

THE DENTAL PROBLEM OF ELEMENTARY SCHOOL CHILDREN¹

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FINDINGS from a number of studies indicate that the order of 95 per cent of elementary school children of the United States are affected by dental caries.² Research workers in this field would agree, however, that the status and constitution of the problem, in representative groups of children, warrant further detailed statistical analyses. From the public health point of view, the collection of statistical information on the prevalence and extent of attack by caries, in school children, may be considered a first step in the analysis of this major health problem. Considerations such as the above are largely responsible for the initiation of a detailed study of the dental caries experience of the grade school population of a representative urban community.

COLLECTION OF DATA

The small city, Hagerstown, Maryland, the grade school children of which were studied, has a population of approximately 32,000 persons. Somewhat over 90 per cent of the inhabitants are native white and of these 95 per cent have native parents. The city contains several small manufacturing and industrial units and includes the usual retail and wholesale commercial establishments. In general, the population is representative of the broad middle range of socio-economic groups in the United States. Approximately 95 per cent of the children of grade school age attend the municipal elementary schools. The enrollment of white children in the first eight grades of these schools was, in October 1936, approximately 4,700. Of this number, 4,416 received, in the spring of 1937, complete dental examinations by dental officers of the United States Public Health

¹ From Child Hygiene Investigations, Division of Public Health Methods, National Institute of Health, United States Public Health Service.

² See bibliographic references.

Service. The children examined, therefore, include 94 per cent of the enrolled elementary school population. The distribution of these children, with respect to age and many other characteristics, may be considered representative of many urban communities in the United States.

The collection of the data which form the basis of the present paper was preceded by conferences with the community dental, health, and school authorities,³ whose cooperation made the study possible. The two dentists assigned to the task of making the dental examinations received preliminary training designed to better acquaint them with the peculiar demands of dental examinations of school children. Each of the dental officers was supplied with a portable dental chair, equipped with adjustable head rest and such essential accessories as examination lamp, mirrors, explorers, bracket tables, and steam sterilizers. Enough instruments were supplied to make possible a satisfactory sterile technique in the examination procedure. In addition, each examiner received aid from a dental assistant in the assembling and sterilization of instruments and in the handling of the children. These dental assistants functioned, also, as secretaries in that the findings of each examination were recorded by the assistant from coded, verbal information supplied by the examining dentist. This arrangement greatly facilitated the examination procedure and permitted the dentists to spend all their time in making examinations of the teeth.

The examinations were made with Number 3 plain mirrors and fine pointed pig-tail explorers under favorable lighting conditions. Observations were made on *all* teeth present in the mouths and, in

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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 caries. Teeth designated as carious were those which showed actual although, occasionally, small cavities. The lesions recorded are those which are readily found on careful clinical dental examinations. 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 considered as past carious surfaces. Full crowns, of which few were encountered, were considered equal to five filled surfaces (five surfaces affected by past caries).

FINDINGS

Preliminary Considerations. Before proceeding with the presentation of data derived from the study of 4,416 grade school children, it is essential to consider, briefly, certain constituents which make up the caries problem and the manner in which these affect the measurement of dental status and needs in children. The first of these considerations concerns the numbers and kinds of teeth present in, or absent from, the mouths of the children examined. The range of age of elementary school children, 6 through 15 years, covers the period during which the deciduous is being replaced by the permanent dentition. Since entirely different teeth and numbers of teeth are involved in the description of status in older as contrasted with younger children, it is essential that findings be given for specific age and sex groups, and given separately for deciduous and permanent teeth.

A second major consideration which influences the choice of methods of presenting the findings concerns the fact that dental

caries is a cumulative disease. A precise description of status of the disease in a population group requires, therefore, a quantitative evaluation of the *complete caries experience*. Such an evaluation requires a full consideration of what may be termed *past* and *present* caries. Present caries may be defined as actual carious lesions which are present in the mouth at the time of examination. The term past caries may be used in designating those teeth that are filled and those that are missing (extracted) because of caries. For purposes of precision and brevity, the term DMF is introduced and used in this paper, therefore, to designate the complete caries experience. This measurement of complete caries experience, DMF, is obtained readily for the permanent teeth since missing permanent teeth which constitute a part of the caries experience of children may be considered, at least for purposes of the present discussion, as the result of severe caries. An equivalent measurement of the complete caries experience in the deciduous teeth is not possible in the

Table 1. Numbers of children examined, total numbers of permanent teeth erupted, numbers of permanent teeth erupted per 1,000 children, numbers of deciduous teeth present in the mouth, and the numbers of deciduous teeth present in the mouth per 1,000 children, by specified ages.

