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STUDIES ON DENTAL CARIES

VII. SEX DIFFERENCES IN DENTAL CARIES EXPERIENCE OF ELEMENTARY SCHOOL CHILDREN¹

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INTRODUCTION

Data available in the literature (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11) clearly indicate that girls have more dental caries experience (greater number of permanent teeth decayed, missing, or filled)² at the same chronological age and erupt their permanent teeth at an earlier chronological age than boys. The first of these findings would appear to suggest that girls have a higher susceptibility to attack by caries. Before such a conclusion may be accepted, however, it is desirable to inquire to what extent the earlier time of eruption of the teeth in girls affects or determines their higher caries experience. Analysis of this question constitutes the purpose of the present paper.³

MATERIAL AND METHODS

The data on which the present analysis is based were derived from dental examinations of 2,232 boys and 2,184 girls attending the municipal elementary schools of a small urban community, Hagers-

¹ From Child Hygiene Investigations, Division of Public Health Methods, National Institute of Health U. S. Public Health Service.

The preceding papers of this series are as follows:

I. Dental status and dental needs of elementary school children. By Henry Klein, C. E. Palmer, and J. W. Knutson. *Pub. Health Rep.*, 53: 751-765 (May 13, 1938).

II. The use of the normal probability curve for expressing the age distribution of eruption of the permanent teeth. By Henry Klein, C. E. Palmer, and M. Kramer. *Growth*, 1: 385-394 (1937).

III. The measurement of post-eruptive tooth age. By C. E. Palmer, Henry Klein, and M. Kramer. *Growth*, 2: 149-159 (1938).

IV. Tooth mortality in elementary school children. By J. W. Knutson and Henry Klein. *Pub. Health Rep.*, 53: 1021-1032 (June 24, 1938).

V. Familial resemblances in the caries experience of siblings. By Henry Klein and C. E. Palmer. *Pub. Health Rep.*, 53: 1353-1364 (Aug. 5, 1938).

VI. Caries experience and variation in the time of eruption of the teeth. By Henry Klein and C. E. Palmer. *Child Development*, 9: 203-218 (1938).

² Caries experience is defined as the total number of DMF permanent teeth or tooth surfaces (the number of permanent teeth or tooth surfaces decayed, missing, or filled). For a full discussion of the DMF concept, see reference (3).

³ Stoughton and Meaker (1) write, " * * * a higher percentage of girls than boys have one or more permanent teeth decayed, missing, or filled * * * . As suggested in the preceding section, it may be that girls lose their temporary teeth somewhat earlier than boys, and consequently their permanent teeth erupt sooner and are exposed to caries over a longer period."

town, Md. The dental examinations were made with plain mirrors and fine-pointed pig-tail explorers under favorable lighting conditions. Observations were made on all teeth present in the mouth and, in addition, unerupted and extracted permanent teeth were noted. Pits and fissures in which the explorer caught, and which after thorough inspection were not considered definitely carious, were noted as separate items and were not counted as carious. Teeth designated as carious were those which showed actual cavities. The lesions recorded are those which are readily found on a careful clinical dental examination. The extent of caries in any single tooth was measured in terms of tooth surfaces involved. When such areas extended from one surface to others, the involved surfaces were counted separately as carious surfaces. Remaining roots were considered as equal to five carious surfaces. Records for filled teeth were made in a similar manner, that is, filled surfaces were counted as past carious surfaces. Full crowns, of which few were encountered, were considered equal to five filled surfaces (five surfaces affected by past caries). These procedures were designed to make possible the measurement and tabulation of caries experience.

ANALYSIS

In order to determine the effect of sex differences in the time of eruption of the teeth on the caries experience of children, it is necessary to collect and tabulate two major classes of data. The first of these, shown in table 1, makes it clearly apparent that, at the same chronological age, girls have more permanent teeth and tooth surfaces affected by caries experience than boys. The second tabulation of data, presented in table 2, makes available, for each sex, information which gives a measure of the length of time the teeth are exposed in the mouth (post-eruptive tooth age).⁴

In order to show whether or not girls have a greater susceptibility⁵ to attack by caries than boys, it becomes necessary to inquire whether or not the number of tooth surfaces showing a history of attack by caries is greater for girls than it is for boys at points where *each sex has accumulated the same amount of post-eruptive tooth years of mouth exposure*. To make this determination, the caries experience values given in table 1 are plotted against the tooth age values given in table 2. The graph shown in figure 1 is thus obtained, from which

⁴ The application of an epidemiological perspective to the finding of coincident sex differences in eruption and in caries experience leads directly to the suggestion that the teeth of girls, because they erupt earlier than those of boys, have been exposed in the mouth to the risk of attack by caries for longer periods of time than the teeth of boys. Because of the implications of this perspective in the analysis of the sex differences in caries experience, the collection of data on the mouth years of exposure of the permanent teeth of the separate sexes has been undertaken and the findings on this point have been presented in a previous publication (15).

