90	11.27	3.78	32.6	14.9
9.47-----	223	13.97	2.42	9.07	3.43	19.7	18.4
10.47-----	199	18.28	3.09	5.32	2.30	16.6	33.7
11.50-----	191	22.47	4.39	2.59	1.29	12.6	52.4
12.54-----	228	25.48	4.96	1.03	.47	8.3	77.2
13.51-----	233	27.05	6.15	.32	.16	6.9	91.0
14.50-----	188	27.56	7.66	.18	.07	3.7	94.1
15.36-----	65	27.80	8.57	.00	.00	7.7	100.0
All children—10.60---	1,950	18.07	3.69	6.49	2.03	26.3	50.3

¹ Decayed, missing, or filled.

² Decayed, extraction indicated, or filled.

higher after 1 year of fluoridation at Grand Rapids and Brantford (8, 10). The effect is specifically graphed, for first molars, in the third-year report from the Newburgh-Kingston study (12).

Table 3. Mean numbers of decayed, missing, or filled permanent teeth reported for 14,936 white children in Montgomery and Prince Georges Counties, 1952¹

Age last birthday	Number of children examined	Mean number of DMF ² teeth
5	409	0.04
6	1,360	.34
7	1,389	1.08
8	1,428	1.78
9	1,333	2.44
10	1,167	3.19
11	1,059	3.79
12	1,260	5.10
13	1,145	6.36
14	1,150	7.80
15	1,238	8.83
16	1,057	10.68
17	811	11.68
18	117	10.68
19	12	15.33
20	1	7.00

¹ From unpublished data reported by Southern Maryland District Dental Society to Public Health Service Region III (Washington, D. C.).

² Decayed, missing, or filled.

Lesions detected for the first time by mirror and explorer, after 1 year of fluoridation, are mostly lesions which began before fluoridation was instituted. By the end of the second year, however, it may be assumed that the majority of lesions detected for the first time by the explorer had their inception after fluoridation began. In the present study population, the second postfluoridation examination shows a drop in total numbers of decayed, filled, or missing permanent teeth, a drop averaging 0.27 teeth per child. Mean numbers of deciduous teeth which are decayed, filled, or indicated for extraction (def) are unchanged or slightly higher.

Mean caries data for the baseline children examined in 1952 and for comparable children examined in 1954 after 2 years of fluoridation are illustrated in the accompanying chart.

Increments of New DMF Teeth

Expectancy increments of newly decayed, missing, or filled permanent teeth over a period of 1 year were computed for each age group, by the method used in the Hagerstown studies (13), from findings for the 1952 baseline group. Baseline children aged 7 years, for example, had an average of 1.090 decayed, missing, or filled permanent teeth. Six-year-old children

Table 4. Summary of findings for continuous-residence children in Montgomery and Prince Georges Counties, Md., who used city water, had not received topical fluoride or other caries-preventive treatments, and were examined in 1952, 1953, and 1954

Age last birthday	Number of children examined			Mean number of DMF ¹ teeth				Mean number of def ² teeth			
	1952	1953	1954	1952	1953	1954	Difference, 1952 and 1954	1952	1953	1954	Difference, 1952 and 1954
5	60	67	94	0.03	0.02	0.01	-0.02	2.77	2.06	2.49	-0.28
6	171	238	306	.41	.32	.22	-.19	3.67	4.05	4.07	+.40
7	211	175	268	1.09	1.01	.80	-.29	4.04	3.95	4.19	+.15
8	181	192	189	1.90	1.63	1.37	-.53	3.78	3.93	3.91	+.13
9	223	175	192	2.42	2.43	2.08	-.34	3.43	3.36	3.52	+.09
10	199	210	190	3.09	3.01	2.86	-.23	2.30	2.41	2.33	+.03
11	191	181	204	4.39	3.82	4.11	-.28	1.29	1.11	1.25	-.04
12	228	245	279	4.96	5.13	4.70	-.26	.47	.68	.44	-.03
13	233	252	284	6.15	6.65	5.99	-.16	.16	.23	.23	+.07
14	188	287	249	7.66	8.35	7.43	-.23	.07	.07	.12	+.05
15	65	119	116	8.57	9.62	7.92	-.65	.00	.04	.03	+.03
All children	1,950	2,141	2,371	3.69	4.11	3.42	-.27	2.03	1.91	2.08	+.05

¹ Decayed, missing, or filled.

