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The influence of maternal diabetes on dental development of the non-diabetic offspring in the stage of transitional dentition

By

P. Adler,* K. D. Fett,** and L. Bohátka*

* Department of Stomatology, University Medical School, Debrecen, Hungary
** Dental Service, Zentralinstitut für Diabetes »Gerhardt Katsch«
Karlsburg, GDR

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Dental development was studied in some 150 to 170 non-diabetic, 6 to 15 year-old children of diabetic mothers. As compared to standards from Hungary, and partly from the GDR, no conspicuous differences were found as to median age at loss of the individual deciduous, and at eruption of the individual permanent teeth, as well as in the numbers of erupted permanent teeth, in yearly cohorts of boys and girls. Dental development was furthermore assessed individually by comparison to a USA standard and expressed by a single figure ("character number"). The influence of some filial and maternal parameters was assessed upon the mean and distribution of these character numbers in the total sample and its subgroups, *viz.* actual body weight at dental examination, birth-weight and birth-length, classification of the mothers according to White, presence and degree of retinopathy, metabolism during pregnancy, and chronological age of the examinees. The severity of material diabetes assessed according to any of the three parameters exerted some influence upon dental development in the offspring, manifesting with increasing delay, without having found statistically significant differences between subgroups formed according to the aforementioned criteria. A statistically significant delay was demonstrated in dental development of the 8.5 to 11.5-year old group as compared with children of 12.5 to 14.5 years in whom a slight advance was demonstrated. The advance of dental development was not significant statistically in the 6.5 to 7.5 years old children. Some influence was exerted upon dental development by the actual body weight of the examinees, with a slight advance in the high body weight groups. Weight and length at delivery by themselves had no obvious effect upon dental development. As to actual body weight, birth-weight, and length at delivery, the sample was significantly different from the internationally accepted standards.

In a former study of 222 poorly controlled juvenile diabetics, age-dependent differences in median age were shown at loss of the individual deciduous, and at eruption of the individual permanent, teeth [9]. By expressing the dental development of the individual children by a single figure varying between 0 and 100, it could be demonstrated in 194 juveniles of this sample that dental development depended on the chronological age of the examinees in a statistically significant manner while the duration of overt diabetes exerted only a modifying influence; the age at which the disease was detected had no influence whatever [5]. Accordingly, it was assumed that the juvenile diabetic is born with a special constitution which is apparently capable of affecting dental development prior to the manifestation of diabetes.

In order to test this assumption, a similar study was conducted in the non-diabetic offspring of diabetic mothers. This particular population was chosen for obvious reasons. If diabetes is a genetically transmissible condition, there is a 50% chance of the transmission of the particular gene or genes responsible for the aforementioned shift in dental development. Disregarding this possibility, the offspring is exposed during pregnancy to an environment characteristic of the mother's diabetic state. While in the general population up to the age of 15 yr the frequency of diabetes amounts to approximately 0.03% [7, 16], in the offspring of diabetics the frequency is about twentyfold [11, 6]. Thus, if there is a "diabetic constitution", in the offspring of diabetic mothers it should manifest itself in some way, although in this particular population not more than a few per cent are afflicted. In these children, the inherited "diabetic constitution" turns into a manifest disease, preferentially between 3 and 4, between 6 and 8, and most markedly between 10 and 11, years of age [13, 18, 23].

Material and Methods

In the Zentralinstitut für Diabetes »Gerhardt Katsch«, dental records were collected from 169 children who proved free from manifest or latent diabetes detected by routine laboratory tests. Of this sample, 152 had been delivered in the Institute by mothers who stood under continuous control during pregnancy. Eight boys and 9 girls had been born elsewhere but were kept since birth together with their mothers under systematic control at Karlsburg like their institute-born age-mates and their mothers. Of these 152 children and their mothers, complete case records were available from the files of the Institute as to duration and severity of maternal diabetes, course of pregnancy, delivery and diseases of the children, etc. In a few cases some data were lacking; therefore, in the different analyses the number of examinees varied slightly. As to sex and age distribution, see Table II.

Dental development was assessed by comparing the number of erupted permanent teeth individually with tabulated cumulative percentages for boys and girls of each year with 0, 1, 2, etc ... 26, 27, and 28 erupted permanent teeth, in reliance on data from Hagerstown, Md. [15]. Extracted permanent teeth were counted as erupted. The mean of the upper and lower percentage limit of the cells for particular numbers of erupted teeth rounded off to the next full number was allotted to each of the examinees. In this way, their dental development was expressed by a single figure varying between 0 and 100. This figure is termed the "character number" of dental development in the individual child [8].

