

## LONGITUDINAL DENTAL CARIES STUDY IN CHILDREN 9-15 YEARS OF AGE

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**Abstract**—A longitudinal caries study was carried out in a group composed of fifty girls and fifty boys. The children, who were born in the same year (1945) and permanent residents of the same town were examined at the age of 9, 11, 12, 13, 14 and 15 years. The yearly examination was done by the same dentists. Special precautions were taken to avoid a shift in the standards of examination. Proximal lesions were recorded from radiograms; pit and fissure lesions and free smooth surface lesions by intra-oral examination.

The number of lesions at the different ages are given separately for each specific surface and in two degrees, i.e. the total number of caries lesions, and the number of lesions which show either a carious involvement of the dentine or a break in the continuity of the enamel surface.

**Zusammenfassung**—Eine kontinuierliche Kariesuntersuchung an 50 Mädchen und 50 Jungen im Alter von 9–15 Jahren wurde durchgeführt. Die Kinder, welche im selben Jahre (1945) und im selben Ort geboren sind und wohnen, wurden im Alter von 9, 11, 12, 13, 14 und 15 Jahren von den gleichen Zahnärzten untersucht. Eine ständige Kontrolle zur Festhaltung der Untersuchungsmassstäbe wurde durchgeführt. Die Approximalkaries wurde nur im Röntgenbild beurteilt; die Okklusalkaries und die Karies der freien Zahnflächen (bukkal und lingual) in der klinischen Untersuchung.

Die Anzahl der Läsionen wird für jede Altersklasse und für jede Zahnfläche in zwei Stufen gegeben: Gesamtzahl aller Läsionen und separat Dentinläsionen.

### INTRODUCTION

STUDIES on the progress of dental caries with age in the same patients (longitudinal caries survey) in which the caries attack is studied for each type of surface separately are relatively scarce. During other studies data were obtained which amounted to such a longitudinal survey. Though they were not intended as such, it seemed worthwhile to report these results.

### MATERIAL AND METHODS

A group of 50 girls and 50 boys, randomly selected from the school population, were regularly examined at the age of 9, 11, 12, 13, 14 and 15 years. All children were born in 1945 and were permanent residents of the town of Culemborg (Netherlands). As the examinations were carried out in the second half of each year,

the mean age of the group was  $9\frac{1}{4}$ ,  $11\frac{1}{4}$  etc. Each examination consisted of two parts, a standardized radiographic examination of proximal surfaces and a standardized intra-oral examination for the pits and fissures and the free smooth surfaces.

The radiographic examination has been performed at the indicated ages, the intra-oral examination only at the ages of 9, 11, 13 and 15 years.

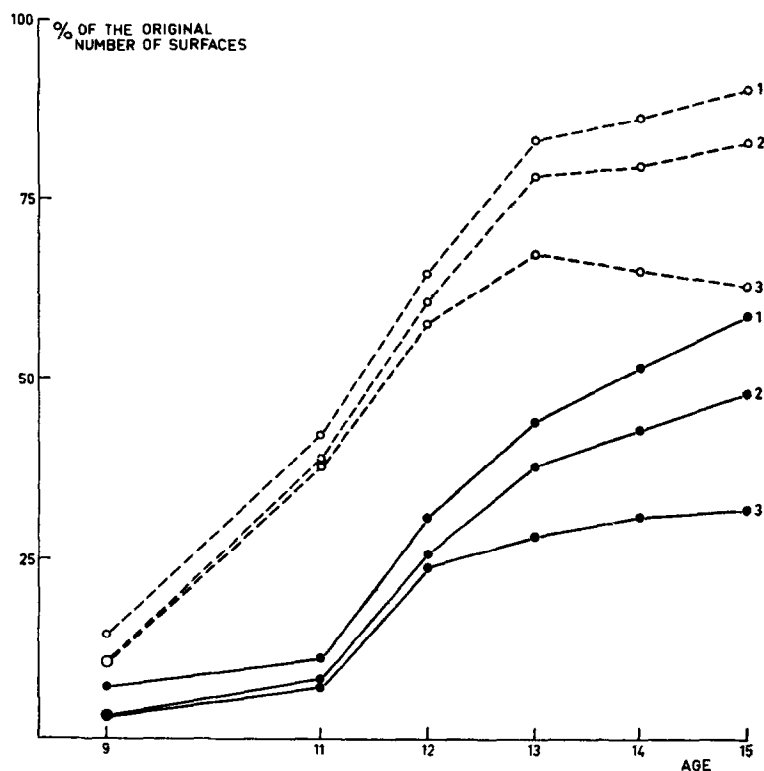


FIG. 1. Percentage of carious lesions of the distal surface of the upper first molar.