⁵ In the present analysis caries susceptibility is measured as the number of permanent teeth or tooth surfaces affected by caries experience expressed as a function of accumulated posteruptive tooth age.

may be read the average number of DMF permanent teeth and the number of DMF permanent tooth surfaces observed for each sex for specified average numbers of post-eruptive tooth years of mouth exposure.

TABLE 1.—Numbers of children, numbers of DMF* permanent teeth, numbers of DMF permanent teeth per child, numbers of DMF permanent tooth surfaces, and numbers of DMF permanent tooth surfaces per child, by age and sex groups (4,416 elementary school children, Hagerstown, Md.)

Item	Age (last birthday)										All ages
	6	7	8	9	10	11	12	13	14	15	
Number of children:											
Boys.....	171	197	231	253	270	262	299	267	199	83	2,232
Girls.....	156	206	256	240	259	269	297	278	165	58	2,184
Number of DMF permanent teeth:											
Boys.....	43	115	255	452	646	722	1,068	1,065	1,012	554	5,932
Girls.....	52	178	328	542	683	788	1,111	1,413	886	359	6,340
Number of DMF permanent teeth per child:											
Boys.....	0.25	0.58	1.10	1.79	2.39	2.76	3.57	3.99	5.09	6.67	2.66
Girls.....	.33	.86	1.28	2.26	2.64	2.93	3.74	5.08	5.37	6.19	2.90
Number of DMF permanent tooth surfaces:											
Boys.....	59	169	365	826	1,301	1,334	2,094	2,216	2,004	1,191	11,559
Girls.....	66	237	470	1,038	1,274	1,424	2,161	2,852	1,850	822	12,194
Number of DMF permanent tooth surfaces per child:											
Boys.....	0.35	0.86	1.58	3.26	4.82	5.09	7.00	8.30	10.07	14.35	5.18
Girls.....	.42	1.15	1.84	4.33	4.92	5.29	7.28	10.26	11.21	14.17	5.58

*See definition in the text.

TABLE 2.—Accumulated post-eruptive tooth ages (in years) per child, by age and sex groups (4,416 elementary school children, Hagerstown, Md.)

	Chronological age (years)									
	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5
Boys.....	1.87	7.41	16.94	29.18	44.09	62.47	84.68	109.96	137.15	164.95
Girls.....	3.16	9.76	20.18	33.49	50.15	70.71	94.65	120.87	148.26	176.08

Study of the data presented in this figure leads to the conclusion that no significant difference in caries susceptibility appears to exist between the two sexes. This conclusion is based on the fact that for equal numbers of years of accumulated post-eruptive tooth age, the caries experience of girls does not *consistently* exceed or fall below the caries experience of boys. The curve showing the increase of caries experience with increasing tooth age for girls (dotted line) for the first twenty years of accumulated post-eruptive tooth age almost exactly coincides with the curve for boys (solid line). With increase in tooth age, the crossing and recrossing of the lines representing the caries experience trends of the two sexes strongly suggest that the slight differences which are observable are due to chance variations and are not indicative of significant differences in the caries suscepti-