Median age at loss of the deciduous, and at eruption of the permanent, tooth-entities (and standard deviations) was determined graphically after conversion of the percent values of lost deciduous, and erupted permanent, units ("tooth absence" and "tooth presence" percentages, respectively) into probits. With regard to the small number of examinees in some cohorts, one third of the sum of the tooth absence or presence percentages of the particular year of age, and of the preceding and following year was taken into account (smoothing by sliding means).

Actual body weight at dental examination was chosen as another parameter of physical development. Children were grouped into seven classes in reliance on Heimedinger's figures [14]: the lowest 2.5, then up to the 10th, 25th, 75th, 90th, 97.5th percentiles, and above (actual body weight classes; in the following: WtC). Since in these tables weights are given for each half-year of age, our examinees were compared with the figures as shown for their sex and age in intervals of half-years.

As to chronological age, the last birthday was taken into account.

Weight and length of children at delivery. Since in pregnant diabetics delivery is mostly induced before term, the actual measurements of the newborn babies were compared with the corresponding standards for pregnancies of equal duration given by Lubchenco et al. [19, 20]. Accordingly, six length and weight classes (in the following: BLC and BWtC, respectively) were formed, *viz.* 1) children falling into the lowest 10 percentiles; 2) between >10 and 25; 3) between >25 and 50; 4) between >50 and 75; 5) >75 and 90; and 6) >90 percentile. Children of Class 6 whose length or weight exceeded by more than 10% the numerical values for the 90th percentile standard for the same sex and the same duration of pregnancy, were allotted to a special Subclass 6A.

Maternal diabetes was grouped according to White [22] into classes (WhC) A, B, C, D, and F. WhC E was disregarded. In this classification, the mother's history of diabetes as age at manifestation, duration (in the absence of retinopathy), and in Classes D, E and F, the presence of some complications such as retinopathy in Class D and nephropathy in Class E were taken into account. The presence and degree of retinopathy in late pregnancy were chosen as another basis for classification on the one hand, and the state of maternal metabolism during the whole course of pregnancy, on the other. As to retinopathy, freedom from it (R_0), and severity degrees 1, 2, 3 (R_1, R_2, R_3) and as to maternal metabolism a "good", "fair" and "poor" state [12] were distinguished.

Standards. Besides the aforementioned normal standards [14, 15, 19, 20], findings were compared with a selected Hungarian population sample characterized by a small proportion of children with an early loss of deciduous teeth from the "support zone" [1], with findings from Karl-Marx-Stadt prior to fluoridation of the public water supply [17] and with data of the aforementioned juveniles suffering from poorly controlled diabetes [5, 9]. In most instances, subgroups of the present sample were compared with each other.

Statistical treatment. In most comparisons, distributions of the "character numbers" were relied upon, mostly into quartiles, exceptionally into quintiles. In testing significance, a well-known modification of the χ^2 test was used by which samples unequal in size can reliably be compared [10]. In a few comparisons with well-established standards that could be regarded as the "expected frequencies", the common χ^2 test was used. Exceptionally, standard errors of the mean were relied upon. As the limit of statistical significance, $p < 0.05$ was adhered to.

Results

1. *Median ages* at loss of the deciduous, and at eruption of the permanent, teeth are summarized in Table I. In contrast to the poorly controlled juvenile diabetic groups, no consistent age-dependent deviations could be detected from the Hungarian and from the GDR standards.

The mean number of erupted permanent teeth in yearly cohorts of boys and girls is shown in Table II. As compared to the formerly examined diabetics, the mean was lower in the present population up to 9.5 (9 to

TABLE I

Median age at loss of the deciduous, and at eruption of the permanent, teeth in the non-diabetic offspring of diabetic mothers (in years: and months, and decimals of months)

