Decrease in the Incidence of Dental Caries in 6—7 Years Old Copenhagen Elementary School Children 1936—1943.

By

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During recent years Danish dentists have undertaken a number of investigations of the caries incidence in children both in Copenhagen (6, 19, 20), in provincial towns (1, 2) and in rural districts (14, 18). These investigations have disclosed an extensive carious destruction of the teeth of the children.

In all instances the object has been to establish the immediate caries incidence within groups of children. Hence the investigations do not disclose whether the caries frequency has remained unchanged, or whether it has been increasing or decreasing. In other words, nothing is learned regarding the development which may have occurred.

In Copenhagen, the Dental Service available to the Elementary School children has taken into account the importance of tracing the development of the caries frequency, and throughout a number of years data have been accumulated to elucidate this important question. It has now been decided to analyse the material, which comprises 57,000 children.

Since 1936 uniform examinations have been made each year of the teeth of about 7,000 children entering the 1st class.[1] The examination was made before dental treatment and during the time May—June to about the 1st of November, the age of the children being 6—7 years. During the period 1936—1943 the average age shows a tendency to increase, though the increase does not exceed 1 month.

[1] During the period 1936—1943 the percentage of school children subject to Dental Service has increased steadily from 94.4 to 96.1.

The annual investigation has been carried out by 35—50 School Dentists, but only some of these have been steadily employed in this work throughout the years considered. Consequently some variation as to the recording of incipient carious lesions was inevitable. But this circumstance is of minor importance as regards the present investigation, just as it is inessential to an investigation of the development of the caries incidence whether the diagnosis rests on more radical or more conservative ideas, as long as the *same* criterion is applied throughout the entire period. The directions have not been changed during the years mentioned and one may regard as entirely out of the question that the participating dentists lately should have recorded fewer incipient carious lesions than before. The opposite tendency would perhaps be more probable, since the number of children per dentist has diminished considerably during the period in question.

Table 1 shows the results of the investigation covering the years 1936—1943. Column I shows the number and percentage of children without dental caries. Columns II—V show the numbers and percentages of carious (respectively non-carious) teeth in the children examined, in accordance with the methods generally applied in this kind of statistical investigations.

When it is desired to evaluate the variations from year to year, it is necessary to know the uncertainty of the percentages involved; but this uncertainty cannot be calculated in the present case. The usual calculation of the standard deviation requires that the observations (*i. e.*, whether each of the teeth examined is carious or not) are mutually independent. It is a well known fact, however, that if one tooth in a mouth has become carious, the chances of carious attacks in other teeth in the same mouth — especially certain of these other teeth — will increase to a substantial degree. Thus the observations are not mutually independent (cf. 19, p. 651, 1, p. 602, and 20, p. 493). The strong correlation causes the standard deviation calculated according to the usual formula to be far too small. Only more detailed information as to the individual teeth, and a more comprehensive analysis of these data, will make it possible to disclose the actual magnitude of the standard deviation. Hence there is reason to try to solve the problem along different lines:

With regard to the children without caries (column I) we may ignore the difficulties mentioned. Here we are not dealing with correlated observations — it is the children that have been count-

Table 1.

Incidence of dental caries 1936—1943 in Copenhagen Elementary School children, aged 6—7 years.

Year	Number of children examined	I Children without caries		II First permanent molars			III Deciduous molars		IV Deciduous molars		V Deciduous molars						Year
				No. erupted	With caries		Without caries		With light caries		With severe caries		Previously extracted		Total severe caries		
		No.	Percentage		No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	
1936	6977	172	2.47	22581	7869	34.85	12855	23.03	14811	26.54	25918	46.43	2232	4.00	28150	50.43	1936
1937	7163	161	2.25	23691	8309	35.07	13190	23.02	17164	29.95	24588	42.91	2362	4.12	26950	47.03	1937
1938	6929	202	2.92	22842	7516	32.90	13229	23.87	17568	31.69	22618	40.80	2017	3.64	24635	44.44	1938
1939	6057	171	2.82	20029	5831	29.11	12216	25.21	16826	34.72	17775	36.68	1639	3.38	19414	40.07	1939
1940	6529	216	3.31	21415	6036	28.19	13439	25.73	18540	35.50	18424	35.27	1829	3.50	20253	38.78	1940
1941	7591	311	4.10	25059	6707	26.76	17050	28.08	20977	34.54	20527	33.80	2170	3.57	22697	37.38	1941
1942	7748	349	4.50	25899	6595	25.46	18734	30.22	20238	32.65	20928	33.76	2084	3.36	23012	37.13	1942
1943	7907	424	5.36	25997	6412	24.66	20280	32.06	21377	33.80	19334	30.57	2259	3.57	21593	34.14	1943

Table 2.

Estimates of the constants in the parabolae describing the reduction of caries experience during the period 1936—1943 in Copenhagen Elementary School children, aged 6—7 years.

