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**PREVALENCE OF DENTAL CARIES AND DENTAL
HEALTH IN RELATION TO VARIABLE CONCEN-
TRATION OF FLUORIDES IN DRINKING WATER
A CLINICAL STUDY ON FINNISH SCHOOL-CHILDREN**

by

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INTRODUCTION

The negative correlation between the fluoride content of drinking water and the prevalence of dental caries has been firmly established in a great number of studies carried out all over the world. In Finland, *Koski et al.* (1957) and *Haataja et al.* (1957) first observed a marked difference in the geographic distribution of dental caries as registered in 2,386 Finnish children. These studies were performed without available data of the concentration of the water fluorides. *Haataja* (1958) showed, however, on the basis of a limited number of fluorine determinations that the distribution of dental caries in the aforementioned materials was at least partly related to the concentration of water fluorides. Thus two communes, Elimäki and Mynämäki, with a noticeable low prevalence of caries in the age groups studied, had a high water fluoride concentration, viz. 1.70 and 0.83 p.p.m., respectively. A high prevalence of caries in the communes of Kauhava and Rovaniemi was related to 0.09 and 0.07 p.p.m. fluoride, respectively. In addition *Hautera & Kantola* (1960) made a separate clinical study on the prevalence of dental caries in school-children

aged 7—12 years in one high- and two low-fluoride areas in Turku. In this town, one area was receiving intermittently, about 15 hours a day, 2 p.p.m. fluoride containing water. In this district the fluoride concentration varied between 0.3—2.0 p.p.m., being usually well above 1 p.p.m. In the corresponding low-fluoride areas the concentration varied between 0.04 and 0.3 p.p.m. The authors found a significant difference in the prevalence of dental caries between the high fluoride and the two low-fluoride groups, the latter having nearly twice as many DMF-teeth as the high-fluoride group.

The present study was made in order (1) to assess the quantitative relationship between the prevalence of dental caries and a wide concentration range of water fluorides, (2) to investigate the rate of eruption of permanent teeth in relation to fluoride concentration, and (3) to observe the occurrence of mottled enamel in relation to fluoride concentration.

Preliminary fluoride analyses were carried out by *Kasanen* (1955) and *Wäre* (1961). The latter author performed 2,764 fluoride determinations, each representing a random sample covering 1,000 rural inhabitants. It was observed that 6 per cent of the rural population was using water containing at least 1 p.p.m. fluoride. 41 per cent of rural population had a water supply containing less than 0.1 p.p.m. fluoride. The fluoride concentration values thus obtained by *Wäre* were much lower than those earlier published by *Kasanen* in his more limited study.

MATERIAL AND METHODS

Nine communes, each situated in the South-East part of Finland, were selected according to information suggesting a wide range of variation of fluoride concentration in well waters (*Wäre* 1961). These rural communes were: Artjärvi, Askola, Elimäki, Iitti, Myrskylä, Parikkala, Taipalsaari, Valkeala and Vehkalahti. The entire population in these communes used well water for drinking and cooking purposes. Occasionally up to five families were using the same water supply.

In these communes all children aged eleven years were submitted to a dental examination, performed by two qualified den-

tists. The dental examinations were carried out as a blind study, the examiners having no information of the preliminary fluoride determinations.

The material initially comprised 1,174 children. At the dental examination each child was given a 250 cc polyethylene bottle to be entirely filled with a water sample from the home well and to be delivered to the examiners on the following day. Part of the material, initially 419 children, were submitted to a duplicate dental examination. A part of this material and a part of the total material was excluded on the following grounds: (1) Residence for a period less than 6 years, (2) Fluoride concentration of drinking water unknown. The distribution of the material is shown in Table I.

Table I.

Distribution of final, excluded and total material.

	Distribution of material			Double examinations		
	Girls	Boys	Total	Girls	Boys	Total
Final material	481	502	983	169	170	339
Residence > 6 years	79	76	155	30	21	51
Fluoride conc. unknown	11	25	36	7	22	29
Total	571	603	1,174	206	213	419

The final material which was statistically treated thus comprised 983 children. Of these individuals, 339 were examined by both examiners for determining the error of method in connection with variables encountered in the study.

The dental examinations were mostly performed in good daylight. Under adverse conditions low-voltage headlamps were used. All examinations were made using magnifying mouth mirrors and sharp probes.

The following abbreviations were used during recording and also in the presentation of the results:

F mg/l	Fluorine content, milligrams per liter, p.p.m.
DMF	Decayed, missing and filled permanent teeth
DMFS	Decayed, missing and filled permanent tooth surfaces
T	Number of erupted permanent teeth per child
t 04, 05	Number of retained deciduous molars per child
T 4, 5	Number of erupted premolars per child
T 7	Number of erupted second permanent molars per child
ic	Incisors and canines
p	Premolars
m	Molars
H	Performer of clinical examination
M	" " " "

Dental caries was defined, for recording purposes, as a cavity diagnosed by mouth mirror and probe examination.

The number of erupted permanent teeth was assessed by considering a tooth erupted when its entire occlusal surface or incisal edge was visible.

The occurrence of mottled enamel was indexed by noting the degree of mottling. Assuming a low degree of dental fluorosis to be expected as related to a low water consumption in a cool climate, the following sensitive index of fluorosis was computed on a tooth unit basis per child:

- 1 Normal enamel in all teeth erupted
- 2 Questionable opacities in one or more teeth
- 3 Small, irregular white spots in one or more teeth
- 4 White opacities involving at least one quarter of the facial surface in one or more teeth
- 5 Beginning discoloration of tooth surface in one or more teeth.

Statistical Methods

The statistical treatment of the material was performed with the χ^2 -test by using the equation

$$\chi^2 = \sum (O - E)^2 / E,$$

in which the symbol O means the observed (empirical) frequency and E the corresponding theoretical frequency. With the value

of χ^2 the corresponding probabilities were taken from statistical tables, with entry at the degree of freedom. The values of χ^2 , degrees of freedom and corresponding probabilities will be given in conjunction with the presentation of the results (Tables X—XII).

The error of method was calculated by using the equation

$$s = \sqrt{\frac{\sum d^2}{2k}}$$

in which s means the error of method, d the difference between duplicate determinations and k the number of duplicate sets.

RESULTS

The final material consisting of 983 school-children aged 11 years can be divided both according to the commune of residence and according to the fluoride concentration of their drinking water. On the basis of the corresponding 983 fluoride determinations the mean fluoride concentrations of the nine communes are given in Table II.