In the radiographic survey the lower incisors were not included. The intra-oral examination was limited to the pits and fissures of molars and bicusps, and with regard to the free smooth surfaces, to the buccal and labial surfaces. The diagnostic methods used in this survey are described elsewhere (BACKER DIRKS, VAN AMERONGEN and WINKLER 1951; BACKER DIRKS and KWANT 1954; BACKER DIRKS, KWANT and KLAASSEN 1957). Special precautions were taken to prevent and check any shift in the diagnostic criteria from year to year (BACKER DIRKS, HOUWINK and KWANT, 1961). This report deals only with lesions in permanent teeth.

The number of lesions are reported in two degrees of severity i.e. all diagnosed lesions (including enamel lesions) and the more severe lesions cavities) which either show carious involvement of the dentin (radiographic examination) or a break

in the continuity of the enamel surface (intra-oral examination). No distinction is made between fillings (past caries lesions) and caries lesions.

In every caries survey the recording of extractions and fillings present special problems. The purpose of the survey will generally decide in which way the extractions are to be counted.

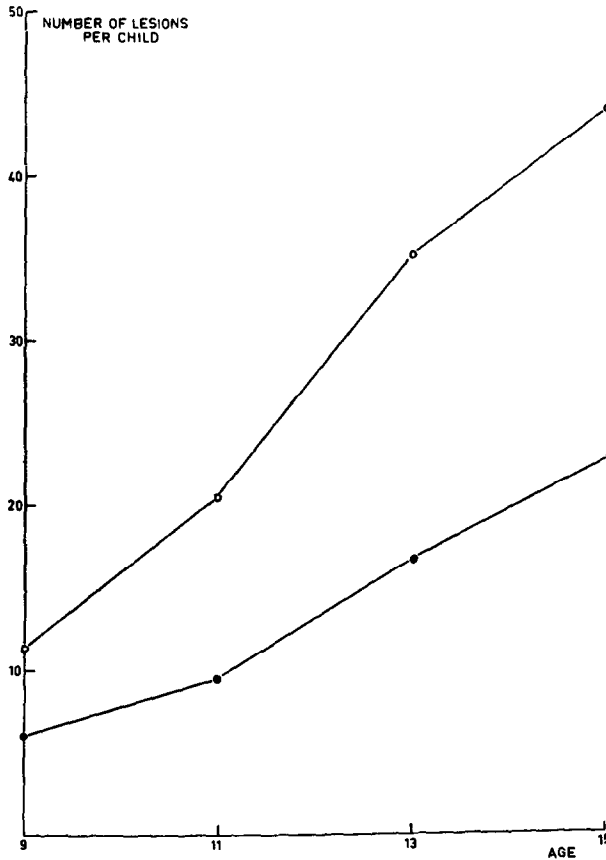


FIG. 2. Number of carious lesions per child (○) and number of cavities or lesions with involvement of the dentine per child (●).

The influence of various ways of scoring extractions can be read from Fig. 1 for the distal surface of the upper first molar. In curve 1 extractions are included scoring all surfaces lost by extraction as carious. In curve 2 extractions are also included, but scored according to the last observation before the extraction. Curve 3 shows the number of lesions not including extractions. Especially the curves for the surfaces with lesions of the dentin are strongly influenced by the method of scoring extractions.

For a longitudinal survey the second method (curve 2) seems to be the best one. As far as possible this method will be followed here.

The influence on the caries score of the method of scoring the fillings will be discussed in the section on pit and fissure lesions.

Out of the vast amount of data only a selection can be reported. For instance the data for boys and girls will only occasionally be given separately.

## RESULTS

The caries score in number of lesions per child at the age of 9, 11, 13 and 15 years, is given in Fig. 2. These combined data give a poor impression of the true progress of caries, as the contribution of proximal caries and fissure caries to the total score is quite different at various ages. Moreover the scoring method over-emphasizes the contribution of pit and fissure caries as the two fissures of the upper molars and the occlusal fissure and the buccal pit of the lower, molars are scored separately. The separate data for the different type of lesions will be more informative.

### (a) *Pit and fissure lesions*

The number of pit and fissure lesions at the different ages is shown in Table 1 and Fig. 3. All curves show a rather steep increase in the number of caries lesions over the whole period from 9 through 15 years.