Tooth unit	Boys		Girls	
	upper teeth	lower teeth	upper teeth	lower teeth
Deciduous teeth				
Central incisor	7 : 01.3 ± 1 : 01.3	6 : 02.1 ± 1 : 00.1	7 : 01.4 ± 0 : 07.7	5 : 09.2 ± 1 : 06.6
Lateral incisor	8 : 03.9 ± 1 : 03.6	7 : 00.9 ± 0 : 11.9	7 : 03.8 ± 1 : 00.8	7 : 04.0 ± 1 : 11.0
Cuspid	11 : 04.8 ± 1 : 04.7	10 : 09.4 ± 1 : 06.9	10 : 01.2 ± 1 : 10.6	9 : 04.8 ± 0 : 08.1
First molar	10 : 08.9 ± 1 : 04.9	10 : 11.0 ± 0 : 10.9	9 : 09.8 ± 1 : 10.6	9 : 11.0 ± 1 : 02.3
Second molar	11 : 00.1 ± 1 : 02.4	11 : 00.5 ± 1 : 04.1	11 : 03.8 ± 1 : 09.3	10 : 04.3 ± 1 : 04.4
Permanent teeth				
Central incisor	7 : 04.9 ± 0 : 09.2	6 : 00.9 ± 1 : 04.0	7 : 03.3 ± 0 : 09.6	5 : 09.2 ± 1 : 06.6
Lateral incisor	8 : 06.8 ± 1 : 01.2	7 : 02.4 ± 0 : 10.8	8 : 01.1 ± 1 : 05.8	7 : 06.4 ± 1 : 05.6
Cuspid	11 : 05.8 ± 1 : 05.5	10 : 11.6 ± 1 : 08.1	10 : 11.6 ± 1 : 07.5	9 : 05.5 ± 1 : 03.6
First premolar	10 : 08.9 ± 1 : 03.2	10 : 11.4 ± 1 : 01.7	10 : 03.0 ± 1 : 11.1	10 : 05.5 ± 1 : 08.4
Second premolar	11 : 01.8 ± 1 : 04.8	11 : 07.8 ± 1 : 02.3	11 : 02.0 ± 1 : 08.8	11 : 03.7 ± 1 : 10.2
First molar	6 : 07.6 *	6 : 08.0 *	< 5 : 09.2 *	< 5 : 09.2 *
Second molar	12 : 01.2 ± 1 : 09.3	11 : 11.2 ± 1 : 03.4	11 : 10.3 ± 1 : 08.5	11 : 04.2 ± 1 : 08.3

* Extrapolated median; the standard deviation was not assessed

For a few teeth, an earlier median age was assessed at eruption of the successional than at loss of the deciduous (predecessor) unit; in a few others, the two medians were equal. This is due to having plotted the probits of tooth absence and presence percentages, respectively, in the deciduous and permanent teeth independently from each other. In drawing straight lines for loss and eruption of the teeth, central probit values were strongly adhered to.

TABLE II

Mean number of erupted permanent teeth and, in brackets, the number of examinees, in yearly cohorts of boys and girls

Last birthday	Boys	Girls
6	3.38 (8)	4.67 (3)
7	8.10 (21)	10.59 (17)
8	11.55 (11)	11.36 (11)
9	12.25 (8)	15.63 (8)
10	17.57 (7)	21.25 (4)
11	19.86 (7)	22.43 (7)
12	25.17 (12)	25.86 (14)
13	27.31 (13)	27.83 (6)
14	27.57 (7)	27.60 (5)

10) years of age, and higher in all older cohorts. As compared to the Hungarian population, from 2×8 comparable cohorts, higher mean numbers occurred in the offspring of diabetic mothers in 11 instances and lower ones in only four instances, whereas the mean number of erupted permanent teeth was equal in boys of 11.5 years in these two populations.

2. *The mean character numbers of dental development* are shown in dependence on the chronological age of the examinees on the one hand, and on their actual body weight on the other hand, in Table III.

The distribution into quintiles of the total sample (disregarding age) differed significantly from that of the Hagerstown standard ($p < 0.025$).

Next, attention was focussed upon the age-changes of these mean character numbers. Erratic variations were seen that might have been due to the small sample size at some ages. In order to have groups allowing valid statistical comparisons, more or less arbitrarily three age-groups were set up, *viz.* age-group I from the 6.5 and 7.5; age-group II from 8.5, 9.5, 10.5 and 11.5; and age-group III from the 12.5, 13.5 and 14.5 years old children, with 45, 55 and 52 examinees, respectively, in each combined group. The mean character numbers were 58.91 ± 6.86; 46.27 ± 4.49; and 56.40 ± 3.25. The differences between any two means were not significant statistically. The distribution of the examinees in the four quartiles of character numbers was significantly different between age-groups II and III ($p < 0.05$).