Table II.
Mean fluoride concentration of drinking water.

Commune	Median of fluoride concentration mg/l
Artjärvi	0.36
Askola	0.26
Elimäki	1.34
Iitti	0.51
Myrskylä	0.44
Parikkala	0.07
Taipalsaari	0.10
Valkeala	1.05
Vehkalahti	1.15
Total	0.55

Table III.*Distribution of the material according to fluoride concentration and sex.*

Fluoride concentration mg/l	Boys	Girls	Total
0.00 — 0.10	85	87	172
0.11 — 0.39	110	96	206
0.40 — 0.99	101	98	199
1.00 — 1.59	90	105	195
1.60 —	95	116	211
Total	481	502	983

The distribution of the final material in relation to the fluoride concentration per child unit base, is shown in Table III and in Fig. 1. The material is divided in five nearly equal groups, the

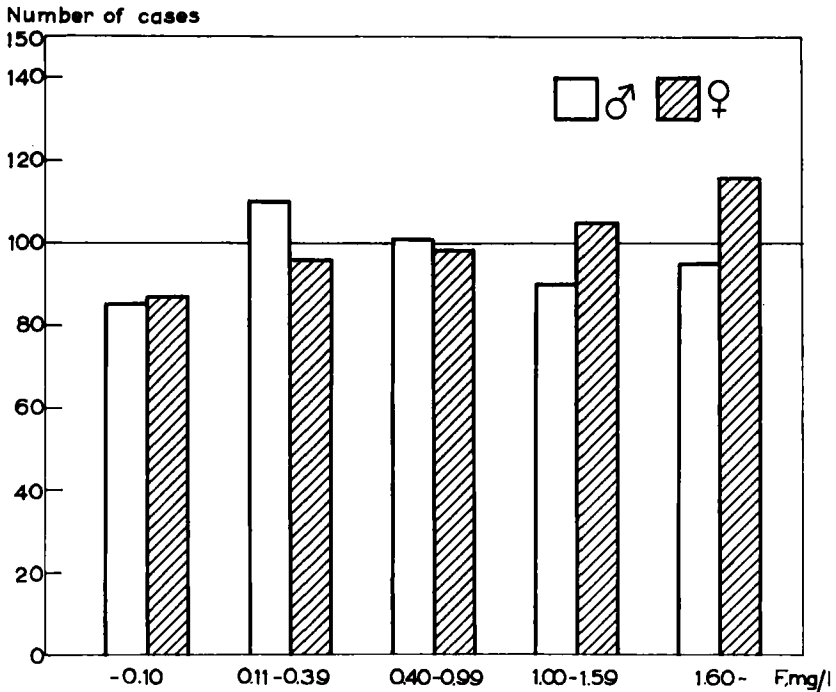


Fig. 1. Distribution of 983 children aged 11 years according to sex and fluoride concentration groups.

Table IV.
Distribution of material according to fluoride concentration groups and residence.

Fluoride concentration	Artjärvi		Askola		Elimäki		Iitti		Myrskylä		Parikkala		Taipalsaari		Valkeala		Vehkalahti	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
— 0.10	3	2	8	5	1	1	11	10	3	4	42	42	12	16	4	5	1	2
0.11 — 0.39	10	15	13	11	8	3	21	22	9	5	16	10	14	10	12	13	7	7
0.40 — 0.99	10	5	4	7	15	8	14	20	5	5	1	—	1	1	37	33	14	19
1.00 — 1.59	3	2	1	—	24	33	13	17	9	3	—	—	—	—	29	35	11	15
1.60 —	1	2	—	1	34	41	11	12	—	2	—	—	—	—	25	33	24	25
Total	27	26	26	24	82	86	70	81	26	19	59	52	27	27	107	119	57	68

Table V.
Means of duplicate determinations performed by examiners H and M.

Item examined	Sex		Fluoride concentration						Communes				
	Boys	Girls	0.00-0.10	0.11-0.39	0.40-0.99	1.00-1.59	1.60-	Artjärvi	Askola	Parikkala	Vehkalahiti	Total	
			0.10	0.39	0.99	1.59							
Index of fluorosis	1.73	1.78	1.61	1.58	1.63	1.69	2.51	1.76	1.45	1.69	1.93	1.76	
	1.76	1.76	1.65	1.57	1.60	1.69	2.53	1.80	1.41	1.71	1.93	1.76	
DMFS, H , M	9.44	9.00	12.04	9.92	8.43	6.47	5.00	7.28	11.16	12.11	6.73	9.22	
	9.14	9.27	12.00	9.74	8.53	6.75	5.00	7.28	11.06	11.98	6.84	9.20	
DMF, H , M	6.03	6.06	7.19	6.47	6.22	4.38	3.87	5.61	7.20	7.07	4.86	6.04	
	6.02	6.15	7.22	6.46	6.18	4.72	3.92	5.72	7.29	7.06	4.90	6.09	
T, H , M	18.94	21.24	19.64	19.62	21.52	20.75	19.79	20.57	19.90	19.66	20.35	20.09	
	19.02	21.19	19.51	19.72	21.60	20.84	19.81	20.72	19.86	19.60	20.39	20.11	
t 04, 05, H , M	2.21	1.67	1.99	2.01	1.30	1.88	2.49	1.48	1.92	2.02	2.08	1.94	
	2.30	1.73	2.00	2.15	1.42	2.03	2.49	1.56	2.02	2.08	2.15	2.01	
T 4, 5, H , M	4.47	5.27	4.59	4.67	5.82	5.13	4.55	5.28	4.92	4.64	4.89	4.87	
	4.42	5.25	4.58	4.56	5.73	5.16	4.58	5.20	4.88	4.63	4.84	4.83	
T 7, H , M	0.55	1.04	0.72	0.55	1.15	0.91	0.89	0.72	0.61	0.74	0.95	0.80	
	0.52	1.11	0.67	0.67	1.15	0.97	0.87	0.89	0.61	0.70	0.96	0.81	
DMFS ic. H , M	2.17	1.75	2.95	2.48	1.52	0.75	0.36	1.43	2.57	3.13	0.92	1.96	
	2.15	1.71	2.90	2.40	1.47	0.78	0.40	1.48	2.59	2.95	0.94	1.93	
DMFS p. H , M	0.85	0.86	1.18	0.92	0.92	0.47	0.25	0.67	1.45	1.03	0.54	0.86	
	0.87	0.95	1.22	0.94	1.03	0.69	0.23	0.70	1.45	1.09	0.62	0.91	
DMFS m. H , M	6.42	6.39	7.90	6.52	6.00	5.25	4.40	5.19	7.14	7.96	5.26	6.40	
	6.12	6.62	7.88	6.39	6.03	5.28	4.38	5.09	7.02	7.94	5.27	6.37	