The boys show lower caries numbers than the girls. Between the age of 13 and 15 the boys show about the same number of cavities as the girls one year younger. The difference in the total number of lesions is (including "incipient caries") less pronounced.

At the age of 9 the number of lesions is already very high in comparison with the number of pits and fissures at risk. Consequently even before this age the curves must have been steep.

For a more detailed understanding of these data, Table 2 gives the number of cavities per 100 children for each specific class of fissures.

At the age of 9 only an insignificant fraction of the caries score is contributed by other teeth than the first molars. The occlusal fissure of the lower molar leads, followed by the mesial and distal fissure of the upper molar.

Figure 4 pictures the increase in the number of cavities during each two-year-period for first and second molars and bicuspid separately (the increment for the period 5-7 and 7-9 years is assessed from the caries increments of similar groups of children).

Up to the age of eleven almost the total caries increment is due to lesions in the first molar. The increased slope of the caries curve after the age of 11 is due to lesions in the second molar and to a lesser extent in the bicuspid.

The second molar erupts 6 years after the first molar; at the age of 15 the second molar attains the same post-eruptive age as the first molar at 9 years. The number of cavities of the first molar at 9 years is about equal to that of the second molar

TABLE 1. PIT AND FISSURE CARIES EXPERIENCE OF MOLARS AND BICUSPIDS YEAR OF BIRTH 1945

Age (years)	Sex	No. of pits and fissures*	No. of carious lesions†	No. of cavities†
9	♀ ♀	9.5	6.5	5.3
	♂ ♂	9.8	6.3	4.8
11	♀ ♀	17.1	9.5	7.2
	♂ ♂	15.9	9.0	6.5
13	♀ ♀	22.4	14.8	11.8
	♂ ♂	22.0	13.5	9.9
15	♀ ♀	23.0	17.1	14.1
	♂ ♂	23.2	16.5	12.7

\* Including pits and fissures lost by extraction.

† Extractions are counted as the last diagnosis before the extraction.

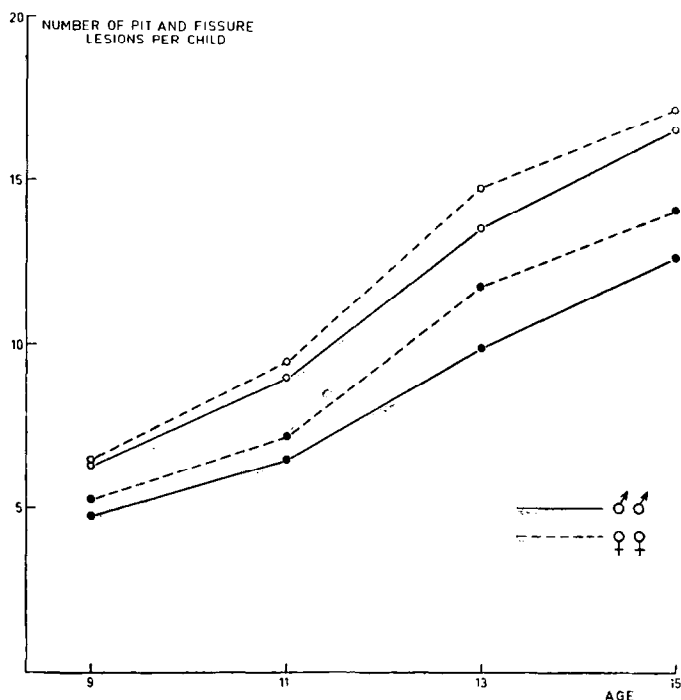


FIG. 3. Number of pit and fissure lesions per child. o, Total number of lesions; ●, Number of cavities. Boys: full drawn lines; Girls: dotted lines.

at 15 years (Table 2). This is especially striking for lower molars. For upper molars there is a difference in caries number of the disto-occlusal fissure. This difference might be explained by the anatomical form of the disto-occlusal fissure of the upper second molar which is very shallow and occasionally absent. Apart from this difference, first and second molars seem to have the same caries susceptibility.