3. *Physical development* of the examinees, judged in reliance on their actual body weights at dental examination, was significantly different from the Heimedinger standard ($p <$ < 0.005). The difference was mainly due to 15% of the children in WtC 7 (over the 97.5th percentile). Into the combined WtCs 1 and 2 (lower than the 2.5th, and 2.5 to 10th percentiles, respectively), belonged only 7.19% instead of the expected 10%. Percentages higher than in the normal standard were seen in WtC 6 also but consistently lower ones were found up to WtC 5.

The character numbers of dental development in reliance on actual body weight were not significantly differently distributed into quartiles in the combined WtCs 1—3 as compared with WtC 4, in WtC 4 as compared with the combined WtCs 5—7, whereas the difference between the combined WtCs 1—3 against WtCs 5—7 proved to be significant statistically ($p < 0.05$).

In Table IV, the dependence on the examinees' age of the character numbers in WtC 4, the combined WtCs 1—3 and 5—6, are shown. It is seen that in the combined WtCs 5—7 there were no age-dependent differences whereas in the combined WtCs 1—3 the mean character numbers in the two younger age-groups were lower than in age-group III. While in age-groups I and III a steady rise was displayed by the mean character number with the increase of body weight (from combined WtCs 1—3 through WtC 4 to the combined WtCs 5—7), in age-group II a lower mean character number was seen in WtC 4 than in any of the aforementioned combined WtCs. In age-group II, the quartile distribution of the combined WtCs 1—4 was significantly different from that of the combined WtCs 5—7 ($p < 0.05$).

As also shown in Table IV, the mean character numbers of WtC 7 on the one hand, and of the combined WtCs 5—6 on the other, were mark-

TABLE III

Dependence of the mean "character numbers" (of dental development) on actual body weight and chronological age

Last birthday	Actual body weight class							Body wt. record lacking	Mean of the yearly cohort
	1	2	3	4	5	6	7		
6	—	35.00 (1)	—	53.00 (4)	71.00 (1)	6.00 (1)	63.50 (2)	—	50.11 (9)
7	—	32.33 (3)	57.50 (2)	62.05 (19)	65.00 (3)	46.67 (3)	80.40 (5)	72.00 (1)	61.11 (36)
8	—	20.33 (3)	62.00 (3)	42.00 (8)	66.00 (3)	68.00 (1)	51.00 (4)	—	47.86 (22)
9	—	2.00 (1)	14.00 (1)	34.40 (5)	—	60.33 (3)	32.00 (1)	—	36.45 (11)
10	98.00 (1)	—	—	30.00 (5)	100.0 (2)	—	48.50 (2)	42.00 (1)	53.36 (11)
11	—	—	43.25 (4)	45.00 (3)	—	14.00 (1)	90.00 (2)	2.00 (1)	45.82 (11)
12	—	8.00 (1)	—	56.09 (11)	74.00 (3)	41.33 (3)	58.50 (4)	—	55.23 (22)
13	—	—	63.50 (4)	55.90 (10)	72.00 (1)	—	58.50 (2)	76.00 (1)	59.89 (18)
14	—	10.00 (1)	61.50 (4)	60.83 (6)	—	—	—	19.00 (1)	53.33 (12)
15	—	—	—	52.00 (3)	52.00 (1)	66.00 (1)	52.00 (1)	—	54.33 (6)
Wt. class mean	$\underbrace{\text{28.27 (11)}}$		54.89 (18)	52.45 (74)	72.14 (14)	46.08 (13)	62.83 (23)		

In parentheses: number of examinees

TABLE IV

Summarized mean character numbers in three age-groups in different combinations of body weight classes

Age-group	Weight classes				
	1—3 combined	4	5—7 combined	5—6 combined	7
I	41.16 (6)	60.48 (23)	62.73 (15)	51.50 (8)	75.57 (7)
II	41.08 (13)	37.76 (21)	61.79 (19)	66.10 (10)	57.00 (9)
III	51.81 (10)	52.07 (27)	59.15 (13)	59.70 (7)	58.50 (6)

In age-group II, the quartile distribution of the 34 examinees in the combined weight classes 1—4 was 16 : 5 : 9 : 4, whereas in the combined weight classes 5—7 a distribution of 3 : 4 : 4 : 9 was found. The difference proved significant statistically ($\chi^2 = 8.712$, at 3 degrees of freedom, $p < 0.05$).