fluoride concentration ranges being 0.00—0.10, 0.11—0.39, 0.40—0.99, 1.00—1.59 and 1.60—F mg/l. The highest fluoride concentration observed is 5.0 mg/l. The distribution of the material according to fluoride concentration groups and communes of residence is given separately for boys and girls in Table IV. In the communes Artjärvi, Askola, Parikkala and Vehkalahti 169 boys and 170 girls were submitted to duplicate dental examinations covering dental caries, mottled enamel, number of erupted permanent teeth and number of retained deciduous molars. The results with regard to (1) the index of fluorosis, (2) the number of DMF-surfaces per child (DMFS-index), (3) the number of DMF-teeth per child (DMF-index), (4) the number of erupted permanent teeth per child, (5) the number of retained deciduous molars per child, (6) the number of erupted permanent premolars per child, (7) the number of erupted permanent second molars per child, (8) the number of DMF-surfaces of incisors and canines, premolars and molars are given separately for both examiners in Table V. The corresponding errors of the method, calculated as stated above, are given in Table VI. The variation between the examiners is also shown in Figs. 2—5, with regard to the total means.

Table VI.

*The variation between examiners H and M.
(Errors of the method).*

Variables	Fluoride concentration					Total
	0.00-0.10	0.11-0.39	0.40-0.99	1.00-1.59	1.60-	
Index of fluorosis	0.22	0.20	0.20	0.00	0.22	0.20
DMFS	0.64	0.59	0.59	0.56	0.87	0.65
DMF	0.55	0.45	0.51	0.52	0.56	0.52
T	0.72	0.72	0.47	0.53	0.54	0.64
t 04,05	0.52	0.34	0.35	0.31	0.48	0.42
T 4.5	0.28	0.44	0.30	0.13	0.31	0.33
T 7	0.40	0.46	0.32	0.50	0.42	0.42
DMFS ic	0.32	0.50	0.30	0.13	0.33	0.38
DMFS p	0.51	0.29	0.33	0.42	0.22	0.38
DMFS m	0.43	0.50	0.45	0.52	0.56	0.45

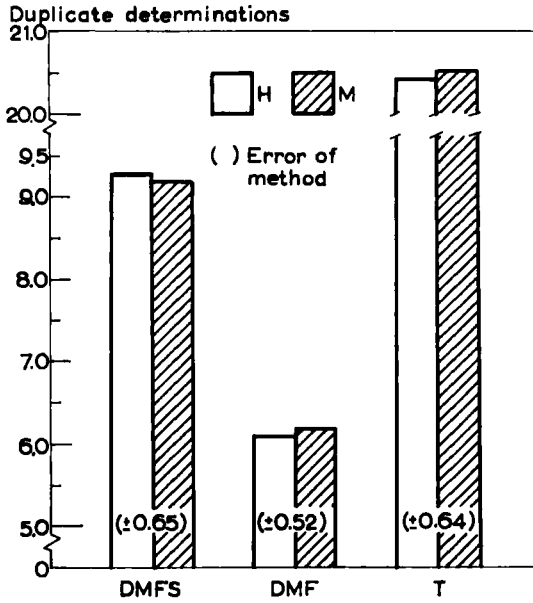


Fig. 2. Variation between examiners with regard to total means of DMFS- and DMF-indexes and number of erupted teeth.

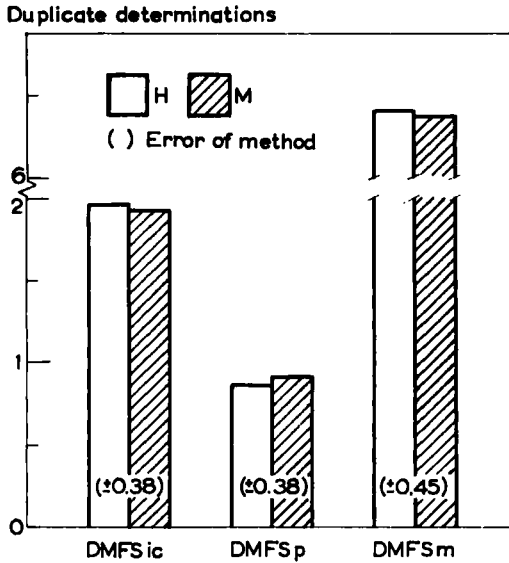


Fig. 3. Variation between examiners with regard to total means of partial DMFS-indexes in the incisors and canines, premolars and molars.

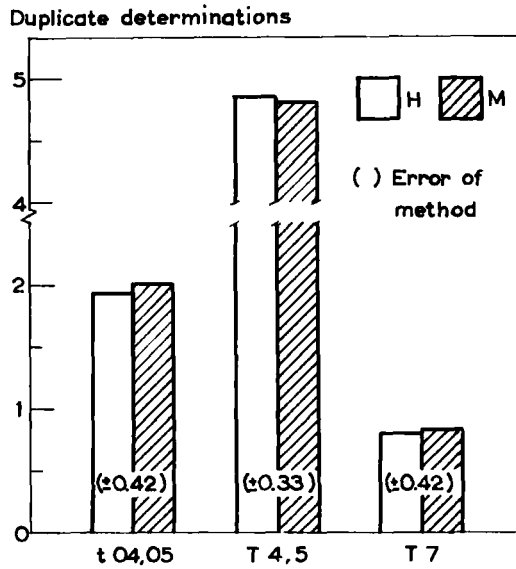


Fig. 4. Variation between examiners with regard to number of retained deciduous molars and number of erupted permanent premolars and second molars.

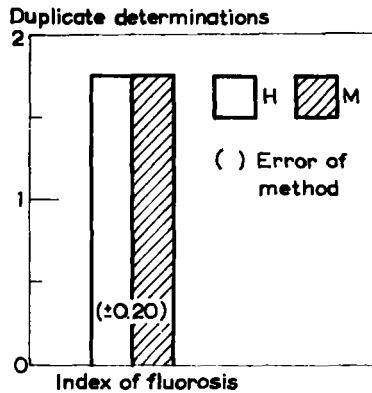


Fig. 5. Variation between examiners with regard to occurrence of mottled enamel.