Column (table 1)	a	b	Standard deviation (b)	t	f	P	c	Standard deviation (c)	t	P
							$10^4\times$	$10^4\times$		
I.....	3.16 %	+0.42	0.030	14.2	5	$\leqslant$0.1 %	5.86	1.49	3.93	2—1 %
II.....	29.27 %	—1.65	0.150	11.0	5	$\leqslant$0.1 %	6.92	7.61	0.91	40 %
III.....	25.51 %	+1.34	0.052	25.5	5	$\leqslant$0.1 %	16.86	2.62	6.43	1—0.1 %
IV.....	34.45 %	+0.88	0.157	5.6	5	1—0.1 %	—38.58	7.83	—4.92	1—0.1 %
V.....	40.03 %	—2.21	0.138	16.1	5	$\leqslant$0.1 %	21.70	6.88	3.15	5—2 %

ed. It is possible to make a direct comparison between 1936 and 1943, showing that the percentage of children with non-carious teeth in 1943 lies about 9.0 × the standard deviation above the percentage for 1936. Taken together with the unmistakably increasing tendency during the years of investigation, this must be recognized as proof of *a noticeable improvement of the caries level from 1936 to 1943.*

However, the relative number of children with carious teeth is not a satisfactory expression of the caries incidence. A better

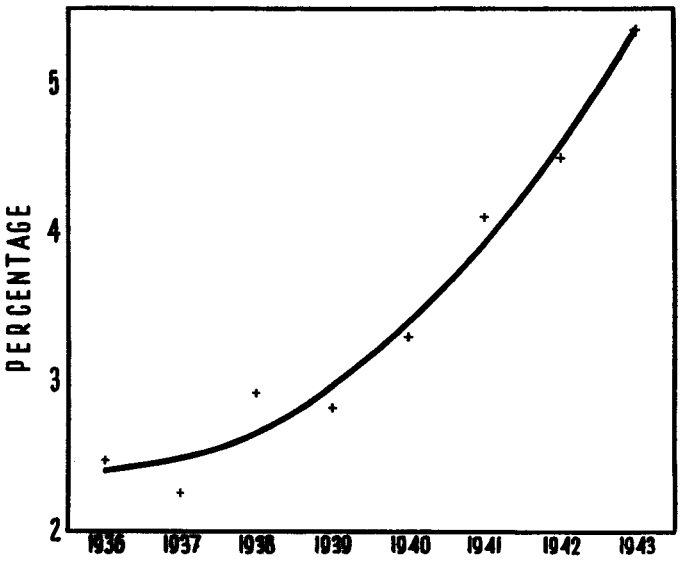

Fig. 1. Percentage of caries-free Copenhagen Elementary School children, aged 6—7 years. 1936—1943.

expression is found in the number of the carious (respectively non-carious) teeth as recorded in table 1, columns II—V. Moreover, it is desired to study the development within the period from 1936 to 1943, and not merely compare the findings at the extremes of this period. Hence we look upon the problem in a different light, aiming to investigate directly whether there is a continuous fall in the caries incidence during the whole period, or the fall is more or less confined to a chance development in 1943. This point of view may be applied to all columns in table 1, inasmuch as it is independent of the correlation previously mentioned.

Accordingly, the percentages are plotted against the years in

question. It is then seen (figs. 1—5) that the points are located about simple curves. The simplest curve to reckon with is a parabola:

$$y = \alpha + \beta x + \gamma x^2$$

where x denotes the times — *e. g.*, measured from the middle of 1939 — and y the percentages in the particular columns, while α, β and γ are coefficients that determine the course of the parabola. α characterizes the level; β denotes the rate at which the

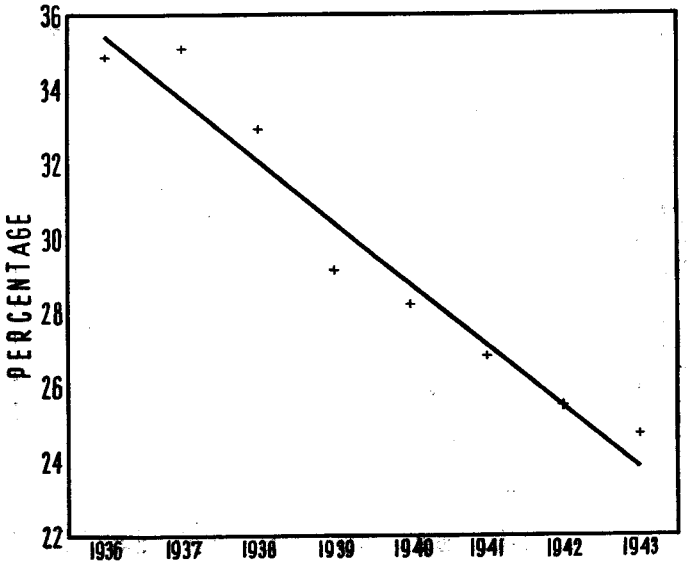

Fig. 2. Percentage of carious first permanent molars in Copenhagen Elementary School children, aged 6—7 years. 1936—1943.

process on the average progresses (more definitely, the rate at the mid-point of the whole period); 2γ is the acceleration, *i. e.*, the increase in rate per year.

Table 2 presents a review of the estimates a, b and c of α, β and γ together with a statistical evaluation of their uncertainty through a calculation of their standard deviations.[1] t is the ratio between b or c and the standard deviation of these quantities, and f is the number of degrees of freedom. P denotes the probability of getting as large values of t as those found by us, provided the

[1] Regarding these calculations, se R. A. FISHER (7, § 27 and 28).

true values of β and γ were 0, *i. e.*, provided no changes had occurred in the course of the years.