Including the 15-year-old examinees, in the combined weight class 1—3 a 12 : 3 : 7 : 7 distribution was found, and in the combined weight classes 5—7 the distribution was 6 : 10 : 19 : 15. The difference is significant statistically ($\chi^2 = 9.3177$, at 3 degrees of freedom, $p < 0.05$).

edly different in age-group I (75.6 against 51.5). The difference was practically negligible in age-group III, whereas in age-group II a lower mean character number was found in WtC 7 than in the combined WtCs 5—6. As to the quartile distribution, none of these differences proved significant statistically. Combining children of WtCs 6 and 7 only, instead of 5—7, in the three age-groups, mean character numbers of 61.36; 55.43; and 52.78, were found.

4. *Birth weight* in the population differed significantly from the standard [20]. While in the latter a 10 : 15 : 25 : 25 : 25 : 10% distribution prevailed, in our subjects including the 15-year group a 4 : 18 : 23 : 24 : 29 : 59 distribution was found ($p < 0.001$). Such a deviation was expected in view of the maternal diabetes. As shown in Table V, no clear trends in dental development were obvious in dependence on birth-weight. The lowest mean, amounting to 49.73, was found in the combined BWtCs 1—2 and the highest, 63.78, in BWtC 3. In the special Subclass 6A, the mean character number was 56.84.

In order to form groups suitable for statistical comparison, BWtC. 1—2—3 on the one hand, and 4—5 on the other, were combined, while BWtC 6 was handled by itself. In Table V, the interdependence of BWtC and chronological age is shown. High mean character numbers were found in the youngest BWtC 1—3, and in the oldest BWtC 6. Within age-group II, the differences between BWtCs were small. In all three age-groups, the lowest mean character numbers were found in children in the combined BWtC 4—5. Although none of the age-group III/BWtC 6

TABLE V

Dependence of the mean "character numbers" (of dental development) on birth-weight and chronological age

Age-group	Birth-weight class							
	1	2	3	1—3 combined	4	5	4—5 combined	6
I	19.00 (2)	62.67 (6)	68.33 (9)	*60.53* (17)	33.63 (8)	72.43 (7)	*51.73* (15)	59.92 (13)
II	—	38.20 (5)	65.20 (5)	*51.70* (10)	47.14 (7)	44.64 (11)	*45.61* (18)	46.00 (26)
III	84.50 (2)	45.71 (7)	59.25 (8)	*56.65* (17)	42.67 (9)	52.11 (9)	*47.39* (18)	66.17 (17)
15 years	—	—	52.00 (1)	—	—	59.00 (2)	—	52.00 (3)
All ages (6 to 15 years)	51.75 (4)	49.28 (18)	63.78 (23)		40.96 (24)	54.65 (29)		52.69 (59)

In parentheses the number of examinees

had a character number lower than 26, the difference in distribution against age-group II/BWtC 6 just failed to reach the $p < 0.05$ limit of statistical significance. In no other comparison of subgroups formed in reliance on BWtCs was there a difference of quartile distribution that would have so closely approached the level of significance.

5. *Length at delivery.* The distribution of the subjects into quartiles was significantly different from the standard [19]. As seen from Table VI, no clear influence of BLC on dental development was detected when partly combined BLCs were arranged according to age. The lowest mean character numbers were seen in all three age-groups in BLC 1—3; in age-groups I and II, the number of examinees was so small that reliable statistical comparison did not seem feasible. The differences in the mean character numbers of individual BLCs (not shown in Table VI), disregarding age,

TABLE VI

Influence of body length at birth upon dental development (mean character numbers) in three age-groups

Age-group	Birth-length classes		
	1—3 combined	4—5 combined	6
I	42.33 (3)	66.06 (17)	55.33 (24)
II	42.60 (5)	48.94 (18)	46.45 (31)
III	49.85 (13)	50.33 (21)	68.22 (18)

were small except for a markedly lower mean in BLC 3 (45.06); as compared to the other BLCs, even this failed to differ significantly in quartile distribution.