The mean values of the duplicate determinations are used in the presentation of the total results of the clinical examinations in the selected nine communes (Table VII). The variation of the DMFS-index in these communes is additionally shown in Fig. 6.

Table VII.

Means of variables in residence communes.

Variables	Communes								
	Artjärvi	Askola	Elimäki	Iitti	Myrskylä	Parikkala	Taipalsaari	Valkeala	Vehkalahti
DMFS	7.28	11.11	4.29	7.11	7.96	12.05	9.96	5.78	6.78
DMF	5.67	7.24	3.58	4.96	6.18	7.07	6.19	4.15	4.88
T	20.52	19.88	19.85	20.20	20.71	19.63	20.61	19.64	20.37
t 04,05	1.52	1.97	1.97	1.76	1.60	2.05	1.54	1.99	2.12
T 4,5	5.24	4.90	4.71	5.00	5.18	4.64	5.20	4.82	4.86
T 7	0.81	0.61	0.75	0.82	0.96	0.72	0.85	0.61	0.96
DMFS ic	1.45	2.58	0.33	1.25	2.00	3.04	2.26	0.67	0.93
DMFS p	0.69	1.45	0.30	0.65	0.73	1.06	0.65	0.50	0.58
DMFS m	5.14	7.08	3.67	5.21	5.22	7.95	7.06	4.61	5.27
Index of fluorosis	1.78	1.43	2.63	1.72	1.42	1.70	1.43	2.19	1.93

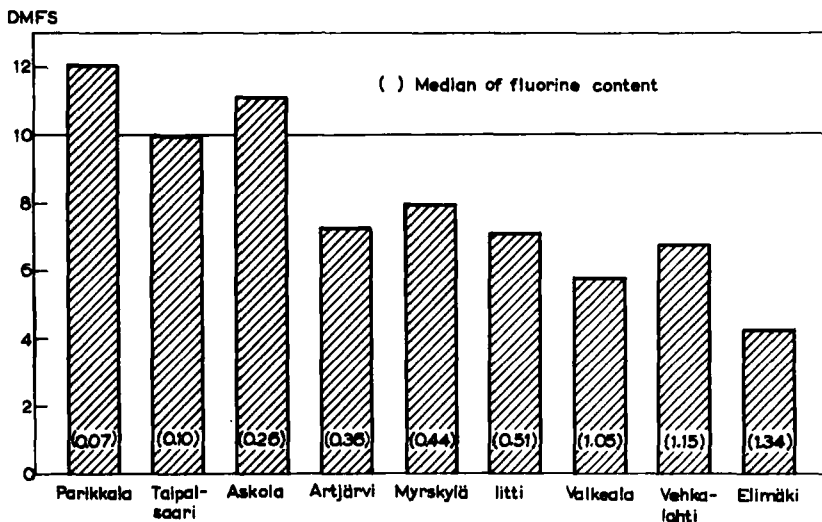


Fig. 6. Variation of DMFS-index in nine communes with varying water fluoride concentrations.

The means of the variables in relation to the five fluoride concentration groups and in relation to sex are given in Table VIII. The corresponding DMFS- and DMF- indexes as well as the number of permanent teeth erupted are shown separately for both sexes in relation to the fluoride concentration groups (Table IX, Figs. 7—8). Separate graphic presentations show the variations of the DMFS-index in the incisor-canine region (Fig. 9), in the premolars (Fig. 10) and in the molars (Fig. 11). The numbers of erupted second molars (Fig. 12), and of erupted premolars and

Table VIII.

Means of variables in relation to fluoride concentration groups.

Variables	Sex			Fluoride concentration				
	Boys	Girls	Total	0.00 — 0.10	0.11 — 0.39	0.40 — 0.99	1.00 — 1.59	1.60 —
Index of fluorosis	1.97	1.97	1.97	1.58	1.61	1.77	2.17	2.64
DMFS	7.20	7.28	7.24	11.26	9.11	7.38	5.16	3.93
DMF	4.90	5.18	5.04	6.87	6.07	5.30	4.01	3.26
T	19.14	20.86	20.02	20.03	20.25	20.50	19.81	19.52
t 04, 05	2.09	1.73	1.90	1.76	1.77	1.57	2.04	2.35
T 4, 5	4.53	5.21	4.88	4.89	5.05	5.19	4.68	4.59
T 7	0.60	0.92	0.76	0.75	0.77	0.89	0.73	0.67
DMFS ic	1.39	1.19	1.29	2.76	2.01	1.09	0.51	0.29
DMFS p	0.59	0.69	0.64	1.08	0.83	0.78	0.39	0.20
DMFS m	5.22	5.40	5.31	7.42	6.27	5.51	4.26	3.44

Table IX.

Means of DMFS- and DMF-indexes and mean numbers of permanent teeth erupted in relation to sex and fluoride concentration groups.

Variables	Fluoride concentration group									
	0.00 — 0.10		0.11 — 0.39		0.40 — 0.99		1.00 — 1.59		1.60 —	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
DMFS	11.90	10.64	8.68	9.59	6.79	8.01	5.58	6.67	3.78	4.05
DMF	6.92	6.82	6.01	6.13	4.84	5.78	3.56	4.40	3.17	3.34
T	19.31	20.74	19.48	21.15	19.45	21.60	19.14	20.39	18.30	20.52

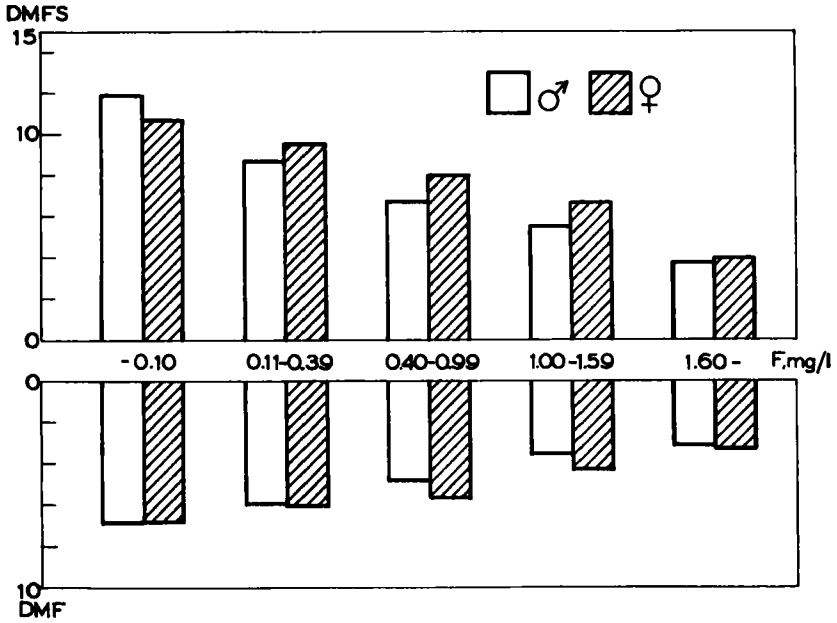


Fig. 7. Prevalence of dental caries in boys and girls aged 11 years according to variations in water fluoride concentration. Upper graph shows number of DMF-surfaces per child; lower part shows number of DMF-teeth per child.