Since b in all cases is significantly different from 0, we have in this way found a new — and both safer and more detailed — proof that *the condition actually has improved* during the 8 years of investigation, inasmuch as the children with non-carious teeth has increased, the number of carious first permanent molars has decreased, the number of non-carious deciduous molars has increased, and the number of deciduous molars with severe caries (including extracted deciduous molars) has decreased. The spe-

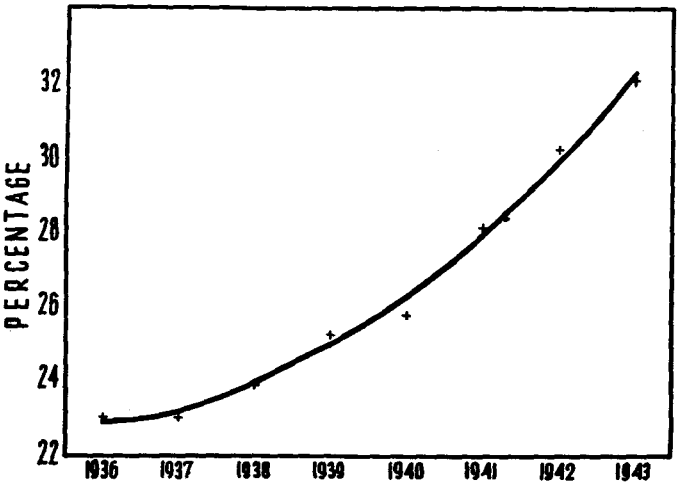

Fig. 3. Percentage of non-carious deciduous molars in Copenhagen Elementary School children, aged 6—7 years. 1936—1943.

cial course of the curve for the deciduous molars with light caries is, as later will be explained, an additional proof of the retrogression of the carious attacks.

As far as γ is concerned it is seen that the estimate, c, in all cases except II deviates significantly from 0 (limit of significance $P = 5$ per cent). This means that we cannot regard as constant the rate at which the number of children with non-carious teeth (I) and the number of non-carious deciduous molars (III) increases. Here we have a progressive process — *a decrease in caries at increasing rate.* The rate at which the improvement has occurred is slight during the years 1936—1938, but has become so pronounced during the later years that there can be no doubt about it. With regard to the percentage of carious first permanent molars (II)

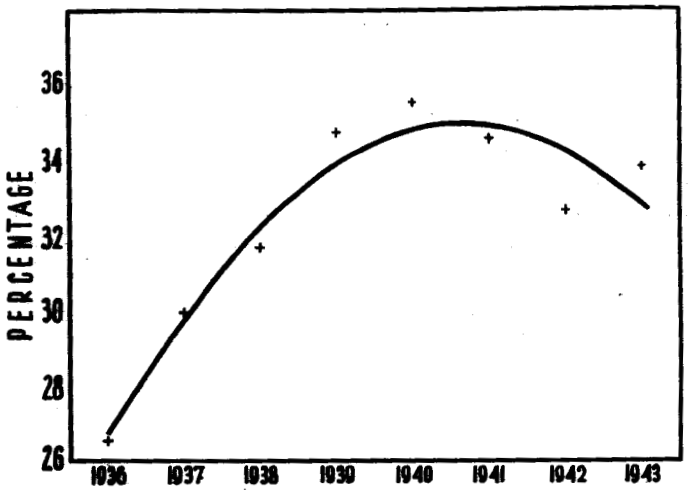

Fig. 4. Percentage of deciduous molars with light caries in Copenhagen Elementary School children, aged 6—7 years. 1936—1943.

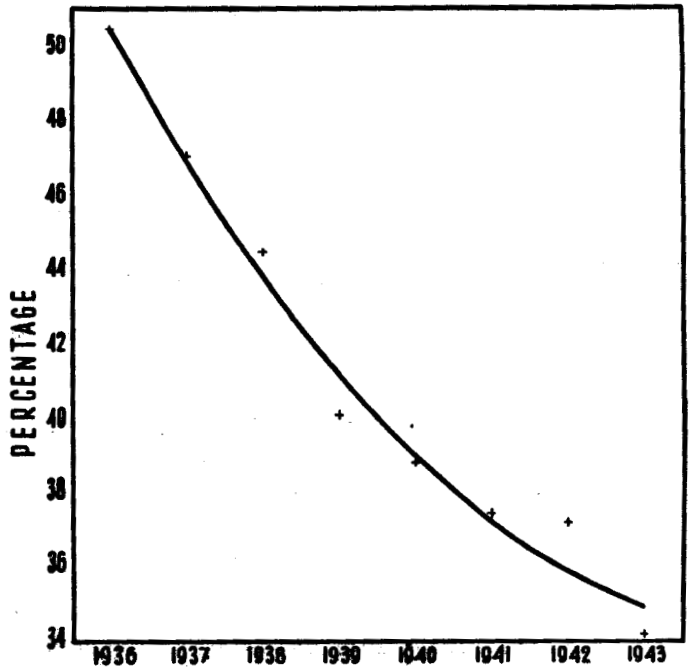

Fig. 5. Percentage of deciduous molars with severe caries in Copenhagen Elementary School children, aged 6—7 years. 1936—1943.

one cannot claim that the fall increases from year to year, inasmuch as c in this case does not deviate significantly from 0.