TABLE 2. NUMBER OF PIT AND FISSURE CAVITIES (TOTAL OF LEFT AND RIGHT MOUTH HALF) PER 100 CHILDREN

Age (years)	Upper						Lower					
	P <sub>1</sub>	P <sub>2</sub>	M <sub>1</sub>		M <sub>2</sub>		P <sub>1</sub>	P <sub>2</sub>	M <sub>1</sub>		M <sub>2</sub>	
	o	o	mo	do	mo	do	o	o	o	b	o	b
9	5	2	146	121	0	0	0	3	170	54	0	0
11	13	15	173	160	5	1	2	9	182	78	25	9
13	46	45	192	186	92	38	17	34	191	83	71	31
15	64	70	198	189	143	89	23	57	192	97	162	45

o=occlusal fissure

mo=mesio-occlusal fissure

b=buccal pit

do=disto-occlusal fissure

For extracted molars the caries diagnosis preceding the extraction is used.

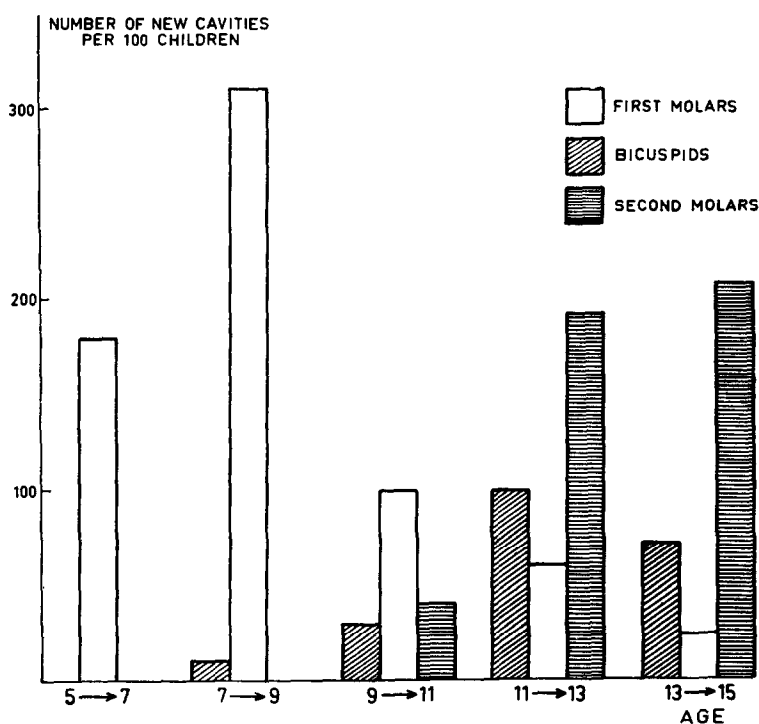


FIG. 4. Increment of pit and fissure cavities.

The bicuspid, erupting somewhat earlier than the second molars, show a far lower attack rate.

The caries score of the occlusal fissure of the bicuspid is strongly affected by the number of proximo-occlusal fillings inserted for proximal lesions. At the age of 15 years, 19 per cent of the upper bicuspid which are scored for occlusal caries

(cavity or filling) show a proximo-occlusal filling. For the lower first and second bicuspid this percentage is resp. 13 and 28 per cent. These percentages are a measure for the inaccuracy of the occlusal score of these bicuspids. At the age of 13 these percentages are smaller, i.e. 10 per cent for the upper bicuspids and resp. 5 and 16 per cent for the first and second bicuspid.

If we make the supposition that the percentage of occlusal cavities was the same in bicuspids with proximal fillings and without proximal fillings, the caries score of the bicuspids would decrease. Under this supposition the number of cavities as given in Table 2, would become at 15 years for the lower first and second bicuspids 20 and 46 and for the upper bicuspids 56 and 62.

For the molars there is no such problem as all occlusal fissures of the first molar were already carious at the age of 9 years.

The difference in caries score between girls and boys seems not only to be determined by an earlier eruption but also by another factor. If the time of eruption was the only factor, the first molars of girls and boys would have attained the same caries level at 15 years. Moreover, although the premolars erupted at about the same time in the girls and the boys, the premolars of the girls show a 20 per cent higher attack rate than the boys.

#### (b) *Proximal lesions*

The curves of Fig. 5 show the number of proximal lesions per child from 9 through 15 years for girls and boys separately. The difference in number of lesions between girls and boys is slight in contrast to the caries attack in pits and fissures. The shape of the curves is also different from those in Fig. 3. In Fig. 5 the curve for lesions affecting the dentin lags behind the curve for all lesions (including enamel lesions) with a time interval of about 3 to 4 years. This means that caries develops slowly, as it takes—in the mean—3–4 years for an incipient lesion to develop to a lesion affecting the dentin. The rate of progression of initial pit and fissure caries is much larger and the period for development to a cavity is less than one year at least up to the age of 13 years.