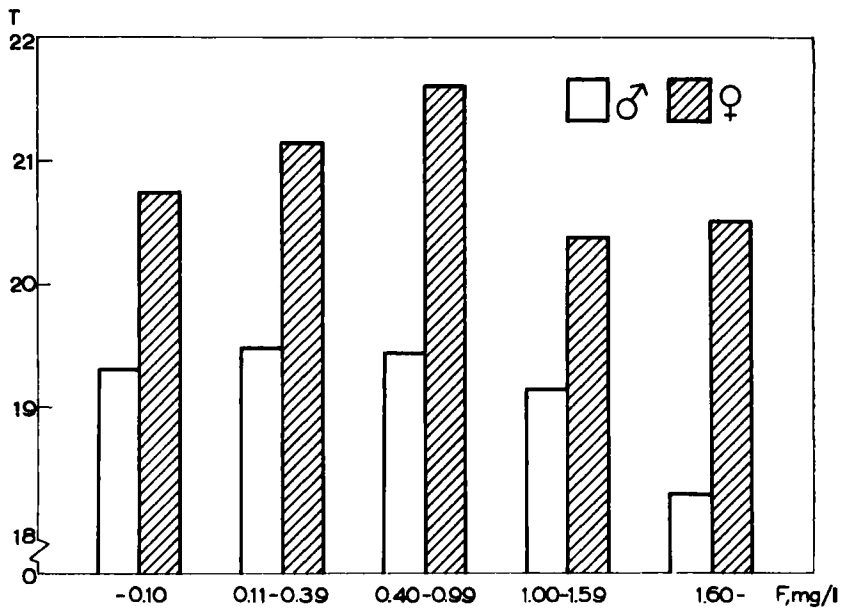


Fig. 8. Number of permanent teeth erupted in boys and girls aged 11 years according to variations in water fluoride concentration.

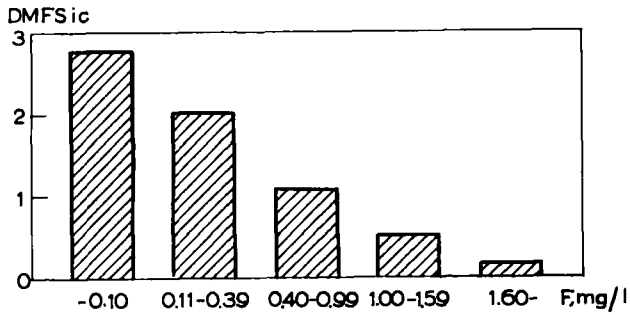


Fig. 9. Prevalence of dental caries in the incisor-canine region in relation to water fluoride concentration.

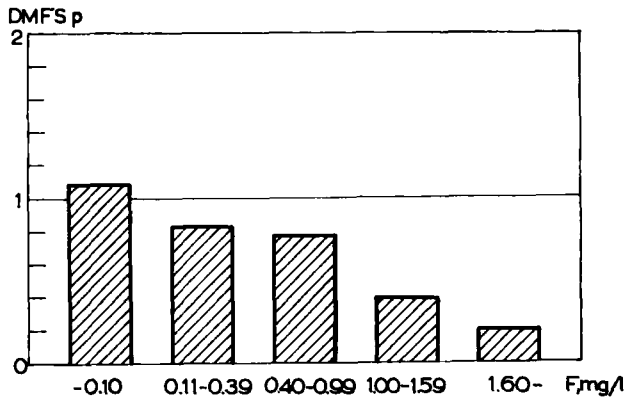


Fig. 10. Prevalence of dental caries in the premolar region in relation to water fluoride concentration.

retained deciduous molars (Fig. 13) are similarly shown. The variations of the degree of mottled enamel are seen in Tables VII and VIII, and in Fig. 14. The distribution of the degree of dental fluorosis is shown in Fig. 15.

The results of the statistical treatment, by comparison of the observations with the aid of the χ^2 -distribution, are given with regard to differences between boys and girls (Table X), and by comparing the differences between all and selected fluoride concentration groups (Tables XI and XII).

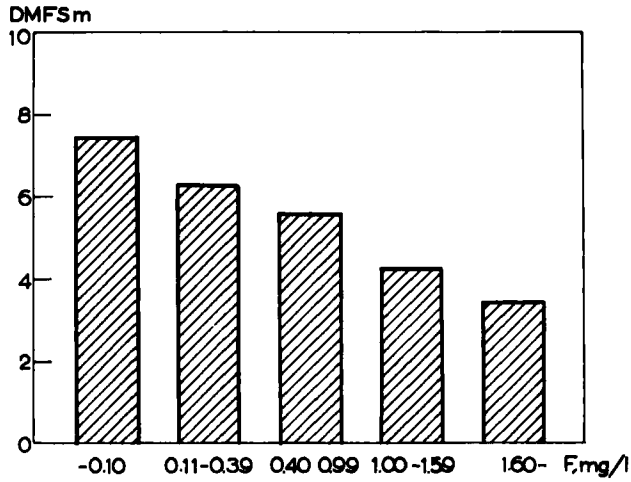


Fig. 11. Prevalence of dental caries in the molar region in relation to water fluoride concentration.