AGE (Last Birthday)	NUMBERS OF CHILDREN EXAMINED	NUMBERS OF PERMANENT TEETH ERUPTED	NUMBERS OF PERMANENT TEETH ERUPTED PER 1,000 CHILDREN	NUMBERS OF DECIDUOUS TEETH PRESENT IN MOUTH	NUMBERS OF DECIDUOUS TEETH PRESENT IN MOUTH PER 1,000 CHILDREN
6	327	1,594	4,874.6	5,384	16,464.8
7	403	3,361	8,339.9	5,523	13,704.7
8	487	5,473	11,238.2	5,362	11,010.3
9	493	6,947	14,091.3	3,887	7,884.4
10	529	9,194	17,380.0	2,733	5,166.4
11	531	11,500	21,657.2	1,180	2,222.2
12	596	14,611	24,515.1	602	1,010.1
13	545	14,446	26,506.5	202	370.6
14	364	9,897	27,189.6	58	159.3
15	141	3,864	27,404.3	9	63.8
ALL AGES	4,416	80,887	18,316.8	24,940	5,647.6

data collected since a definite decision may not be made as to whether a missing deciduous tooth has or has not been carious. These latter considerations emphasize again that quantitative facts regarding dental caries in children should be presented separately, and in different ways, for the deciduous and permanent dentitions.

Total Caries Experience (DMF) in the Permanent Teeth. The findings to be presented on the status of caries experience are derived from data on a population of approximately 80,000 erupted permanent teeth in 4,416 grade school children.⁴ At this point it may be stated again, that although part of the total caries experience is

Table 2. Numbers of children with one or more DMF¹ permanent teeth, numbers of children with one or more DMF permanent teeth per 1,000 children, numbers of DMF permanent teeth, numbers of DMF permanent tooth surfaces, numbers of DMF permanent teeth, and numbers of DMF permanent tooth surfaces per 1,000 children; by specified ages.

ITEM TABULATED	AGE (Last Birthday)										ALL AGES
	6	7	8	9	10	11	12	13	14	15	
Numbers of Children With One or More DMF Permanent Teeth	52	146	260	348	414	435	523	495	347	136	3,156
Numbers of Children With One or More DMF Permanent Teeth per 1,000 Children	159.0	362.3	533.9	705.9	782.6	819.2	877.5	908.3	953.3	964.5	714.7
Numbers of DMF Permanent Teeth	95	293	583	994	1,329	1,510	2,179	2,478	1,898	913	12,272
Numbers of DMF Permanent Tooth Surfaces	125	406	835	1,864	2,575	2,758	4,255	5,068	3,854	2,013	23,753
Numbers of DMF Permanent Teeth per 1,000 Children	1,826.9	2,006.8	2,242.3	2,856.3	3,210.1	3,471.3	4,166.3	5,006.1	5,469.7	6,713.2	3,888.5
Numbers of DMF Permanent Tooth Surfaces per 1,000 Children	382.3	1,007.4	1,714.6	3,780.9	4,867.7	5,194.0	7,139.3	9,299.1	10,587.9	14,276.6	5,378.8

¹ DMF, as defined in the text.

⁴ Details of the respective caries experience of the two sexes may be found in a recent publication: Klein, Henry; Palmer, C. E.; and Knutson, J. W.: Studies on Dental Caries: I. Dental Status and Dental Needs of Elementary School Children. *Public Health Reports*, May 13, 1938, 53, No. 19, pp. 751-765.

represented by teeth restored to physiological function through the placement of fillings, the total DMF surfaces represent, in essence, the total number of tooth surfaces which show objective evidence of attack by caries. Accordingly, counts of such surfaces constitute a census of the density of the dental caries problem in a population of teeth, or in a population of children. Details of the caries experience in the children examined, expressed in terms of DMF teeth and surfaces per 1,000 children, are given in Tables 1, 2, 3, and 4.

These tabulations (Table 2) indicate that caries has attacked one or more permanent teeth in 159 out of each 1,000 six-year-old children. As age increases, more children become affected by the disease until, for the age group 15 years, 964.5 of each 1,000 children show evidence of attack by dental caries. Somewhat parallel increases with age are apparent in DMF teeth and DMF tooth surfaces. Each 1,000 children in the age group 6 years have 382.3 permanent tooth surfaces with evidence of caries attack; those of 7 years, 1,007.4; those of 8 years, 1,714.6. Thus the caries attack rates for permanent tooth surfaces increase progressively with age increase until, at age 15, each 1,000 children have 14,276.6 surfaces showing evidence of attack by the carious process.