From 9 through 13 years of age the increase in caries numbers is very high, after 13 years the increase is smaller. At the age of 15 years, 50 per cent of the proximal surfaces are affected. The increment in the number of surfaces with involvement of the dentin from 9 to 12 years is smaller than that from 12 to 15 years.

The distribution of the lesions over the various surfaces for the nine-years-old group is shown in Fig. 6. The caries distribution at the age of 15 is shown in Fig. 7, whereas Fig. 8 pictures for the same age the distribution of the lesions in which the dentin is also involved. In these three Figs. 6, 7 and 8, the *mean* of the right and left mouthhalves are given. The numbers on the top of the bars for the first molars indicate the number of carious surfaces, that were lost by extraction.

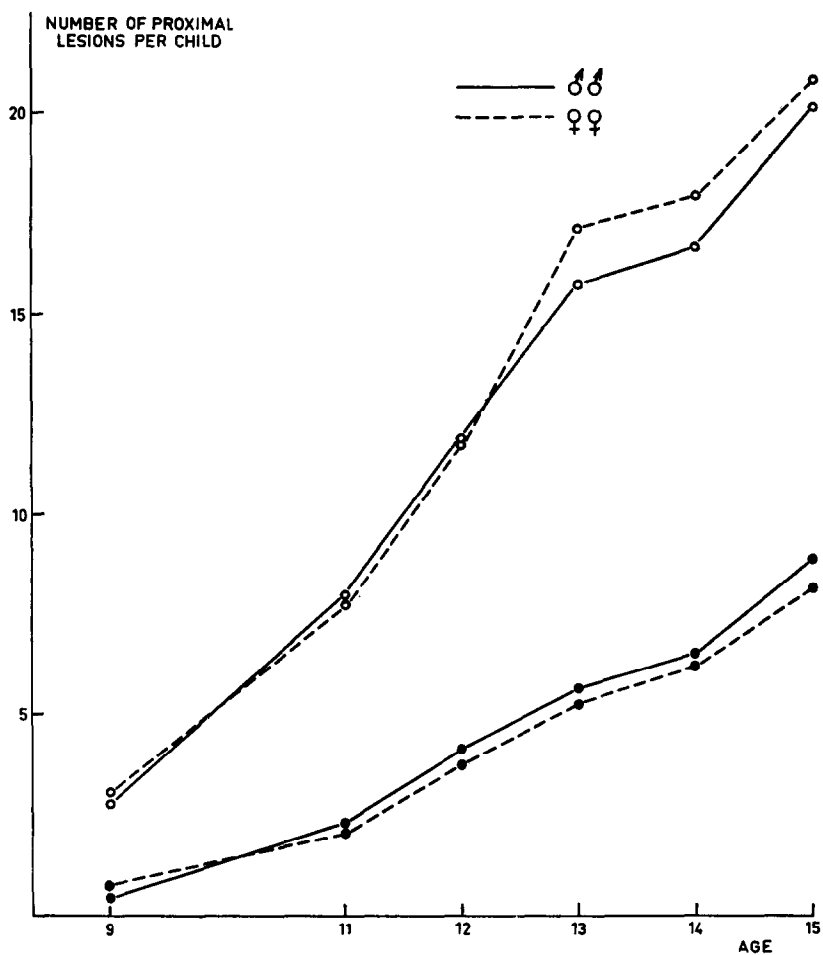


FIG. 5. Number of proximal lesions per child. ●, Total number of lesions; o, Number of lesions with involvement of the dentine. Boys: full drawn lines; Girls: dotted lines.