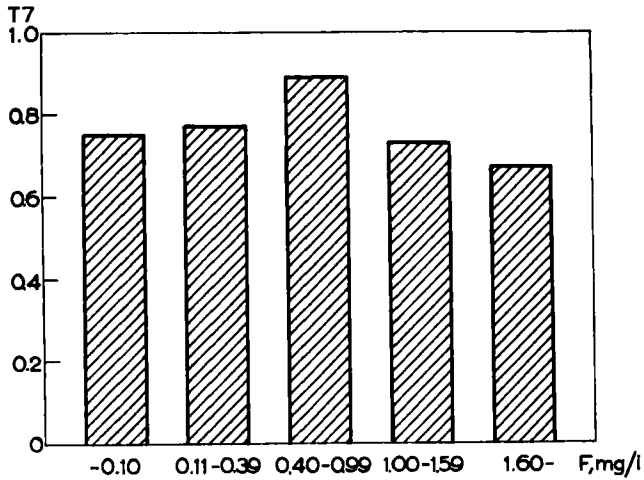


Fig. 12. Number of permanent second molars erupted in relation to water fluoride concentration.

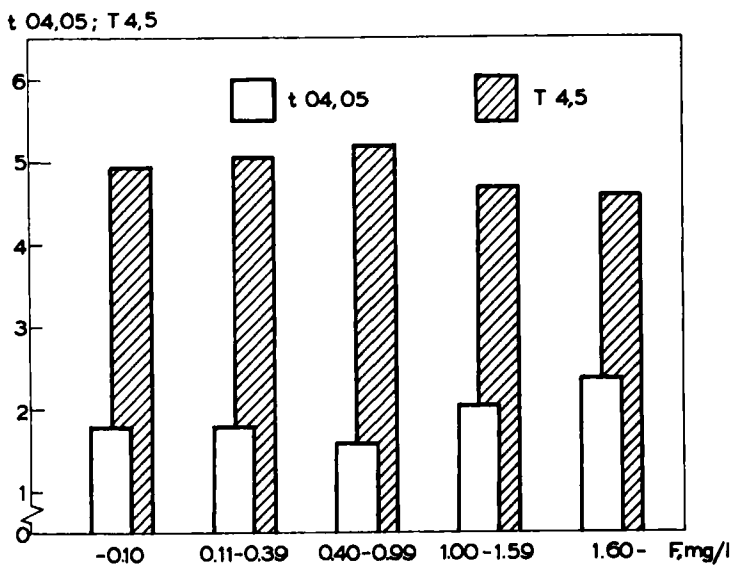


Fig. 13. Number of retained deciduous molars and number of erupted premolars in relation to water fluoride concentration.

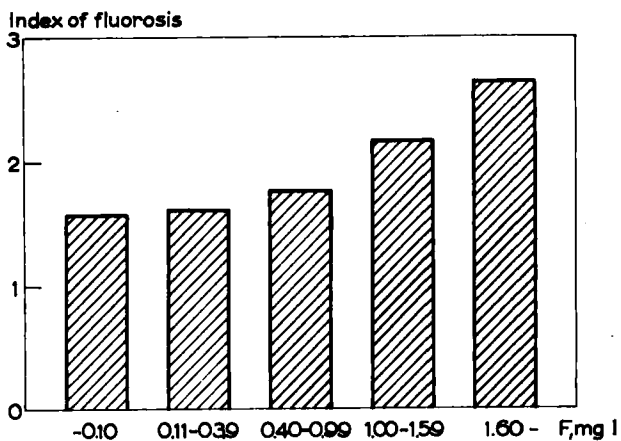


Fig. 14. Relation between index of fluorosis and water fluoride concentration.

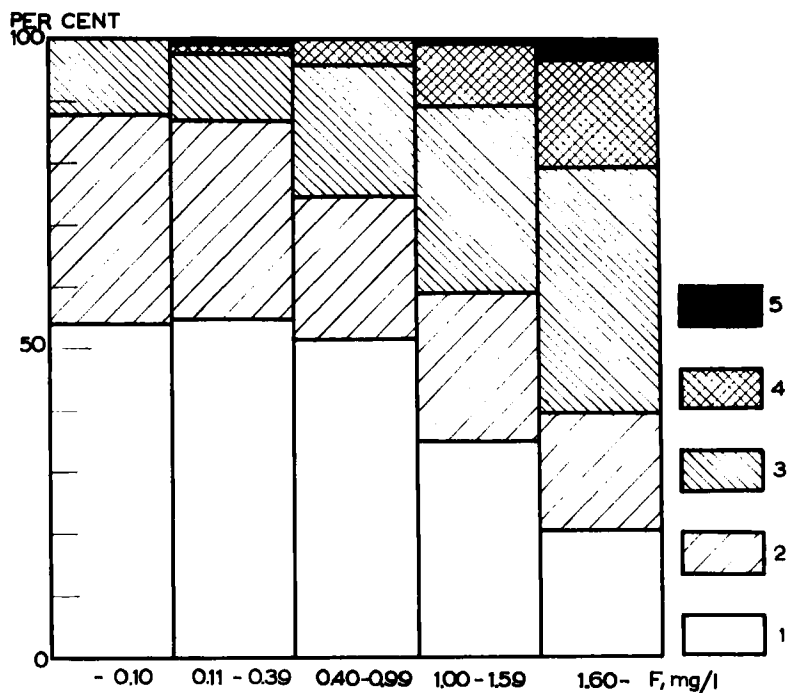


Fig. 15. Distribution of the degree of tooth enamel opacities in relation to water fluoride concentration.

Table X.

Sex differences with regard to variables studied. χ^2 , degrees of freedom and probabilities.

Variable	χ^2	Degrees of freedom	p
Index of fluorosis	0.71	3	..
DMFS	18.6	17	..
DMF	13.1	11	..
T	44.6	16	0.001
t 04, C5	12.1	8	..
T 4, 5	27.4	8	0.001
T 7	15.1	4	0.01
DMFS ic	11.0	7	..
DMFS p	8.32	4	..
DMFS m	14.0	13	..

Table XI.

Differences between fluoride concentration groups with regard to variables studied. χ^2 , degrees of freedom and probabilities.

Variable	χ^2	Degrees of freedom	P
Index of fluorosis	179	12	0.001
DMFS	293	68	0.001
DMF	250	44	0.001
T	61.1	64	..
t 04, 05	32.6	32	..
T 4, 5	40.1	32	..
T 7	19.5	16	..
DMFS ic	175	28	0.001
DMFS p	67.6	16	0.001
DMFS m	220	52	0.001

Table XII.

Differences between selected fluoride concentration groups with regard to number of erupted permanent teeth and to retained deciduous teeth. χ^2 , degrees of freedom and probabilities.