That the improvement was well under way as early as in 1936—1939 is plainly seen from the numbers of the deciduous molars with severe dental caries (V) and the numbers of those with lighter carious lesions (IV). The number of severe carious lesions diminished strongly already from 1936. This did not mean, though, that the severe cases were eliminated, but that dental caries on the whole took a turn for the better. This caused an increase in the number of milder cases. Gradually as the improvement progressed, the total number of carious lesions became less, and the increase of the milder cases at the expense of severe cases was counteracted by the increase of non-carious cases at the expense of light caries cases. During the last years, however, the rate at which the severe cases (V) diminished in number was somewhat lessened (this, in case of a falling curve, is indicated by the positive c), and, correspondingly, the decrease of the milder cases (IV) has become so dominant that the curve representing these cases passes a maximum and begins to fall (compare the negative c).

Before definitely accepting what has been said above, one should consider whether it is at all possible that this reduction in caries incidence should not correspond to actual conditions. One might regard it as wholly or in part attributable to sources of error like changes in the age of the children, time of examination, or the like. This idea would be wrong, however. Both the previously mentioned very slight movement towards higher age of the children attending 1st class, as well as changes in the intensity of investigation — if such changes occur at all — would result in the recording of relatively *more* carious lesions at the end than at the beginning of the period. Both possible sources of error would therefore be in disfavour of the development demonstrated. Finally, it should be mentioned that the time of examination has not been subject to any displacement, and it is especially precluded that the examination should have been made at an earlier date during the later years. Thus it will be seen that the factors just mentioned hardly can explain, wholly or in part, the reduction in dental caries. Hence there is every reason to regard this reduction as a fact — so much more as a similar development has been observed in other countries.

Naturally, it is of the very greatest importance whether the favourable development can be maintained. Only continued investigations will show whether this is possible. Of interest in this connection are observations made in Norway, Sweden, England and Germany during the two world wars and in the interim between the wars. These observations contribute at the same time to some degree towards elucidating the causes of the decrease in caries observed by us. They will be reviewed in the following.

Norway.

After the first world war JACOB RAMM (21) published a paper on the decrease in the caries incidence in 7 years old children in Rjukan. RAMM was the first to publish material of this kind. It was not very comprehensive (198 children examined in 1917—1918, and 216 in 1918—1919), but shows an unmistakable decrease in dental caries during the period 1918—1919. During this year the children — their permanent teeth erupting "had not had access to sweets, and lived on coarse bread made from unbolted flour, with little coffee". Unfortunately, the investigation does not seem to have been continued during the following years.

The most important contribution to our knowledge regarding the caries development in a large number of children is likewise Norwegian. It comes from the Dental Service of the Elementary Schools in Oslo. The Chief of this Service, T. GYTHFELDT, is the first to have published well controlled continuous caries investigations of children aged 6—7 years, and covering a period as long as from 1929 to 1943. GYTHFELDT (10) records carious lesions per 100 permanent teeth in 2,500—3,000 children each year. The results are shown in Fig. 6.

Fig. 6. Incidence of dental caries in Oslo Elementary School children, aged 6—7 years, according to GYTHFELDT. 1929/30—1942/43. Carious lesions per 100 permanent teeth.

GYTHFELDT mentions two "maxima" prior to the time when our investigations begin, and explains (10, Report 1940—1941) that "of the two peaks, the first one in 1932—1933 probably is due to the widespread unemployment at that time, accompanied by low income and poor nutrition. The pronounced peak in 1936—1937 should presumably also be due to the unemployment, since the children then attending the 1st class were infants in 1932—1933, or the mothers at that time were pregnant."

For the period during which the investigations in Oslo and Copenhagen are contemporary, the same development is found in both places, namely a pronounced decline in the caries incidence. It is impossible on the basis of available data to decide whether the decrease in Oslo follows exactly the same line as in Copenhagen. It is striking that in Oslo there is a strong fall from 1940—1941 to 1941—1942 — and — especially — that the decline (which began in the late Thirties) thereafter (1941—1942 to 1942—1943) seems to have been arrested.

In his report for 1940—1941 GYTHFELDT (10) explains that the decrease is particularly pronounced during the last 3 years "in spite of the rationing". At this time the restrictions were not so severe, however; the children still received milk. GYTHFELDT also mentions the intensive propaganda for better nutrition as a possible cause of the decline in the caries frequency in the Oslo children. In an earlier paper GYTHFELDT, on the basis of a smaller material, has given evidence of the caries-reducing influence of rational attempts to improve oral hygiene (9, p. 832). In his report for 1942—1943 he finally demonstrates a very considerable decrease in the amount of caries in the permanent teeth of children whose deciduous teeth have been systematically treated from the age of 3, a comparison being made with children who had not, or only to a slight degree, received dental treatment before school age.

Sweden.

Contemporary with RAMM's observations are those made by V. BENSOW in Gothenburg, published in 1919 and based on a much larger material. During the period ranging from 1914—1915 to 1918—1919 BENSOW (4) annually examined about 2,900 children (7 years of age). The caries incidence remained approximately constant during the first 3 years, but showed a considerable decrease during the last 2 years of investigation. The number of fillings per 100 children in the 1st class were: In 1914—1915, 449; in 1915—1916, 475; in 1916—1917, 450 in 1917—1918, 398; 1918—1919, 329. In the higher classes the decrease was greater — *e. g.*, in the 3rd class, 1914—1915, 413 fillings per 100 children, and in 1918—1919 only 128.