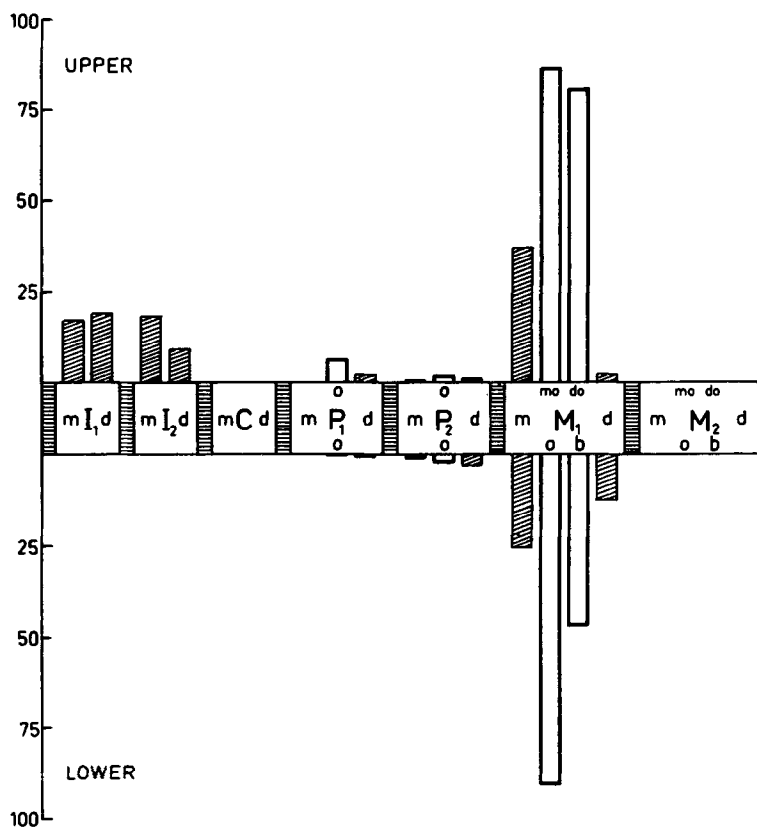


FIG. 6. Number of lesions per 100 children at 9 years of age. Mean of left and right halves of the mouth.

I<sub>1</sub> = first incisor

C = cuspid

P<sub>1</sub> = first bicuspid

M<sub>1</sub> = first molar

m = mesial surface

d = distal surface

o = occlusal fissure

mo = mesio-occlusal fissure

do = disto-occlusal fissure

b = buccal pit.

The top of the molar bars indicate the number of lesions that were lost as a consequence of extraction.

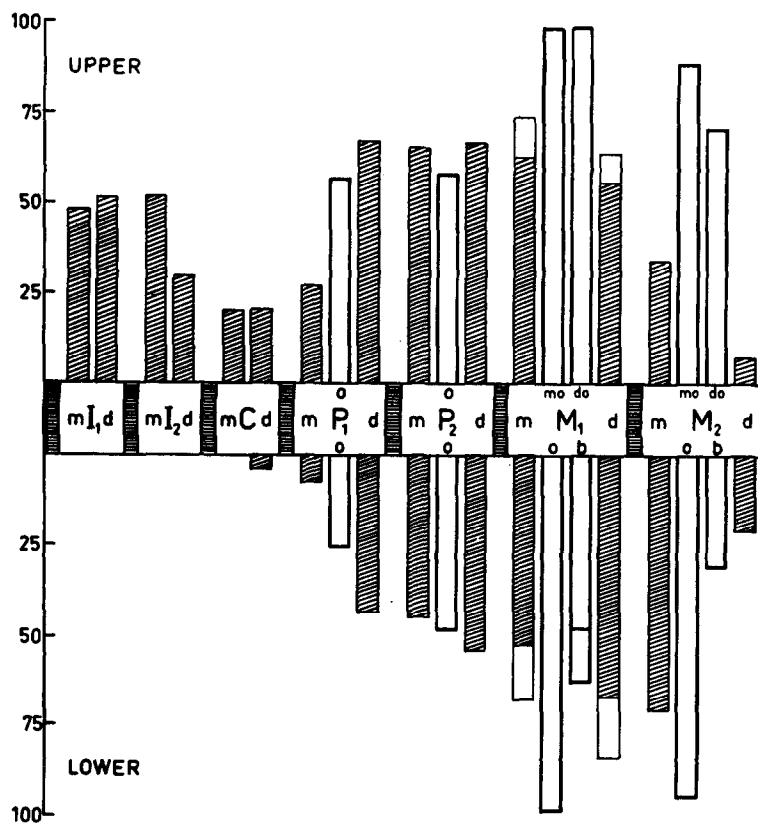


FIG. 7. Number of lesions per 100 children at 15 years of age. Mean of left and right halves of the mouth. For legend see Fig. 6.

Table 3 shows the attack of separate surfaces—in two degrees—as the *sum* of the right and left mouthhalves at the various ages. The difference in number between the two classes of lesions is the number of lesions that—as far as visible on the X-ray—are confined to the enamel. Numerically they are a very important fraction of the total number of lesions; at 9 years 80 per cent of the lesions are enamel lesions and at 15 years 58 per cent.