Variable	Selected fluoride concentration group	χ^2	Degrees of freedom	P
T	1.60 — contra 0.00 — 0.10	15.05	16	..
	1.60 — contra 0.11 — 0.39	10.52	16	..
	1.60 — contra 0.40 — 0.99	30.36	16	0.01
T 04, 05	1.60 — contra 0.00 — 0.10	8.34	8	..
	1.60 — contra 0.11 — 0.39	11.15	8	..
	1.60 — contra 0.40 — 0.99	16.65	8	0.05
T 4, 5	1.60 — contra 0.00 — 0.10	12.51	8	..
	1.60 — contra 0.11 — 0.39	12.08	8	..
	1.60 — contra 0.40 — 0.99	16.62	8	0.05
T 7	1.60 — contra 0.00 — 0.10	5.49	4	..
	1.60 — contra 0.11 — 0.39	4.65	4	..
	1.60 — contra 0.40 — 0.99	7.66	4	..

CONCLUSIONS AND DISCUSSION

The examination of the material was limited to a clinical study. Only for practical reasons bite-wing X-ray films were not used as a diagnostic adjunct.

The reliability of the results of the present study were tested by using large sets of duplicate determinations with regard to all variables to be observed. The mean values of the duplicate determinations were very nearly the same (Table V, Figs. 2—5). This suggests that both examiners were using the same scoring technique. Thus the calculations regarding the average error of the method seem to be adequately made by using the formula

$$s = \sqrt{\frac{\sum d^2}{2k}}$$

On the basis of the standard deviations thus calculated (Table VI), it can be seen that the error in estimating the prevalence of dental caries (DMFS- or DMF-index) is of the same magnitude as that found in reporting the number of erupted teeth. The lowest degree of variation between the examiners was surprisingly found in the estimation of the degree of mottled enamel.

The reliability of the results was positively influenced by examining the total population in the particular eleven year old age group in the nine communes of residence covered by this study. A similar effect was achieved by the distribution of the material according to the five fluoride concentration groups (Tables III and VIII), and not only according to the site of residence (Table VII). The material was rendered as homogeneous as possible by choosing a single age-group, and by excluding the non-continuous residents and the group for which the fluoride concentration remained unknown (Table I).

The findings in relation to the fluoride concentration showed a highly significant difference between the fluoride concentration groups with regard to the prevalence of dental caries as estimated by the DMFS-index ($P < 0.001$), DMF-index ($P < 0.001$), and the DMFS-index covering separately the incisors and canines ($P < 0.001$), premolars ($P < 0.001$) and molars ($P < 0.001$) (Table XI). Thus the inverse relationship between prevalence of dental caries and fluoride concentration was clearly established (Tables VIII and IX, Figs. 6, 7, 9—11).

Table XIII.

Dean index of fluorosis on a single tooth basis in relation to fluoride concentration groups.

Fluoride concentration	Modified Dean index of fluorosis
0.00 — 0.10	0.29
0.11 — 0.39	0.33
0.40 — 0.99	0.41
1.00 — 1.59	0.68
1.60 —	0.95

A highly significant difference was also found between the fluoride concentration groups in relation to the degree of mottling of the teeth ($P < 0.001$) (Tables VIII and XI, Figs. 14 and 15). It should be noted, however, that the particular index used when estimating the degree of dental fluorosis, yielded much higher values than the commonly used Dean index (*Dean 1938; Hodge 1950*). The point prevalence rates, as indicated in Fig. 15, were used to transform the index of fluorosis values to corresponding Dean index values. The latter are, however, stated here on a single tooth basis and therefore give too high readings (Table XIII). This can directly be seen from the transformed value 0.29 in the 0.00—0.10 fluoride concentration group. Even so, the degree of mottling, as observed in the present study, remained at a very low level and yielded results between "very mild" and "normal" in all five fluoride concentration groups.

No differences between the fluoride concentration groups were found with regard to the variables related to the number of teeth. A closer study between selected fluoride concentration groups (Table XII) revealed, however, that the number of erupted teeth was significantly smaller in the 1.60— group than in the 0.40—0.99 group ($P < 0.01$). The same tendency was observed in connection with the number of erupted premolars ($P < 0.05$).

It was anticipated that the retention of deciduous molars could be related to the slightly delayed eruption of permanent teeth in the highest fluoride group. The numbers of retained deciduous molars in the different fluoride concentration groups were there-

fore compared. It was found that the number of retained deciduous molars was slightly higher in the high fluoride group than in the middle group ($P < 0.05$). On the other hand, a slight tendency to slow eruption rate of permanent second molars was found upon comparison of the 1.60— group and the 0.40—0.99 groups. This difference, however, was not significant.

The results regarding the number of erupted teeth and the number of retained deciduous teeth suggest that the eruption rate of the permanent teeth is slightly delayed at high fluoride concentrations. On the other hand, the results also suggest that the eruption of the permanent teeth might be slightly accelerated at a moderate level (0.40—0.99 mg/l) of water fluoride.

Sex differences were found only with regard to the number of erupted permanent teeth ($P < 0.001$), the number of erupted premolars ($P < 0.001$), and the number of erupted second molars ($P < 0.01$) (Table X). No other differences between the sexes were observed with respect to the variables studied.

SUMMARY

The material consisted of 983 children aged eleven years. These children were residents of at least 6-years' standing in nine communes with varying fluoride levels in the drinking water. The dental examinations were carried out as a blind study, the examiners having no information of the fluoride concentrations in the communes studied. Duplicate clinical examinations were made in one third of the material.

The determination of the fluoride content of the drinking water was carried out by obtaining a 250 cc sample from every child examined. The great majority of these samples consisted of water from wells. By these means it was possible to group the children (1) according to the site of residence, and (2) according to the fluoride concentration. The material was thus divided into five groups, the fluoride concentration ranges being 0.00—0.10, 0.11—0.39, 0.40—0.99, 1.00—1.59 and 1.60— mg/l (= p.p.m.).

(1) It was found that the error of the method in estimating the prevalence of dental caries (DMFS- or DMF-index) was of the same magnitude as when recording the number of erupted teeth.

The lowest degree of variation between the examiners was observed in the estimation of the degree of mottled enamel.

(2) There was a highly significant inverse relationship between prevalence of dental caries and fluoride concentration. This correlation was found between all five fluoride groups mentioned above ($P < 0.001$).