The different kinds of permanent teeth which contribute to the caries attack rates are indicated in Table 3, which gives, by specified corresponding pairs of teeth,⁵ the observed numbers of surfaces and the numbers of these per 1,000 children, showing evidence of attack by caries. As is clearly indicated in this table, of the total of 5,378.8 surfaces with evidence of attack by caries in each 1,000 children, 4,178.9, or 77.7 per cent, are located in the first molar teeth. Of the surfaces attacked in the lower jaw, 87.3 per cent are in the lower first molars. Study of the data given in this table indicates further details concerning the types of teeth which contribute the major

⁵ The data are presented for corresponding teeth since caries occurrence is bilaterally equal.

proportion of carious surfaces. For example, 4,878, or nearly 91 per cent, of all DMF surfaces in the permanent teeth of each 1,000 children are found in the upper and lower first molars, the lower second molars, and the upper central and lateral incisors. Other details regarding the location of caries attack in the permanent teeth are

Table 3. Numbers of DMF¹ permanent tooth surfaces, numbers of DMF permanent tooth surfaces per 1,000 children, and per cents of DMF permanent tooth surfaces; contributed by specified teeth. Children 6 to 15 years of age, all ages.

CORRESPONDING TEETH	NUMBERS OF DMF PERMANENT TOOTH SURFACES	NUMBERS OF DMF PERMANENT TOOTH SURFACES PER 1,000 CHILDREN	PER CENTS OF DMF SURFACES CONTRIBUTED BY SPECIFIED TEETH
<i>Upper Jaw</i>			
Central Incisors	1,197	271.1	12.3
Lateral Incisors	871	197.2	8.9
Canines	69	15.6	0.7
First Premolars	512	115.9	5.3
Second Premolars	472	106.9	4.8
First Molars	6,222	1,409.0	63.9
Second Molars	394	89.2	4.0
ALL TEETH	9,737	2,204.9	100.0
<i>Lower Jaw</i>			
Central Incisors	150	34.0	1.1
Lateral Incisors	107	24.2	0.8
Canines	8	1.8	0.1
First Premolars	101	22.9	0.7
Second Premolars	397	89.9	2.8
First Molars	12,232	2,769.9	87.3
Second Molars	1,021	231.2	7.3
ALL TEETH	14,016	3,173.9	100.0
<i>Both Jaws</i>			
Central Incisors	1,347	305.0	5.7
Lateral Incisors	978	221.5	4.1
Canines	77	17.4	0.3
First Premolars	613	138.8	2.6
Second Premolars	869	196.8	3.7
First Molars	18,454	4,178.9	77.7
Second Molars	1,415	320.4	6.0
ALL TEETH	23,753	5,378.8	100.0

¹ DMF, as defined in the text.

SPECIFIED TOOTH SURFACE	NUMBERS OF DMF PERMANENT TOOTH SURFACES	NUMBERS OF DMF PERMANENT TOOTH SURFACES PER 1,000 CHILDREN	PER CENTS OF DMF SURFACES CONTRIBUTED BY SPECIFIED SURFACES
Occlusal	10,215	2,313.2	43.0
Mesial	4,102	928.9	17.3
Distal	3,355	759.7	14.1
Buccal	3,127	708.1	13.2
Lingual	2,954	668.9	12.4
ALL SURFACES	23,753	5,378.8	100.0

¹ DMF, as defined in the text.

Table 4. Numbers of DMF¹ permanent tooth surfaces, numbers of DMF permanent tooth surfaces per 1,000 children, and per cents of DMF surfaces; contributed by specified surfaces. Children 6 to 15 years of age, all ages.

shown in Table 4 which gives the observed numbers and the numbers per 1,000 children, and the per cents of DMF surfaces contributed by specified tooth surfaces. From data given in this table, it may be noted that 43 per cent of the 5,378.8 DMF surfaces in each 1,000 children are found in occlusal surfaces, 31 per cent in distal and mesial surfaces, and 26 per cent in buccal and lingual surfaces. Thus almost one-half of all tooth surfaces affected by caries experience are occlusal surfaces.⁶

ANALYSIS

The Yearly Increment. The data previously presented afford detailed definition of the frequently encountered impression that defects due to dental caries in children constitute a health problem of major proportions. Analysis⁷ of the constitution of this problem

⁶ Data given here must not be interpreted as measuring the relative susceptibility of the various teeth and surfaces to attack by caries. In explanation of this caution it need only be pointed out, as an example, that the first molar teeth contribute a large proportion of the total caries experience primarily because these teeth have erupted into the mouth of nearly all of the 4,416 children examined while the second molars, for instance, have erupted into the mouths of a much smaller proportion of children.

⁷ For the purpose of the immediate discussion, caries experience is considered without regard for the fact that some of this experience may have been treated by fillings. This facilitates the analysis since the question under discussion concerns the details of the accumulation of *caries attack experience*. Thus from the viewpoint of the analysis, a filled tooth represents a tooth which has been attacked by caries.

is considerably facilitated when an examination is made of the manner in which caries experience accumulates in the permanent teeth.