BENSOW (4, p. 269) is of the opinion that during the war years, especially the last two, "the limited access to sugar, pastry and chocolate" contributed to the caries reduction, and he attributes the greatest importance to "the supply of calcium and other mineralsalts which the body received during the last two war years". He adds that "before the bread rationing and the prohibition of flour sifting, which

were introduced in 1917, the consumption in Gothenburg was said to be about 90 per cent of wheat flour and about 10 per cent of rye flour — nearly all of it finely bolted."

It is unfortunate that BENSOW — the significance of whose work the Norwegian JOHAN BRUN tirelessly has emphasized — was not able to realize his plan of publishing results of continued investigations after the war.

SVEN V. SNEIDERN, for many years Chief of Dental Service for School-children in Gothenburg, has recently stated that the caries incidence "in the course of a few years" returned to the same level as before the first world war, but that it was not until 1927 that "normal conditions" were reestablished. V. SNEIDERN (23) has reported the filling frequencies for the years from 1935—1936 to 1943—1944 and finds for the children attending 1st class that the number of fillings per child remains unchanged between 4 and 4.4 from 1935—1936 to 1941—1942. For 1942—1943 the figure is 3.4, for 1943—1944 3.2. In older children the caries reduction is more pronounced. That it does not reach the same magnitude as during the first world war is, according to V. SNEIDERN, due to the circumstance that the restrictions in Sweden are less rigid during the present war.

In 100—150 children in each of the 6 treated school classes in Leksand (Dalarna), Sweden, ALBERT MOLAND (17) has on the average filled a smaller number of permanent teeth in 1943—1944 than in the preceding 4 years. In the case of 1st class the average number per child was 0.94 in 1939—1940; in 1943—1944 it was 0.30 per child. Somewhat similar data are reported by ERIC SKUNKE (22) in Åls (near Leksand). Here the corresponding figures were 1.13 in 1939—1940 against 0.62 in 1943—1944. (Number of children not stated.)

England

Interesting observations — which generally have been ignored in the Scandinavian literature — have been made during the first world war in Shropshire, England, by the School Medical Officer JAMES WHEATLEY (25). In 1920 he reported results of the examination of 37,527 children before the war (the years 1910—1914) and of 10,593 children after the war (the years 1919—1920). During the period prior to the war the caries frequency showed a steady increase, but during the war a very pronounced decline occurred. In 1910—1914 on the average 5 per cent of the 5 years old children were free from caries, in 1919—1920 the percentage was 44.4. The average number of carious teeth was 6.4 in the 5 years old during the period 1910—1914. In 1919—1920 it had fallen to 2.1. No investigation seems to have been made of the actual development within the four years of war. As regards the cause of the decline in caries incidence WHEATLEY says (25, p. 758): "In the first place I attribute it to the restrictions and modifications of food during the war, affecting principally sugar, bread, and milk; and in the second place to the energetic educational campaign carried out in the County of Salop by health visitors, medical officers, teachers, and others."

About the middle of 1944, MAY MELLANBY and HELEN COUMOULUS

(16) published the results of a comparative investigation — 1929 and 1943 — on the tooth structure and caries frequency in 5 years old children from Elementary Schools in London. 1,139 children were examined in 1929 and 1,571 in 1943. The authors find an improvement in the surface structure (perfect structure, *i. e.*, no M-hypoplasia, in 8 per cent of the children in 1929 and in 19 per cent of the children in 1943) as well as a reduction in the caries frequency: 5 per cent caries-free children in 1929 and 22 per cent in 1943; "severe caries" in 62.8 per cent of the children in 1929 and in 29.3 per cent in 1943.

The treatment of the results must be regarded as preliminary. The investigation is interesting, though, in connection with those mentioned above, showing the same ultimate result. It is of special interest in that it includes the structure of the teeth which not previously has been considered from this angle. The simultaneousness with respect to improvement of structure and decline in caries frequency is fully in line with the idea of the importance of the surface structure in caries-etiological respect, strongly emphasized by a number of English writers.

The authors rather thoroughly discuss the causes of the improvement in structure and decrease in caries frequency. They consider it probable that both phenomena are due to "the changes in the feeding habits which have been developing in recent years — in particular the introduction in 1934 of the cheap milk scheme of the Milk Marketing Board and lately to the wartime food policy". In the case of the latter they emphasize especially: 1) Increased rations of milk together with cod-liver oil and fruit juice for pregnant and nursing women, infants and young children, 2) the addition of vitamins A and D_2 to the margarine, and, 3) the addition of calcium carbonate to the bread.

Germany.

Here we have at the least 2 investigations — one from Offenbach a. M. and from Nürnberg. We have not had access to the original papers, but quote from an extract made by JOHAN BRUN (5).

A. WIMMENAUER (26), who was Town Physician in Offenbach a. M., observed towards the close of the Twenties that the school childrens' teeth became increasingly bad. This made him investigate the caries development during the period ranging from 1921—1922 to 1927—1928 on the basis of the records of the annual reports of the Dental Clinics for school children. He found that the percentage of children with carious teeth in the 1st classes, in the case of the boys, was 37.5 in 1921—1922 and 72 in 1927—1928, and in the case of the girls 33.8 in 1921—1922 and 77.2 in 1927—1928. Children whose dental development fell within the war years 1914—1916 were more often caries-free than children whose dental development took place during the time after the war. WIMMENAUER maintains that the lack of sugar[1] and the nature of the bread during the first years of the war decisively influenced this development.