² Decayed, extraction indicated, or filled.

had an average of 0.409 decayed, missing, or filled permanent teeth. The difference between these two findings, 0.681 teeth, was accepted as the expected average increase in carious permanent teeth as a group of children goes from the age of about 6½ to about 7½ years. Similar computations yielded the array of expected yearly caries increments shown in table 5.

Among comparable children examined in 1954, there were 1,218 aged 6 through 15 years who had also been examined in 1953. By matching 1953 and 1954 examination records for each of these children, actual numbers of newly carious permanent teeth were determined and analyzed as mean changes over the 12-month period. This method permitted the computation of standard error for each mean change and estimation of the probability that any observed increment varied only by chance from the absolute expectancies computed from the 1952 data. These analyses are also summarized in table 5.

If the presumptive 1952 increment rates had obtained throughout the year 1953-54, 1,130 newly carious permanent teeth would have developed in the group, or an average of 0.928 tooth per child. The actual increment was 910 newly carious permanent teeth, or an average

of 0.747 per child—a difference of 19.5 percent. It is highly improbable that this difference of almost 20 percent is due to chance variation.

About the same result is obtained if expectancy increments are based upon the independent examination conducted by the Southern Maryland District Dental Society. From their data, 1,146 newly carious permanent teeth would have been predicted for the study children during the 1953-54 school year, a difference of 20.6 percent.

Discussion

Comparisons of observed increments with expected increments, as computed from the 1952 baseline data, should be interpreted with caution. Each of the age groups in the 1952 data is an independent group, subject to biological variation. In the baseline array, DMF totals for children aged 11 years seem rather high. If this be true, the expected increment is an overestimate of DMF incidence between ages 10 and 11 and an underestimate of DMF incidence between ages 11 and 12. This factor of variation is present to a greater or lesser degree throughout the array. Little reliance, then, should be placed on the comparison of expected

Table 5. Increments of new decayed, missing, or filled permanent teeth over 12 months, from 1953 to 1954, in continuous residents of Montgomery and Prince Georges Counties, Md., who were examined in both years, used city water, and had not received topical fluoride or other caries-preventive treatments, as compared with increments computed from data for comparable children of the same counties in 1952

Expected mean DMF ¹ increment, past year	Children examined in 1953 and again in 1954				
	Mean age, 1954	Number ex- amined	Actual mean DMF ¹ incre- ment, 1953-54	Difference be- tween actual and expected increments	Probability differ- ence due to chance ²
0.376	6.63	27	0.111 ± 0.082	-0.265	< 0.001
0.681	7.51	160	.425 ± .070	- .256	< .001
0.811	8.45	121	.736 ± .102	- .075	.23
0.516	9.47	137	.489 ± .097	- .027	.39
0.668	10.51	120	.758 ± .120	+ .090	.23
1.302	11.45	133	1.075 ± .132	- .227	.04
0.569	12.47	106	.840 ± .156	+ .271	.04
1.194	13.53	175	1.006 ± .151	- .188	.11
1.510	14.49	171	.947 ± .176	- .563	< .001
0.909	15.39	68	.324 ± .267	- .585	.01
0.928		1,218	.747 ± .046	- .181	< .001

¹ Decayed, missing, or filled.

² Based on areas under the normal curve.

with observed increment in any specific age group. The study plan intends that age-specific incidence data shall ultimately be shown as trends, valid in themselves, with expectancy values serving only as points of departure.

On the other hand, age-specific error tends to be random, and overestimation at one age tends to cancel out underestimation at another if the entire group is considered as a unit. This is well illustrated by the close agreement between expectancy data calculated from the two independent examinations cited. No matter which one of these expectancy curves is used, the same conclusions are reached: that about 20 percent fewer permanent teeth became carious in the whole group than would have been expected on the basis of the 1952 examination and that it is highly improbable the difference is due to chance.

This particular method is not appropriate at all when applied to deciduous teeth without any means of determining whether a missing deciduous tooth has been lost prematurely or normally. On the basis of the cumulative totals shown in table 4, no change in the prevalence of caries in deciduous teeth is apparent in these study groups. Deciduous teeth in these children had been in eruption and at risk of caries for 3 years or more at the time the water supply was fluoridated.

Summary

This preliminary report has described the examination criteria for dental caries and methods in use and has defined the population under observation in a continuing study of oral health in elementary and junior high school children of Montgomery and Prince Georges Counties, Md. The two counties are adjacent to the District of Columbia. The domestic water used by these children was fluoridated with sodium fluosilicate late in December of 1951. Evidence is presented that there was a statistically valid decrease of roughly 20 percent in the number of permanent teeth becoming carious during the second year of fluoridation, judged by findings from the baseline examination early in 1952.

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