The observed caries experience (number of DMF permanent tooth surfaces) of children six years of age may be viewed as an accumulation of caries attack experience which has been added each year up to age 6. The number of DMF surfaces found at 7 years of age may be considered equal to that which has accumulated to age 6 plus the *increment* of new defects which have appeared between the sixth and seventh years of age. For example, in each 1,000 of the six-year-old children examined, 382.3 DMF surfaces were found to have accumulated in the permanent teeth. In each 1,000 of the seven-year-old children, 1,007.4 DMF surfaces were observed. The difference in caries experience between the two age groups is, therefore, 625.1 DMF surfaces. This last figure represents the increase or increment of new caries experience which appeared between the sixth and seventh years for each 1,000 children. From this point of view a total yearly increment of caries experience for the entire elementary school population may be visualized as equal to the sum of annual increments for each age group from 6 through 15 years. Such a total yearly increment may be interpreted as a reasonably accurate measurement of new carious defects which may be expected to appear each year in the population of school children. Estimates⁸ of the increments for each separate age group, each expressed per 1,000 children, are shown in Table 5. From these data it may be shown that approximately 1,400 new carious tooth surfaces represent the estimated increment of new defects which may be expected to appear in the permanent teeth of each 1,000 of the representative group of elementary school children studied. This annual increment, totaling approximately 6,000 carious surfaces

⁸ It is appreciated by the authors that some influence in depressing the tendency towards new caries or extensions of caries may be contributed by the process of filling carious teeth. This perspective will be discussed more fully in a later section of this paper.

ITEM TABULATED	AGE (Last Birthday)										ALL AGES
	6	7	8	9	10	11	12	13	14	15	
Numbers of DMF Permanent Tooth Surfaces Observed per 1,000 Children	382.3	1,007.4	1,714.6	3,780.9	4,867.7	5,194.0	7,139.3	9,299.1	10,587.9	14,276.6	—
Expected Number of new DMF Surfaces Between Age Specified and Previous Age, per 1,000 Children	382.3	625.1	707.2	2,006.3	1,086.8	326.3	1,945.3	2,159.8	1,288.8	3,688.7	1,427.7 ²

¹ DMF, as defined in the text.

² Average weighted for observed number of children in separate age groups.

Table 5. Statistics for the calculation of yearly increments of new DMF¹ permanent tooth surfaces, by specified ages.

for the entire grade school population of 4,416 children at Hagerstown, would account for the fact that 23,753 permanent tooth surfaces with caries experience were actually observed in the total number of children surveyed. Expressed in more general terms, the analysis indicates that a representative group of grade school children have an average of nearly five and one-half carious permanent tooth surfaces per child (23,753 DMF surfaces in 4,416 children) and that this accumulation of defective surfaces is maintained, as new children enter and leave the school group, by a yearly increase of approximately one and one-third new carious surfaces per child per year (approximately 6,000 new DMF surfaces per year in 4,416 children).

Thus from the perspective of this analysis the dental caries problem of school children may be visualized as representing, in essence, the results of an accumulation of yearly increments of carious defects which originate sometime after the teeth erupt into the mouth and as the children progress from lower to higher school grades. It would seem to follow, therefore, that the basic problem of providing care for carious defects in the permanent teeth in school children may well be a problem of caring for yearly increments of defects.

ITEM TABULATED	AGE (Last Birthday)										ALL AGES
	6	7	8	9	10	11	12	13	14	15	
Numbers of Children Having One or More Filled Deciduous Teeth per 1,000 Children	97.9	91.8	63.7	60.9	90.7	45.2	10.1	7.3	2.7	—	48.2
Numbers of Filled Deciduous Teeth per 1,000 Children	293.6	240.7	176.6	140.0	209.8	84.7	13.4	9.2	2.7	—	117.3
Numbers of Filled Deciduous Tooth Surfaces per 1,000 Children	464.8	344.9	269.0	170.4	296.8	128.1	20.1	9.2	2.7	—	169.6
Numbers of Filled Deciduous Teeth per 1,000 Decayed Deciduous Teeth	60.4	49.2	36.5	38.5	89.4	77.6	28.2	56.8	32.3	—	52.1
Numbers of Filled Deciduous Tooth Surfaces per 1,000 Decayed Deciduous Tooth Surfaces	48.2	33.6	25.0	21.8	59.7	55.4	18.8	23.9	13.7	—	35.3

Table 6. Status of filled teeth in the deciduous dentition, by specified ages.

Fillings in the Permanent and Deciduous Teeth. The data on caries experience presented earlier in this paper indicate that all except a very small segment of a representative elementary school population are affected by caries attack in the permanent teeth. It is of some interest, therefore, to study the distribution of fillings (evidence of dental care) in the teeth of the children examined. Accordingly, Tables 6 and 7 give data on fillings in the permanent and the deciduous dentitions. Among each 1,000 children examined, 222.6 children were found to have had one or more permanent teeth filled. Of each 1,000 DMF permanent teeth observed, 264 had been filled. Of each 1,000 DMF surfaces encountered, 180.3 were filled. It follows, therefore, that less than 20 per cent of the observed DMF surfaces were found to contain fillings.