6. *Classification of mothers.* In Table VII the mean subgroup character numbers are shown, arranged accord-

TABLE VII

Dependence of the mean "character numbers" (of dental development) on the White classification of mothers and on the chronological age of examinees

A. Individual cohorts

Last birthday	White classification of mothers					Mean of the yearly cohort
	A	B	C	D	F	
6	—	41.50 (2)	46.25 (4)	61.00 (3)	—	50.11 (9)
7	82.50 (2)	63.64 (22)	50.83 (6)	62.80 (5)	16.00 (1)	61.11 (36)
8	5.00 (1)	63.13 (8)	55.20 (5)	33.29 (7)	34.00 (1)	47.86 (22)
9	—	8.50 (2)	75.00 (1)	38.17 (6)	40.00 (2)	36.45 (11)
10	—	74.25 (4)	40.33 (3)	54.50 (2)	30.00 (2)	53.36 (11)
11	—	25.00 (1)	57.75 (4)	41.33 (6)	—	45.82 (11)
12	—	65.71 (7)	50.50 (4)	50.27 (11)	—	55.23 (22)
13	—	60.18 (11)	72.00 (1)	53.60 (5)	76.00 (1)	59.89 (18)
14	—	66.33 (3)	49.86 (7)	46.00 (2)	—	53.33 (12)
15	—	55.50 (4)	—	52.00 (2)	—	54.33 (6)
All ages	56.67 (3)	60.47 (64)	51.89 (35)	47.61 (49)	38.00 (7)	

B. Combined data

Age-group	Combined maternal White classes			
	A—B	A—B—C	C—D—F	D—F
I	63.38 (26)	59.38 (36)	52.78 (19)	57.00 (9)
II	53.06 (16)	53.52 (29)	43.48 (39)	38.19 (26)
III	62.90 (21)	58.91 (33)	52.00 (31)	52.05 (19)

ing to severity classes and age. WhC was found to exert a marked, and apparently unequivocal, influence on dental development of the offspring: decreasing mean character numbers were seen in children of all ages from WhC B through WhC C and WhC D to WhC F. WhC A, with three children only, did not fit into this regular pattern. In spite of such a marked tendency, none of the inter-WhC differences proved significant as to quartile distribution, and as to the relation of the differences of any two means to their standard errors.

Combining WhCs A—B—C on the one hand, and D—F on the other, or WhCs A—B and D—F (excluding

TABLE VIII

Mean "character numbers" (of dental development) in the offspring of diabetic mothers in different White classes, in dependence on actual body weight, on body weight and on body length at birth

Filial parameter,	White class of mothers		
	A—B combined	C	D—F combined
A. Actual body weight			
Class 1—3	50.67 (9)	54.00 (7)	35.62 (13)
Class 4	53.16 (31)	57.14 (21)	45.11 (19)
Class 5—7	61.00 (22)	32.29 (7)	55.05 (19)
Class 5—6	48.82 (11)	31.40 (5)	52.70 (10)
Class 7	73.18 (11)	34.50 (2)	57.66 (9)
B. Weight at birth			
Class 1—3	71.00 (16)	63.60 (10)	41.53 (19)
Class 4—5	51.33 (21)	47.88 (17)	49.27 (15)
Class 6	62.59 (29)	45.75 (8)	48.00 (22)
C. Length at birth			
Class 1—3	61.50 (6)	61.67 (6)	25.33 (9)
Class 4—5	60.78 (23)	53.17 (12)	49.29 (24)
Class 6	61.14 (37)	46.06 (16)	50.68 (22)

In parentheses the number of examinees

WhC C), and taking into account the age of examinees, yielded little additional information. In age-group II, WhCs C—D—F differed significantly in quartile distribution of the character numbers from WhCs A—B in age-group I as well as III, but not from other subgroups.