(3) No significant difference in caries prevalence between boys and girls was observed when using the DMFS- and DMF-indexes. The number of erupted teeth, however, was significantly higher in girls ($P < 0.001$).

(4) A retardation of the eruption rate was observed only between the 1.60— mg/l and 0.40—0.99 mg/l groups ($P < 0.01$). The number of retained deciduous molars was correspondingly higher in the high fluoride concentration group ($P < 0.05$). A difference in the eruption rate of the second permanent molars was not significant.

(5) A highly significant relationship ($P < 0.001$) was found between the prevalence of enamel opacities and high fluoride concentration. The degree of mottling was at a very low level in all five fluoride concentration groups.

RÉSUMÉ

FRÉQUENCE GLOBALE DE LA CARIE ET SANTÉ DENTAIRE EN RELATION AVEC LA VARIATION DE CONCENTRATION DES FLUORIDES DANS L'EAU DE BOISSON

ETUDE CLINIQUE SUR DES ÉCOLIERS DE FINLANDE

Le matériel d'observation a été constitué par 983 enfants âgés de 11 ans. Ces enfants avaient résidé 6 mois au moins dans 9 communes dans lesquelles l'eau de boisson présentait des niveaux de fluorides variables. Les examens dentaires ont été effectués sous forme de recherche "aveugle", les examinateurs ignorant la concentration en fluorides dans les communes étudiées. Un examen clinique double a eu lieu dans le tiers des cas.

La détermination de la teneur en fluorides de l'eau de boisson a été effectuée sur un échantillon d'eau de 250 cc fourni par chaque enfant examiné. La grande majorité de ces échantillons était de l'eau de puits. Sur ces données il a été possible de grouper les

enfants 1) d'après leur lieu de résidence et 2) d'après la concentration en fluorides. Le matériel d'observation a ainsi été divisé en cinq groupes, les concentrations allant de 0.00 à 0.10, de 0.11 à 0.39, de 0.40 à 0.99, de 1.00 à 1.59 et de 1.60 mg/l (= p.p.m.).

1. On a constaté que l'erreur d'estimation de la fréquence de la carie dentaire (index DMFS ou DMF) était de la même grandeur que pour le rapport des dents sorties. Le degré de variation le plus bas entre les différents examinants a été observé dans l'estimation du degré de tachètement de l'émail.

2. Il y a un rapport inversement proportionnel hautement significatif entre l'existence de la carie dentaire et de la concentration en fluorides. Cette corrélation a été constatée entre les 5 groupes ci-dessus mentionnés ($P < 0.001$).

3. On n'a constaté aucune différence significative de carie dentaire entre les garçons et les filles quand les index DMFS et DMF ont été employés. Le nombre des dents sorties était cependant plus élevé chez les filles ($P < 0.001$).

4. Un retard de la sortie des dents a été observé seulement dans les groupes 1.60— mg/l et 0.40—0.99 mg/l ($P < 0.01$). Le nombre des molaires temporaires était plus élevé dans le groupe de haute concentration en fluorides ($P < 0.05$). La différence dans la sortie des molaires permanentes n'est pas significative.

5. Une relation hautement significative ($P < 0.001$) a été constatée entre la fréquence d'opacité de l'émail et une forte concentration en fluorides. Le degré de tachètement était très bas dans les 5 groupes.

ZUSAMMENFASSUNG

KARIESVERBREITUNG UND GESUNDHEIT DER ZÄHNE IM VERHÄLTNIS ZUR FLUORKONZENTRATION DES TRINKWASSERS

AN FINNISCHEN KINDERN DURCHFÜHRTE KLINISCHE UNTERSUCHUNG

Das Untersuchungsmaterial umfasste 983 11-jährige Kinder, die seit mindestens 6 Jahren in 9 verschiedenen Gemeinden mit verschieden starkem Fluorgehalt des Trinkwassers lebten. Die Durchführung der Zahnuntersuchungen geschah im Blindverfahren; der Fluorgehalt des Trinkwassers der jeweiligen Ge-

meinde war den Untersuchenden nicht bekannt. Ein Drittel des Untersuchungsmaterials wurde ausserdem einer klinischen Nachuntersuchung unterworfen.

Zwecks Bestimmung des Fluorgehaltes lieferte jedes Kind den Untersuchenden eine Probe von je 250 cm³ Trinkwasser, meistens Brunnenwasser. Auf diese Art wurde die Einteilung des Materials 1) mit Berücksichtigung des Wohnortes und 2) mit Berücksichtigung des Fluorgehalts ermöglicht und das gesamte Material in fünf Gruppen eingeteilt, wobei der Fluorgehalt folgender war: 0.00—0.10, 0.11—0.39, 0.40—0.99, 1.00—1.59 und 1.60— mg/l (= p.p.m.).

1. Es wurde festgestellt, dass die Untersuchungsfehler sowohl beim Bestimmen der Zahnkariesfrequenz (DMFS- oder DMF-Index) als bei der Angabe der Anzahl durchgebrochener Zähne einander entsprachen. Am wenigsten unterschieden sich die Ergebnisse der Untersuchenden voneinander in der Bestimmung des Grades der Zahnfluorose.

2. Ein äusserst signifikantes umgekehrtes Verhältnis zwischen Kariesverbreitung und Fluorkonzentration wurde festgestellt. Dies Verhältnis bestand zwischen sämtlichen obenerwähnten Fluorgruppen. ($P < 0.001$).

3. Unter Verwendung des DMFS- und DMF-Indexes konnte kein signifikanter Unterschied zwischen der Kariesverbreitung bei Jungen und Mädchen festgestellt werden. Bei den Mädchen aber wurde eine bedeutend grössere Anzahl durchgebrochener Zähne beobachtet. ($P < 0.001$).

4. Eine Verzögerung des Zahndurchbruchs wurde nur zwischen den Gruppen 1.60— mg/l und 0.44—0.99 mg/l beobachtet ($P < 0.01$). Die Anzahl nicht abgegangenen Molaren im Milchgebiss war in der Gruppe mit hohem Fluorgehalt entsprechend grösser ($P < 0.05$). Dem Unterschied in dem Durchbruchsgrad der zweiten bleibenden Molaren wurde keine Signifikanz zugesprochen.

5. Zwischen dem Vorkommen von Fleckenbildung des Zahnschmelzes und hoher Fluorkonzentration wurde eine höchst signifikante Beziehung festgestellt. In allen vorhin erwähnten Fluorgruppen bestand Fleckenbildung in äusserst geringem Ausmass.

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