In the deciduous dentition an observed total of 518 teeth were filled in 213 children. It is thus apparent that in all of the children examined less than one-fifth of the permanent tooth surfaces which

ITEM TABULATED	AGE (Last Birthday)										ALL AGES
	6	7	8	9	10	11	12	13	14	15	
Numbers of Children Having One or More Filled Permanent Teeth per 1,000 Children	18.3	29.8	100.6	156.2	221.2	288.1	333.9	374.3	335.2	312.1	222.6
Numbers of Permanent Teeth Filled per 1,000 Children	39.8	62.0	255.9	432.0	655.9	856.9	1,147.7	1,412.8	1,244.5	1,212.8	733.9
Numbers of Permanent Tooth Surfaces Filled per 1,000 Children	52.0	67.0	250.5	553.8	854.4	1,113.0	1,585.6	1,882.6	1,659.3	1,595.7	969.7
Numbers of Filled Permanent Teeth per 1,000 DMF ¹ Permanent Teeth	136.8	85.3	188.7	214.3	261.1	301.3	313.9	310.7	238.7	187.3	264.1
Numbers of Filled Permanent Tooth Surfaces per 1,000 DMF ¹ Permanent Tooth Surfaces	136.0	66.5	146.1	146.5	175.5	214.3	222.1	202.4	156.7	111.8	180.3
Numbers of DMF ¹ Permanent Filled Tooth Surfaces per 1,000 DMF ¹ Permanent Tooth Surfaces Among Children Having One or More Filled Permanent Teeth	944.4	900.0	721.9	705.4	657.0	615.0	558.5	529.1	447.1	412.1	550.3
Numbers of DMF ¹ Permanent Tooth Surfaces per 1,000 Children Having One or More Filled Permanent Teeth	3,000.0	2,500.0	3,449.0	5,026.0	5,880.3	6,281.0	8,502.5	9,504.9	11,073.8	12,409.1	7,915.6
Numbers of DMF ¹ Permanent Tooth Surfaces Filled per 1,000 Children Having One or More Filled Permanent Teeth	2,833.3	2,250.0	2,489.8	3,545.5	3,863.2	3,862.7	4,748.7	5,029.4	4,950.8	5,113.6	4,356.1

¹ DMF, as defined in text.

Table 7. Status of filled teeth in the permanent dentition, by specified ages.

have been affected by caries experience show objective evidence of reparative treatment, and that a much smaller proportion of carious deciduous teeth present show similar evidence of treatment.

An analysis of DMF surfaces in the permanent teeth of those

children who have one or more fillings in the permanent teeth shows (Table 7) the presence of 7,915.6 DMF surfaces in each 1,000 of these children. Since this table also shows that a total of 4,356.1 permanent tooth surfaces are filled in each 1,000 of these children, it is revealed that reparative treatment has been supplied for 55 per cent of the DMF surfaces in this particular group. This selected analysis of the distribution of reparative treatment in children having evidence of one or more fillings indicates that a relatively small group of children (actually 983 children out of the total of 4,416) receive all the dental reparative treatment, yet only one-half of their dental filling needs are supplied. Out of the total 4,416 children examined, 3,156 have one or more permanent teeth showing a history of caries (Table 2). Of these, 2,173 exhibit no evidence of treatment for their carious defects. The conclusion may be reached, therefore, that approximately one-half of the carious defects in the permanent teeth are treated in one-fifth and all such defects are neglected in one-half of the 4,416 grade school children.

Present Dental Needs. For the purposes of the present analysis the term dental needs is applied to include those professional requirements which are directly and obviously the immediate consequence of attack by dental caries. Under this definition tooth defects which make up dental needs are contributed by present unfilled caries in the deciduous and permanent dentitions.

Table 8 presents details concerning the number of deciduous and permanent teeth and tooth surfaces requiring fillings. In each 1,000 children examined, 528, or nearly 53 per cent, have one or more unfilled carious deciduous teeth. It may be shown, also, that of each 1,000 deciduous teeth present in the mouth, 398 have unfilled cavities which involve 850 tooth surfaces. Nearly 40 per cent of the deciduous teeth present, therefore, contain unfilled cavities.