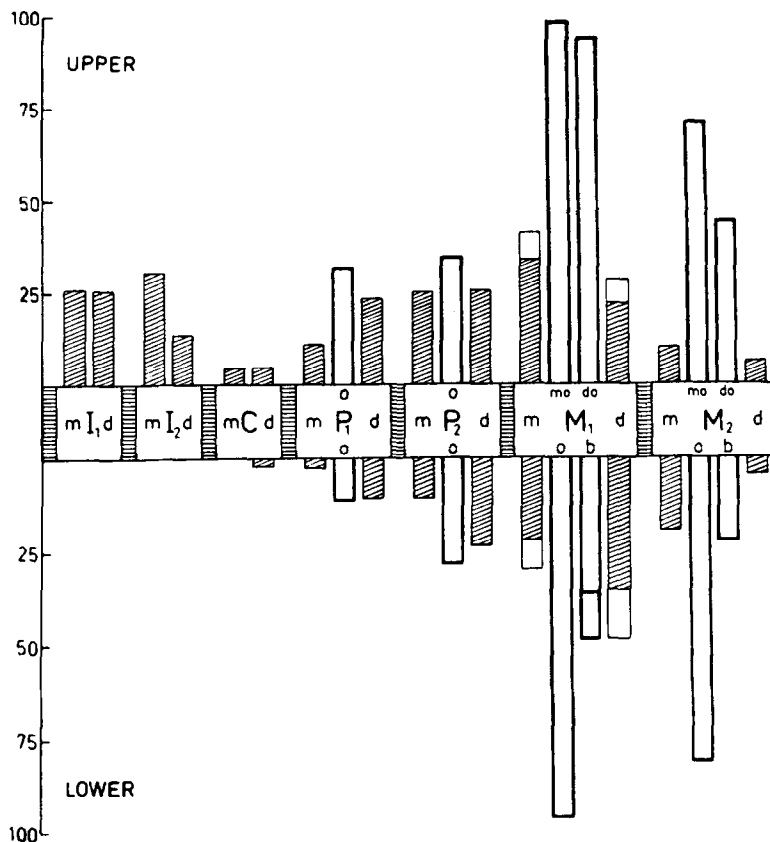


FIG. 8. Number of cavities (for pits and fissures) and of carious lesions with involvement of the dentine (proximal surfaces) at 15 years of age. Mean of left and right halves of the mouth. For legend see Fig. 6.

The Figs. 9 and 10 show the number of lesions for each proximal surface of the maxillary teeth. Three types of curves can be distinguished. The first type are the curves for the surfaces which had already an important number of lesions at nine years. These curves show a moderate slope up to the age of 13, after this age the curve has an insignificant slope. The mesial and distal surfaces of the first incisor, the mesial surface of the second incisor and the mesial surface of the first molar belong to this type. The only difference is the far higher level of the molar curve.

TABLE 3. NUMBER OF PROXIMAL LESIONS (TOTAL FOR LEFT AND RIGHT HALVES OF THE MOUTH) PER 100 CHILDREN

Caries grade	Age (years)	Upper						Lower						Total number of lesions per child
		I <sub>1</sub> m d	I <sub>2</sub> m d	C m d	P <sub>1</sub> m d	P <sub>2</sub> m d	M <sub>1</sub> m d	M <sub>2</sub> m d	C d	P <sub>1</sub> m d	P <sub>2</sub> m d	M <sub>1</sub> m d	M <sub>2</sub> m d	
All lesions	9	34 39	37 19	1 0	0 4	1 3	75 5	0 0	0 0	0 0	1 6	52 24	0 0	3.01
	11	59 71	71 29	3 6	11 37	42 55	102 21	5 0	1 1	2 16	21 41	85 79	35 3	7.95
	12	78 87	89 35	12 14	15 71	72 83	122 54	18 3	0 2	2 37	32 53	89 122	83 11	11.82
	13	89 99	99 47	25 26	37 95	93 116	138 95	40 8	7 13	61 57	85 114	154 116	33 116	16.47
	14	87 98	93 50	29 33	41 107	110 117	138 104	52 6	7 14	69 67	90 114	157 126	24 126	17.33
	15	96 104	104 60	41 41	55 135	132 134	148 128	70 15	7 15	88 90	108 135	167 140	41 140	20.54
Lesions with involvement of the dentine	9	7 7	7 4	0 0	0 0	0 0	10 1	0 0	0 0	0 0	0 1	17 5	0 0	0.59
	11	30 30	29 9	0 1	1 2	3 6	38 6	0 0	0 0	0 1	1 7	30 20	1 0	2.15
	12	40 44	41 13	1 2	5 12	17 22	55 18	1 1	0 1	5 4	17 40	48 5	3 3	3.95
	13	42 48	50 16	2 6	7 27	25 37	65 34	7 2	1 5	8 9	23 51	71 10	4 10	5.50
	14	45 51	52 20	6 7	11 32	34 39	72 48	13 3	1 6	13 13	29 50	80 13	4 13	6.42
	15	52 52	62 27	9 12	22 47	50 52	83 57	20 13	4 6	21 22	47 60	96 40	4 40	8.58

m=mesial surface

d=distal surface

For extracted teeth the caries diagnosis preceding the extraction is used.