[1] With regard to the sugar consumption in Germany during 1914—1918 WIMMENAUER seems to have been poorly informed, since the consumption undoubtedly was the lowest during the last years of the war (cf. v. GORDON, 8, p. 89).

R. BANDEL, Town Physician in the City of Nürnberg, supplemented WIMMENAUER's inquiry with an investigation of the caries frequency through all the years from 1909—1910 to 1927—1928. For school children in the 1st class his investigation (3) showed that the caries frequency (stated as percentage of children "without caries", "with caries", and "with severe caries") was very high from 1911 to 1913. Then it fell during the war and continued to fall until 1923—1924 when it reached its lowest level. From 1924 the frequency again rose to a considerable degree, and the rise continued until the end of the period of investigation. The rise from 1923—1924 to 1924—1925 was particularly great.

It will be seen that the investigations are of two types. The first type deals with observations of the caries incidence during a number of years. Within this type we find three categories: 1) Observations exclusively made during the first world war (RAMM, BENSOW) or exclusively during the second world war (MOLAND, SKUNKE), 2) observations before, during and after the first world war (BANDEL) or before and during the second world war (GYTHFELDT, v. SNEIDERN, KROHN and PEDERSEN), and, 3) observations during the period between the two world wars (WIMMENAUER). The second type includes investigations which, leaving out several years, compares the caries incidence at different times (WHEATLEY, MELLANBY and COUMOULOS).

The last mentioned investigations are limited in their significance when the problem is that of studying a *development*, since they do not show possible fluctuations in the years between the investigations. The advantage in this respect of the continuous investigation is obvious, and it is likewise plain that the value increases with the extension in time of the investigation. It is much to be regretted that the important observations of caries reduction during the last years of the first world war were not continued during the ensuing years. A continuation of these observations to date would have been of the very greatest importance.

Since Dental Health Service for school children later has been introduced and made effective in many countries — including such countries which have been exposed to gigantic and extremely radical "nutritional experiments" during the present world war — it is to be hoped for that many observations have been made before and during this war.[1] Moreover, one may hope that the caries development in the years following the second world war

[1] To our knowledge, comprehensive investigations have been carried out in Norway under the direction of Professor Dr. phil. GUTTORM TOVERUD.

will be observed to a far greater extent than before. It is also to be hoped for that reliable information will be available regarding the varying nature and degree of the restrictions in the countries directly touched by the war, in comparison with the fairly normal conditions in the few relatively unaffected countries, so that this information may be utilized in the interpretation of the development of the caries incidence.

Although we believe that time is not ripe for an adequate explanation of the decrease in caries incidence in 6—7 years old Copenhagen School children with which we have dealt in the present paper, we shall nevertheless attempt to point to certain probable causes, relying on observations made by others and by ourselves.

The caries development observed in Copenhagen School children seems to show an even and steady decline which — at least in so far as the deciduous teeth are concerned — lately has increased in rate under the influence of certain accelerating factors.

Since 1936 (and perhaps before) conditions have prevailed which to a steadily increasing degree have counteracted the caries susceptibility — and/or the intensity of attack.

According to present opinion, increased *caries resistance* is gained especially by improved nutrition of mother and child, first of all during the tooth formation, but perhaps also in the period following. A primary result of improved nutrition is a better dental structure and along with that a greater caries resistance (MAY MELLANBY (15) and others). But some development of caries resistance due to the nutrition after the eruption of the teeth is also possible.

It must be admitted that the concept "improved nutrition" is rather vague. Our present knowledge, however, does not enable us to go into details, but we do know that the nutrition at any rate must be sufficient with respect to mineral substances and fat-soluble vitamins which are of direct importance to the tooth formation and perhaps also may affect the caries resistance later on. A certain regularity and orderliness of diet should also be of significance.

In order to overcome the resistance to carious attacks, *caries-releasing factors* of a suitable intensity are needed. Here fermentable carbohydrates seem to be of primary importance. Generally speaking, excessive use of sticky flour- and sugar-products is regarded as especially harmful.

There is reason to believe that a significant contribution towards

a more favourable relation between the factors that counteract caries and those that promote caries, with a gradually decreasing caries incidence as the visible result, is to be found in the hygienic progress of recent years. One may mention the advances made in the care for mother and child, especially with respect to nutrition, which, thanks to a very energetic propaganda emanating from the Health Authorities and the Physicians, has reached large parts of the population. To this should be added the activity of the Nurses in Public Service, and the progress made in the establishment of all kinds of homes for children, kindergartens, etc. That the caries incidence may be substantially reduced through the care of mother and child — *inter alia* by the means just mentioned — is established by G. TOVERUD (24, p. 643) in investigations of caries frequency at the Norwegian "Health Station" in Skedsmo near Oslo.

The plainly *increased rate* at which the caries incidence has declined during recent years is undoubtedly the result, on the one hand, of the above mentioned work of education and care, and, on the other hand, of *the changes which the war has caused in the nutrition*. It may be assumed that these conditions together have intensified resistance to dental caries and/or brought about an increased weakening of the caries promoting factors mentioned above.