In the permanent dentition the conditions which broadly constitute dental needs include all teeth with clinical histories which

ITEM TABULATED PER 1,000 CHILDREN	AGE (Last Birthday)										ALL AGES
	6	7	8	9	10	11	12	13	14	15	
Numbers of Children Having One or More Carious Deciduous Teeth Requiring One or More Fillings	810.4	861.0	893.2	862.1	741.0	450.1	245.0	97.2	63.2	42.6	527.9
Numbers of Children Having One or More DMF Permanent Teeth Requiring One or More Fillings	140.7	340.0	464.1	596.3	621.9	657.3	708.1	726.6	815.9	858.2	592.6
Numbers of Deciduous Teeth Requiring One or More Fillings	4,862.4	4,890.8	4,837.8	3,636.9	2,347.8	1,092.3	476.5	161.5	85.2	56.7	2,251.6
Numbers of DMF Permanent Teeth Requiring One or More Fillings	247.7	642.7	940.5	1,484.8	1,654.1	1,781.5	2,206.4	2,622.0	3,453.3	4,517.7	1,809.1
Numbers of Deciduous Tooth Surfaces Requiring Fillings	9,648.3	10,275.4	10,763.9	7,807.3	4,975.4	2,312.6	1,068.8	383.5	200.5	177.3	4,798.7
Numbers of DMF Permanent Tooth Surfaces Requiring Fillings	315.0	806.5	1,213.6	2,324.5	2,552.0	2,570.6	3,263.4	4,056.9	4,969.8	6,787.2	2,672.6
Numbers of DMF Permanent Teeth Missing (Extracted)	3.1	27.3	43.1	129.8	245.7	258.0	352.3	565.1	615.4	801.4	276.0
Numbers of DMF Permanent Teeth With Remaining Roots	—	—	8.2	52.7	49.1	49.0	109.1	111.9	186.8	383.0	74.7

Table 8. Status of teeth requiring fillings in the deciduous and permanent dentitions, by specified ages.

indicate untreated defects due to caries. The conditions which fall into this category are actual unfilled cavities, remaining roots, and missing permanent teeth. These several items are tabulated in Table 8. The section of this table giving the numbers and per cents of children having one or more unfilled cavities in the permanent teeth shows that as age advances the proportion of children having such cavities increases. Further analysis of these data indicate that approximately 77 per cent of all teeth giving a clinical history of caries must be considered in a broad discussion of the prob-

lem of dental needs in the permanent dentition of grade school children.

Summarizing the present dental needs for both dentitions, it is found that each 1,000 children have approximately 2,200 deciduous and 1,800 permanent teeth which show unfilled cavities. Defects in these 4,000 teeth in each 1,000 children affect approximately 4,800 deciduous and 2,700 permanent tooth surfaces. In addition to these defective untreated surfaces, 350 permanent teeth in each 1,000 pupils have been lost because of severe caries.

Dental Needs and Dental Care—the Permanent Teeth. On the basis of the previously presented analysis, it becomes of some interest to relate the yearly increment of new defects previously discussed to an analogous estimate of the amount of care now given each year for carious defects in the permanent teeth of the children. Such an estimate of dental care may be obtained by the same method of analysis as was used to determine the total yearly increment of new defects requiring fillings. Basic data which may be used for the calculation of an annual increment of filled surfaces are given in Table 7. The analysis, although not shown in detail here, indicates that the filling of approximately 230 permanent tooth surfaces per year per 1,000 children would result in the finding of the 4,282 filled surfaces in the 4,416 Hagerstown children at the time of the survey. Since, as was shown in Table 5, approximately 1,400 (1,427.7) permanent tooth surfaces develop caries each year in each 1,000 of the grade school population it becomes apparent immediately that the filling of permanent tooth surfaces is being accomplished at a rate which is about one-sixth as large as the rate at which the defects are accruing. Identification of this disparity between the rate of development of defects and the rate of placement of fillings largely explains, in quantitative terms, the existence of the present accumulated dental *needs* of the children and leads to the conclusion that if such accumulation of untreated defects in the permanent teeth is to be avoided in the future some provision

should be made to give elementary school children (in the form of fillings in the permanent teeth alone) approximately six times the amount of dental professional service they now receive.⁹

An Estimate of the Order of Professional Facilities Required to Care for the Dental Needs in the Permanent Teeth of Grade School Children. The data presented in previous sections of this paper on material collected from Hagerstown, Maryland, furnish information which may be used as a basis for estimating the order of professional dental facilities required to care for certain basic dental needs of the grade school children. There were, at the time of the survey, thirty-two practicing dentists in Hagerstown, which has a total population of approximately 32,000 persons and an elementary grade school population of approximately 4,700 children. For present purposes the estimations of professional dental service required to care for the dental needs of school children may be based, therefore, on a ratio of one dentist to each 1,000 of the total population and of one dentist to each 150 of the grade school population.