The premolar surfaces, except the distal surface of the second premolar, and the distal surface of the first molar show an other type of curve. Starting at nine years at zero, a very steep rise follows, which brings the curves to about the same height as the mesial surface of the first molar. The curves of the proximal surfaces of the cuspid and the adjacent surfaces of first premolar and second incisor show the smallest slope. The mesial surface of the second molar seems to have the same type of curve as the mesial surface of the first molar.

In general the caries numbers of two adjacent surfaces show more similarity than the two surfaces of the same tooth. There is therefore perhaps more reason to describe the caries pattern with the interproximal space as the unit, than with the tooth as the unit. The dissimilarity of adjacent surfaces in the younger age groups tends to become smaller each subsequent year. This is especially true in those adjacent surfaces which show an important difference in time of eruption (e.g.  $M_1m-P_2d$ ).

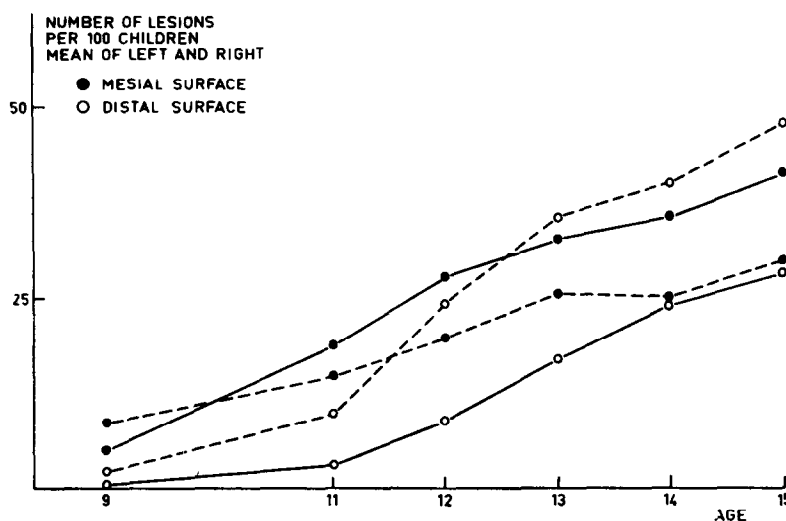


FIG. 11. Proximal lesions with involvement of the dentine. First molar. ●, Mesial surface; ○, Distal surface. Upper molar: full drawn lines; Lower molar: dotted lines.

Figure 11 brings together the four surfaces of the upper and lower first molar. The number of surfaces with lesions of the dentin are shown. Each of these four curves shows a different shape. At nine years both mesial surfaces show a higher caries score than the distal surfaces. However, at the age of 15 the distal surface of the lower molar has a much higher caries number than its mesial surface. The distance between mesial and distal surface of the upper molar curves is fairly constant.

At the age of  $10\frac{1}{2}$  years 50 per cent of the upper second premolars were erupted, for the lower premolars this age was  $11\frac{1}{4}$  years. The upper and lower second molars

were for 50 per cent erupted at resp. 12 and 11 years. The presence of the deciduous molars explains the differences at 9 years; the eruption sequence of the permanent premolars and molars explains, at least partly, the different caries rates after 9 years.

(c) *Buccal and labial smooth surface lesions*

The lesions of the buccal or labial surfaces are diagnosed only in the course of the examinations at 13 and 15 years.

Those surfaces were diagnosed as carious, that after cleaning and drying with compressed air during two to three seconds, either showed a white, chalky, non glossy enamel area, or a break in the enamel, perceptible by the sharp explorer.

TABLE 4. NUMBER OF BUCCAL AND LABIAL LESIONS PER CHILD

	Age (years)	
	13	15
No. lesions	5.3	8.0
No. cavities	0.9	1.7

Table 4 gives the number of buccal lesions in two classes.

Except for the first molars all teeth showed an increment in carious lesions. However, it is not possible upon the basis of these two examinations to draw any further conclusions.

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