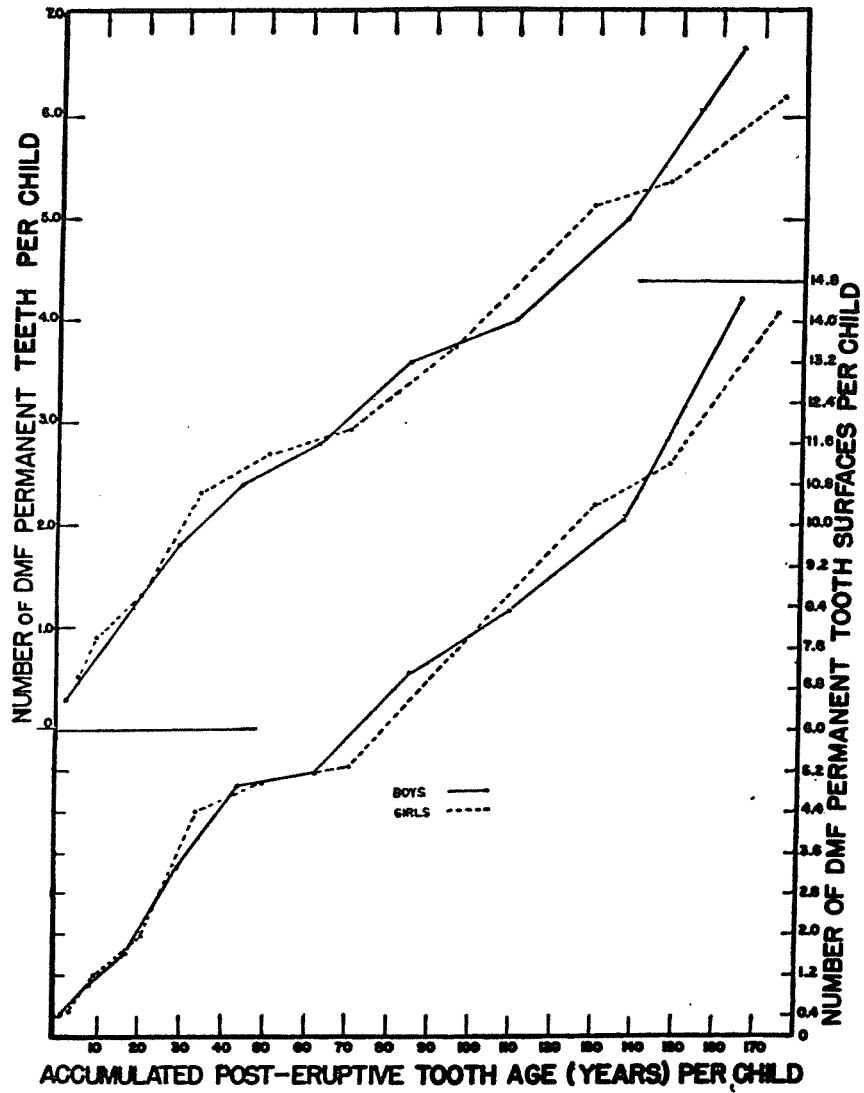


FIGURE 1.—The relations, per child, between accumulated post-eruptive tooth age and caries experience. Data derived from dental examinations of 2,232 boys and 2,184 girls of ages 6 to 15 years, Hagerstown, Md.

bility of the two sexes. The actual observed finding that girls have more caries experience than boys of the same chronological age is explained, quantitatively, by the fact that the teeth of girls, because they erupt earlier, are exposed longer to the risk of attack by caries than those of boys.*

SUMMARY

Results derived from an analysis of dental examinations of 2,232 boys and 2,184 girls indicate that the higher caries experience of girls, as compared with that of boys of the same chronological age, is explained quantitatively by the finding that girls, because their teeth erupt earlier than do those of boys, are exposed longer (have a greater posteruptive tooth age) to the risk of attack by caries than are boys. On the basis of these findings, the conclusion is reached that girls show no greater susceptibility to attack by dental caries than boys.

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* In this connection, it is of interest to point out that boys (or girls) whose teeth erupt early have higher levels of caries experience than boys (or girls) whose teeth erupt late when the sexes are compared on the basis of chronological age. When the caries experience of late and early eruptors are contrasted on the basis of posteruptive tooth age (13), it is indicated that early eruptors have no greater susceptibility to caries than late eruptors.

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STUDIES OF SEWAGE PURIFICATION

VII. BIOCHEMICAL OXIDATION BY ACTIVATED SLUDGE¹

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In a previous paper (1) it has been shown that when sterile sewage or synthetic sewage is aerated in the presence of pure cultures of bacteria isolated from activated sludge, very high rates of oxidation are obtained. The pure bacterial culture sludges consumed oxygen at a very low rate until bacterial food was added to the substrate. The increased quantity of oxygen used following the addition of the food was ascribed to the oxidation of this added material. It is the purpose of this paper to present a somewhat similar study of biochemical oxidation, using natural activated sludges obtained from sewage treatment plants. Without attempting to interpret the entire mechanism of the activated sludge process, data are presented that have been obtained in sewage and in sludge oxidation studies which are helpful for such purpose. As the method of determining the oxygen utilized by the activated sludges employed in the earlier and in the present paper has not been used extensively, a consideration of the precision of the method is presented.

It is generally accepted that, under natural conditions, the biochemical oxidation of organic matter in sewage, as shown by Theriault (2), follows the unimolecular expression,

$$y = L(1 - 10^{-kt}) \quad (1)$$

where y = the B. O. D. satisfied in time t ,
 L = the initial total carbonaceous B. O. D.,
 k = a velocity constant of 0.1 at 20° C., and
 t = time in days.

The results of an experiment are introduced illustrating that biochemical oxidation rates are not necessarily limited to this established natural rate and demonstrating the acceleration of rates of oxidation of organic matter in sewage under artificial conditions of treatment. Data are presented to indicate that rates of oxygen utilization by the sludge in an experimental plant varied considerably, and that information in addition to that concerning the extent and rate of oxidation of

¹ The data on which this paper is based were presented and discussed before the Ninth Annual Meeting of the Central States Sewage Works Association, Indianapolis, Ind., Oct. 30, 1936.