Although it is undoubtedly true that some dentists allocate more time for the treatment of children than others, a number of immediately useful results in the present analysis may be achieved by expressing estimates of dental service for children in terms of an assumed equal distribution of professional time. These estimates are based on the following subsidiary postulates: First, that each dentist of the community would need to care for the defects in the permanent teeth of 150 grade school children. Second, that each dentist may choose to work 1,800 hours per year.¹⁰ Third, that one hour of professional time would be required to care adequately for each defective permanent tooth surface.¹¹

⁹ This figure is estimated without taking into account the dental needs of the deciduous dentition or the care required for remaining roots, missing teeth, and other conditions.

¹⁰ This estimate of working hours per year is used by Strusser. (See bibliographic reference [25]).

¹¹ It is recognized that the location of surfaces to be filled may considerably influence the

From the data given in a previous section of this paper, it may be shown that, at the present time, of the order of thirty-four defective permanent tooth surfaces are filled per dentist per year in the permanent teeth of each 150 grade school children. This estimate of service now given the school children, thirty-four surfaces per year per dentist, means that less than 2 per cent of the total professional time of each dentist is devoted to the filling of permanent teeth in that 15 per cent of the population which attends the elementary schools.

On the basis of the estimate that approximately 1,400 new carious surfaces develop in each 1,000 grade school children each year (214 new carious surfaces in each 150 grade school children), it may be postulated that in order to prevent the accumulation of untreated defects,¹² with the dental professional facilities available, services equivalent to the filling of the order of 200 surfaces per year per dentist would be required. The treatment of this number of surfaces by each dentist means that approximately 10 per cent of the professional time, available in the community as a whole, would be required to give dental care sufficient to *prevent* the accumulation of defects in the permanent teeth of the grade school children.

An attempt to care, during the course of one calendar year, for the present accumulation of 2,700 defective surfaces¹³ in the permanent teeth of each 1,000 children would make it necessary for each dentist, in taking care of 150 children, to fill approximately 400 permanent tooth surfaces. This amount of work by each dentist would involve approximately 20 per cent of the time available from

time required for placing fillings or for providing other indicated treatment. Since the immediate purpose of this discussion is chiefly the dissection of the problem of supplying dental needs due to caries, the estimates of professional services required are arbitrarily stated. Thus, if more or less than one hour be estimated for the treatment of each carious surface, the total services required would be proportionately changed.

¹² It may be emphasized again that the care of yearly increments may be expected to considerably reduce the size of the yearly increments themselves by the prevention of extension of caries.

¹³ No provision being made to restore missing permanent teeth or to extract and restore remaining roots.

the professional men in the community. In connection with this last estimate if an attempt were made to care during one calendar year for the present accumulation of defects, plus those defects which it is estimated would accrue during that year, it may be postulated that approximately 600 permanent tooth surfaces would need to be filled during the course of the year by each dentist, a task which is estimated to require approximately one-third¹⁴ of the professional time of the dental practitioners.

The above summary, although obviously based on arbitrary estimates of professional time requirements for the placement of fillings, provides some clarification of the quantitative characteristics of the problem of supplying dental services for the permanent teeth of school children.¹⁵ It seems necessary to conclude, first, that the magnitude of the present accumulation of dental needs in the permanent teeth alone is of such order as to make difficult its immediate practical handling with existing facilities. Second, it seems reasonable to expect, and desirable to suggest, that provision should be made for handling the yearly increment, the care of which, alone, is estimated to require approximately 10 per cent of the professional time of the dental practitioners. Third, care for the yearly increase in new defects, alone, appears to involve more than a sixfold increase over the time now given to the filling of permanent teeth in the school children.¹⁶

¹⁴ This amount of professional service required by the grade school children for defects in their *permanent teeth alone* obviously might seriously tax the professional dental services available for the adult population.

¹⁵ An equivalent analysis of the problem of supplying care for the deciduous teeth is difficult, since in many instances the short life expectancy of these teeth does not justify extensive reparative dental work. It is appreciated, of course, that a considerable amount of professional service is necessary if the deciduous teeth are to be given adequate dental care.

¹⁶ Estimates of professional requirements for the care of dental defects in school children may be expected to vary with variations among localities in the ratio of dentists to the population, as well as with variations among localities in the density of the caries experience. Since, for the United States as a whole, a ratio of approximately one dentist to each 2,000 of the total population obtains, the estimates of professional services required to care for dental needs of school children would be changed proportionately if the results of this study were to be applied to the country generally.

SUMMARY

1. Detailed findings of the caries experience of a representative grade school population of approximately 4,400 children are presented in tabular form.

2. Analysis of these findings indicates that dental needs in grade school children represent, in essence, an accumulation of neglected yearly increments of attack by caries.

3. It is indicated that new dental carious defects accrue in the permanent teeth each year at a rate which is approximately six times the rate at which fillings are placed.

4. It is estimated that the care of the yearly increment of carious defects in the permanent teeth of the elementary school children would involve approximately 10 per cent of the professional services available in the community studied.