What is said here should not be taken to mean that the restrictions on food of necessity must act reducing on the incidence of dental caries. (In the foregoing we have seen that GYTHFELDT finds a decline in caries "in spite of" food rationing, while others arrive at the opposite result!) However, in Denmark, as probably in most countries, wartime rationing has brought about 1) the cutting down of an excessive use of sugar and finely bolted flour (improvement of the bread as food), 2) provisions to secure essential foods (milk, various vitamins, etc.) for pregnant women and infants, and 3) a reduction in the consumption of sweets and pastry, giving increased appetite at the chief meals, and, on the whole, sounder eating habits of the children.

We still lack exact knowledge as to whether the positive or negative side of the dietary changes in this direction is the most essential. But we cannot very well ignore the significance of these changes as a whole. What we do lack is any proof that will enable us categorically to establish *one* of the factors mentioned as res-

ponsible for the increased rate of the decline in caries incidence — something which other authors claim to have found.

If an attempt is made, on the present basis, to decide whether one should give preference in caries-etiological respect to the tooth formation itself or to the conditions to which the teeth are subject after eruption, it is found impossible to arrive at any definite conclusion as regards either the deciduous molars or the first permanent molars.

Let us consider the first permanent molars. It is found that the low caries percentages of 1942 and 1943 are the result of a *united action* of the conditions prevailing during the mineralization of the dental crowns (1936—1937 and later), and the conditions after the eruption (1941—1943). If, to facilitate matters, we regard the actual mineralization period on the one hand, and, on the other, the exposure after eruption as the main factors, it will be observed that the amount of dental caries in 1942—1943 is a joint result of factors that were active in 1936—1937 and of the conditions prevailing in 1941—1943. In the case of this example we find a joint action of the general hygienic progress (especially the introduction of Public Nursing Service in 1937) and of the "war factor". No definite reason can be seen for attributing more significance to either of the two periods.

It cannot be excluded, however, that continued observations of new movements in the caries development may furnish data that will contribute to a better understanding of this question which is of great importance from the point of view of Dental Science.

The decline in the caries incidence is a distinct benefit to public health. It makes it possible by treatment to save a larger number of deciduous teeth than before. In the Dental Service rendered to school children it has not reduced, but rather *increased* the amount of work.

As distinct from all other treatments of disease, which are started as soon as the disease is recognized, the treatment of dental caries does not begin — rather unfortunately — until the time the child attends school — when caries is in full development and occasionally hopelessly advanced. It follows that the general caries reduction, dealt with in the present paper, is not fully utilized from the point of view of treatment.

If the treatment were started at the age of 3 years, it would not

only be less extensive to begin with, but the caries-preventing significance of the treatment with respect to the other teeth — a significance which is beyond doubt — would in the subsequent years be increased due to the lowered tendency towards caries on the whole. The ultimate result would be an altogether different and a better one than when the treatment, as now, is started in children with advanced caries, even though the caries is less florid than it was some years ago.

The statistical treatment of our material has been made in cooperation with Dr. phil. G. RASCH, to whom we wish to express our best thanks.

Summary.

The paper presents the results of systematic annual investigations on the incidence of dental caries in about 57,000 6—7 years old children attending Elementary Schools in Copenhagen (about 7,000 children each year) during the period from 1936 to 1943. The analysis of the data shows:

1) that the amount of dental caries in 6—7 years old children has been constantly decreasing during the period, and

2) that this decrease — at least in so far as the deciduous molars are concerned — has occurred at a constantly progressing rate during the later years.

The number of children with non-carious teeth has been increasing at a progressive rate (fig. 1).

The number of non-carious deciduous molars has been increasing at a progressive rate (fig. 3).

The number of lighter carious lesions in deciduous molars has been rising at a diminishing rate, thereafter (from about 1940) falling (fig. 4).

The number of severe carious lesions in deciduous molars has been falling at a diminishing rate (fig. 5).

In the case of the first permanent molars there has been a decrease in the amount of caries throughout the years, but no progression has been proved (fig. 2).

Norwegian, Swedish, English and German investigations on the development of dental caries, especially during and close to the two world wars, are reported. These investigations include:

1) Systematic annual investigations on dental caries in children of the same age having the benefit of Dental Service, and,

2) investigations at the interval of a number of years on children of the same age.

All investigations show a decrease in dental caries towards the end of the war periods.

The declining caries incidence which the authors of the present paper have been able to observe since the beginning of the period of investigation (1936) corresponds to the development in Oslo (fig. 6) and is presumably due to general hygienic and social progress, and an increasing understanding, especially with respect to the nutrition of mother and child. These conditions are supposed to have caused a reduction of the caries-producing factors and/or a strengthening of the factors that promote caries resistance.

The progressive rate of the caries decrease in later years is presumably due to the hygienic and social advances mentioned, in connection with the changes which the war has brought in the daily diet.

There is no basis for making any specific dietary factor responsible for the improvement observed.

Zusammenfassung.