WhC being generally accepted as the most characteristic maternal parameter of diabetes, its influence on dental development was examined additionally in relation to actual body-weight, birth-weight, and birth-length. Results are summarized in Table VIII. As to the influence of actual body weight, it was remarkable to find a very low mean character number in the WtCs 5—7 children of WhC C mothers. As in this subgroup there were only 7 children, a statistical comparison was not feasible. In the combined WhCs A—B as well as D—F, higher character numbers

Table IX

Quartile distribution of "character numbers" (of dental development) in the offspring of diabetic mothers in dependence on maternal retinopathy, and the state of metabolism during the whole course of pregnancy

Maternal parameter	Number of children in quartile			
	1	2	3	4
Retinopathy				
free of pathosis (R_0)	17	20	36	28
$R_1-R_2-R_3$, combined	16	13	15	11
R_2-R_3, combined	8	6	5	4
State of metabolism during the whole course of pregnancy				
Good	13	17	33	21
Fair	14	13	17	18
Poor	5	4	3	0

were found in children who were in the upper quartile of the Heimedinger standards (WtCs 5—7) than in those with lower body weight. A rather low mean character number was found in BLCs 1—3 children of WhCs D—F mothers. The trend to lower mean character numbers was nearly regular with worsening maternal WhCs, although in a few comparisons WhC C offsprings had mean values somewhat lower than WhC D—F ones.

7. *Maternal retinopathy* was apparently connected with dental development. In the 101 offsprings of R_0 mothers the mean character number was 56.79; in the 32 children of R_1 mothers it was 48.91; and in the children of R_2 mothers only 48.34, while in the 4 children of R_3 mothers, 43.50. Quartile distributions (Table IX) were compared between R_0 and combined R_{1-3} offsprings on the one hand, and between R_{2-3} offsprings on the other, without finding a statistically significant difference. No additional information was gained from comparison to the WhCs of the mothers. Taking into account the chronological age of the examinees, in age-group II children of R_{1-3} mothers a markedly lower mean character number (39.22) was found than in any other subgroup; in these, mean character numbers varied between 51.78 and 59.75. As to quartile distribution, this particular subsample (age-group II offsprings of R_{1-3} mothers) differed significantly ($p < 0.05$) from the age-group I and age-group III offsprings of R_0 mothers, but not from age-group II offsprings of R_0 mothers.

Retinopathy having been a criterion for the classes D and F, it was not unexpected that only two of the

WhCs D and F mothers could be classified as R_0.

8. *Maternal metabolism* seemed to exert an influence on dental development of the offspring if the disturbance was severe. The mean character numbers were 55.73 in the 84 children of mothers in a "good", 54.23 in the 62 offsprings of mothers in a "fair" state, whereas in the 12 children of mothers with a "poor" metabolism the mean was only 36.00. None of the examinees of this small subsample had a character number exceeding 75 (Table IX). Between the two large groups formed according to maternal metabolism [12], the difference was negligible. No further connections were detected by comparisons according to age and maternal WhCs.

Discussion

The influence of several parameters was examined upon dental development in the non-diabetic offspring of diabetic mothers. The parameters were classified as filial and maternal; the filial parameters were subdivided into actual (i.e. stated at dental examination) and natal ones (recorded at birth). It was shown unequivocally and proved statistically that the actual body weight, BWt and BL of our subjects was significantly different from the standards chosen [14, 19, 20]. These findings indicate that our sample was not a randomly selected group from the general population. These differences may be regarded, though with some reservations, as consequences of the maternal diabetes.

By the maternal parameters, trends were shown only as to the influence on dental development in the offspring. Although they were rather marked, none of them proved significant statistically. The most marked influence on dental development had apparently that filial parameter which is independent of maternal diabetes, i.e. the examinees' chronological age. Children grow older independently of their mothers being free of, or suffering from, diabetes. In age-group II, the quartile distribution was significantly different from that in age-group III. All other statistically significant differences which we could demonstrate were in some way connected with this particular age-group or one of its subsamples. In age-groups I and II, the mean character numbers were practically identical with the means found formerly in the poorly controlled juvenile diabetics, whereas in age-group III a mean character number was assessed that hardly differed, if at all, from the Hagerstown standard [4]. As a tentative explanation, the preferential manifestation of "inherited" diabetes in prepubertal years is referred to [13, 18, 23]. It may therefore be supposed that in our cross-sectional study the age-group III subsample was different in composition from the subsamples of age-groups I and II. In age-group III there were subjects who passed the critical age of puberty without having turned into diabetics. Accordingly, their risk of developing manifest diabetes at a later but still juvenile age is considerably lower than in age-groups I and II. Among these latter children who were examined before their 12th birthday, many may be expected to develop manifest diabetes in the next few years. In other words: age-group III was cleared of the children who develop diabetes at a juvenile age, whereas such children formed an appreciable part of the two younger age-groups. This tentative explanation needs to be confirmed by a closer longitudinal study of a larger group.