BIBLIOGRAPHY

1. Leigh, R. W.: Incidence of Caries in the Different Teeth and Their Respective Surfaces. *Oral Hygiene*, 14: 1202-1211 (1924).
2. Kiernan, R. E.: Average Per Cent of Decay of Teeth from Six to Twelve Years of Age. *Western Dental Journal*, 6: 358-360 (1892).
3. Munblatt, M. A.: A Critical Study of the Incidence of Dental Caries in Children. *Dental Cosmos*, 75: 592-609 (1933).
4. Klöser, A.: Zur Statistik der Zahnkaries. *Deutsche Monatsschrift für Zahnheilkunde*, 31: 585 (1906).
5. Broughton-Head, L. C.: The Influence of Sex and Environment in Relation to Dental Caries and Dentition. *British Dental Journal*, 27: 913-925 (1906).
6. Rypins, R. F.: The Incidence of Dental Caries in the Pre-School Age. *Journal of Dental Research*, 4: 369-373 (1922).
7. Techow, G.: The Distribution of Caries in the Deciduous Denture. *Dental Cosmos*, 58: 828 (1916) Abstract.
8. Cohen, J. T.: A Statistical Study of Caries in the Deciduous and Permanent Teeth of Children. *Journal of the American Dental Association*, 23: 312-325 (1936).
9. Kugelmass, I. N.: Dental Caries in Children: Clinical Control. *New York State Journal of Medicine*, 37: 1733-1742 (October 15, 1937).
10. Driak, F.: Bemerkungen zur Kariesfrequenz der Wiener Bevölkerung. *Zeitschrift für Stomatologie*, 27: 743-751 (August 1929).
11. Zangri, E.: La Frequenza della Carie nei Prima Molari Permanenti dei Fanciulli. *La Stomatologia*, 29: 619-624 (September 1931).
12. Stoughton, A. L. and Meaker, V. T.: Sex Differences in the Prevalence of Dental Caries. *Public Health Reports*, 47: 26-37 (1932).
13. Dwyer, H. S.: A Study of the Liability to Decay of the Deciduous Teeth of School Children. *Journal of Dental Research*, 12: 911-918 (1932).

14. Morelli, M. G.: The Introduction of a Quantitative Caries-Index for the Teeth. *Dental Cosmos*, 66: 1068-1075 (1924).
15. Mitchell, H. H.: A Study of Dental Caries in Porto Rican Children. *Human Biology*, 5: 274-287 (1933).
16. Bödecker, C. F. and Bödecker, H. W. C.: A Practical Index of the Varying Susceptibility to Dental Caries in Man. *Dental Cosmos*, 73: 707-716 (1931).
17. Brekhus, P. J.: A Report on Dental Caries in Ten Thousand Four Hundred Forty-five University Students. (1928-1930). *Journal of the American Dental Association*, 18: 1350-1356 (1931).
18. Joint Committee of the Bronx Dental Societies and the Bronx Tuberculosis and Health Committee and the New York Tuberculosis and Health Association, New York City: Dental Care of Needy Children: The Bronx Plan. *Journal of the American Dental Association*, 21: 163-167 (1934).
19. Day, C. D. M. and Sedwick, H. J.: Studies on the Incidence of Dental Caries. *Dental Cosmos*, 77: 442-452 (1935).
20. Deatherage, C. F.: Prevalence of Active Untreated Dental Caries by Single Ages. *Journal of the American Dental Association and the Dental Cosmos*, 25: 480-488 (1938).
21. Gafafer, W. M. and Messner, C. T.: Results of a Dental Examination of 1,908 White and Colored Males at the Ohio State Reformatory. *Public Health Reports*, 51: 321-332 (1936).
22. Moore, M. M.: Observations on the Age-Incidence of Dental Caries. *Annals of Dentistry*, 3: 77-83 (June 1936).
23. The Murray and Leonie Guggenheim Dental Clinic: Annual Reports, 1934 and 1935.
24. Preliminary Report Twenty-fifth Anniversary Celebration and The Rauh Memorial Survey: The Rauh Memorial Survey. Pages 7-15. Reprint from *Bulletin of the Cincinnati Dental Society*, (February 1937).
25. Strusser, H.: A Community Dental Health Program. *New York Journal of Dentistry*, 8: 51 (February 1938).
26. Welty, L. G.: A Four-Year Study of Student Dental Health Service. *Journal of the American Dental Association and the Dental Cosmos*, 24: 1105-1129 (1937).
27. Messner, C. T.; Gafafer, W. M.; Cady, F. C.; and Dean, H. T.: Dental Survey of School Children, Ages 6-14 Years, Made in 1933-1934 in 26 States. *Public Health Bulletin* No. 226. U. S. Government Printing Office (1936).