Es werden Ergebnisse systematischer jährlicher Untersuchungen über das Kariesvorkommen bei etwa 57,000 sechs- bis siebenjährigen Kopenhagener Gemeindeschulekindern (etwa 7,000 Kindern jedes Jahr) in der Periode 1936—43 vorgelegt. Eine Analyse dieser Daten zeigt

1) *dass die Karieshäufigkeit bei sechs- bis siebenjährigen Kindern innerhalb der beobachteten Periode fortwährend gefallen ist,* und

2) *dass dieser Rückgang — wenigstens was die Milchmolaren anbelangt — während der späteren Jahre in fortwährend steigendem Tempo geschehen ist.*

Die Zahl an Kindern mit kariesfreien Zähnen hat in progressivem Tempo zugenommen (Abb. 1).

Die Zahl an kariesfreien Milchmolaren hat in progressivem Tempo zugenommen (Abb. 3).

Die Zahl an leichteren Kariesangriffen in den Milchmolaren ist in abnehmendem Tempo gestiegen, darauf (von ungefähr 1940) gefallen (Abb. 4).

Die Zahl an schweren Kariesangriffen in den Milchmolaren ist in abnehmendem Tempo gefallen (Abb. 5).

Was die Sechsjahrmolaren anbelangt, ist die Jahre hindurch ein Rückgang der Kariesmenge eingetreten; eine Progressivität liess sich jedoch nicht dokumentieren (Abb. 2).

Norwegische, schwedische, englische und deutsche Untersuchungen über die Kariesentwicklung, besonders während der beiden Weltkriege und in der Zeit darum, werden referiert. Diese Untersuchungen umfassen:

1) systematische jährliche Kariesuntersuchungen von Kindern im gleichen Alter unter Schulzahnpflege und

2) Untersuchungen mit einiger Jahre Zwischenraum von Kindern im gleichen Alter.

Alle Untersuchungen zeigen Kariesrückgang gegen Ende der Kriegsperioden.

Das abnehmende Kariesvorkommen, das die Verfasser gegenwärtiger Arbeit von Anfang der Observationsperiode an (1936) haben beobachten können, entspricht der Entwicklung in Oslo (Abb. 6) und ist anzunehmendermassen auf allgemeine hygienische und fürsorgemässige Fortschritte und zunehmendes Verständnis, insbesondere was die Ernährung bei Mutter und Kind angeht, zurückzuführen. Es ist anzunehmen, dass diese Verhältnisse eine Reduktion der karieserzeugenden und/oder eine Erstarkung der kariesresistenzbefördernden Faktoren herbeigeführt haben.

Das progressive Tempo des Kariesrückganges der späteren Jahre ist anzunehmendermassen auf die genannten hygienischen und sozialen Fortschritte in Verbindung mit den vom Kriege verursachten Änderungen in der Ernährung der Bevölkerung zurückzuführen.

Es gibt keine Grundlage, nach welcher ein bestimmter Ernährungsfaktor für die eingetretene Besserung verantwortlich gemacht werden kann.

Résumé.

On présente les résultats des investigations annuelles systématiques sur la présence de la carie chez environ 57,000 élèves des écoles municipales à Copenhague à l'âge de 6—7 ans (environ 7,000 enfants chaque année) dans la période 1936—43. L'analyse des données montre:

1) *que la fréquence de la carie chez des enfants à l'âge de 6—7 ans a été constamment en diminution dans la période d'observation,*

2) *que cette diminution — au moins en ce qui concerne les mo-*

laires de la première dentition — a eu lieu dans une progression constante pendant ces dernières années.

Le nombre des enfants avec des dents sans de la carie a été croissant dans un degré progressif (fig. 1).

Le nombre des molaires de la première dentition sans de la carie a été croissant dans un degré progressif (fig. 3).

Le nombre des atteintes légères de la carie dans les molaires de la première dentition est augmenté dans un degrée décroissant, puis (d'environ 1940) ce nombre a été en décroissance (fig. 4).

Le nombre des atteintes graves de la carie dans les molaires de la première dentition est diminué dans un degré décroissant (fig. 5).

Pour les premières molaires permanentes il a été une diminution dans la quantité de la carie en cours des années; cependant on ne pouvait documenter une progression (fig. 2).

Des investigations norvégiennes, suédoises, anglaises et allemandes sur le développement de la carie, particulièrement durant et environ les deux Grandes Guerres, sont relatées. Ces investigations comprennent:

1) des investigations annuelles systématiques de la carie chez des enfants du même âge sous la hygiène dentaire scolaire et

2) des investigations à quelques ans d'intervalles sur des enfants du même âge.

Toutes les investigations montrent une diminution de la carie vers la sortie des périodes d'hostilités.

La présence décroissante de la carie, que les auteurs de cette étude ont pu observer du commencement de la période des investigations (1936), correspond au développement à Oslo (fig. 6) et est probablement dû aux progrès généraux hygiéniques et sociaux et à une intelligence croissante, particulièrement en ce qui concerne la nutrition chez mère et enfant. Il est présumé que ces conditions ont occasioné une réduction des facteurs, qui produisent de la carie et/ou un renforcement des facteurs, qui favorisent la résistance à la carie.

Il est présumé que le rythme progressif dans la diminution de la carie pendant ces dernières années est dû aux progrès hygiéniques et sociaux mentionnés, conjointement avec les modifications dans la nutrition de la population provoquées par la guerre.

Il n'existe pas une base pour rendre un facteur particulier dans la nutrition responsable de l'amélioration, qui a eu lieu.

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