The age-dependent connection found between actual body weight and dental development seems noteworthy. In dental development, in age-group I the combined WtCs 1—3 children were markedly delayed as compared to their age-mates who were heavier. In this age-group, a body weight in the lowest 25 percentiles of the standard seems to be indicative of some, probably slight, impairment of physical development of which our character numbers were a partial item only. In age-group II dental development was slightly delayed as compared to age-group I, and especially III. Regarding differences of subsamples within this particular age-group, no delay was obvious in the combined WtCs 5—7 children in the uppermost quartile of the standard. These subjects were physically so well-developed that their dentition was not delayed but rather slightly advanced in comparison to the standards. In a healthy population the advance of dental development at an early age is maintained through long periods of life [21]. Although this experience does not hold true for diabetics, as an increase of delay occurs in overt diabetics with advancing age, additional attention should be paid to the further physical development of this subsample, and generally of high weight children at prepubertal age. In age-group III, advance of WtCs 5—7 children was lower against their age-mates of WtCs 1—4 than in age-group II; nevertheless, a slight advance was demonstrated.

A shortcoming of the study was the limited size of the samples; another shortcoming was the non-random selection of examinees, and the third, its cross-sectional type. As to the selection of subjects, all children were included who visited the Karlsburg Institute for regular control during a certain time interval and who proved to have no manifest diabetes nor some disturbance of carbohydrate metabolism. Although we are not aware of any bias in having scheduled children for regular control at the institute, and accordingly our sample may justifiably be considered an unbiassed one, it was not selected at random. Its small size resulted in subsamples that were hardly suitable for statistical comparison. A longitudinal study of some 100 to 150 randomly selected children of diabetic parentage would be the best means to avoid the shortcomings mentioned.

To examine the significance of differences, since the character numbers were not distributed normally, a comparison of their actual distribution seemed preferable to comparing means and assessing standard errors. We are aware of the difference between statistical significance and clinical importance of any deviation of small subsamples from standards or from each other. By statistical methods, groups only may be compared and not individuals; and therefore, statistical tests are valid only for the groups. Accordingly, for the individual offsprings hardly any prognostic aid was obtained.

The validity of our standards may also be questioned. The character number method used is hardly suited to show an advance in dental development in the final stages of mixed dentition since the 28 teeth stage is attained — except by children with tooth agenesis (hyp- or oligodontia) — at a later age by all. The Hagerstown standards are based upon a cross-sectional study conducted some 40 years ago. In the meantime, a secular acceleration in dental development occurred [2]. Accordingly, in a pilot study consistently higher mean character numbers were found in yearly cohorts of children in Hungary than the expected standard 50 [8]. In dental development some difference may exist in different countries, but in Caucasians such differences are negligible [3]. Nevertheless, it would be preferable to use more recent European standards for comparisons. The age differences at eruption of the individual tooth units in Europeans of various nationalities have recently been shown to be minimal [17]. Thus, the nature of our recent findings was not altered by having used 40-year-old American standards.

As to the validity of the other standards, we are aware of marked differences in comparison with more recent findings from the GDR.*

Besides, or instead of, those examined, the influence of other filial and maternal parameters could have been assessed, such as e.g. maternal age at pregnancy, intercurrent diseases in infancy and early childhood, bone age, etc. They were not examined, although some might have a profound influence upon dental development of the offspring. The parameters relied upon in our study were chosen deliberately; filial as well as maternal parameters were examined which were thought to be markedly influenced by diabetes.

In summary, the influence of maternal diabetes was shown although not in a statistically significant manner on dental development in the nondiabetic offspring.

* As to actual body weight, we refer to Oemisch, W: Die Entwicklung der Körpermaße bei Kindern und Jugendlichen in der DDR. Ergebnisse einer repräsentativen Untersuchung in den Jahren 1967/68. Akad. ärztl. Fortbild., Berlin 1970.

As to normal birth-weights and lengths, the paper by Kyank, H., Herre H. D., Kruse H. J., Löscher H., Löscher K. D. and Plesse R.: Ergebnisse einer Normalwerterhebung Neugeborener in der DDR. I. Mitt.: Geburtsgewicht, Geburtslänge. Zbl. Gynäk. **97,** 129 (1975) was not yet available at the time of our analysis.

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Prof. P. Adler,
Stomatologiai Klinika
H-4012 Debrecen