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Impact of smoking on the duration of breastfeeding in mothers with insulin-dependent diabetes mellitus

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The effect of smoking on breastfeeding was studied in 252 mothers with insulin-dependent diabetes mellitus (IDDM) giving birth in the period 1985–1995 and of whom 31% were classified as White group B, 16% group C, 37% group D and 16% group F or R. As part of a centralized regimen a detailed smoking history was taken during pregnancy. Forty-six percent were smokers. In 1997, a questionnaire was sent out asking for information on the duration of breastfeeding. The response rate was 87%. The duration of breastfeeding was significantly longer in the non-smoking group ($p = 0.004$). Fifty-five percent of non-smokers versus 33% of smokers were still breastfeeding 4 mo after birth. A strong dose–response relationship was established ($p = 0.009$). Cox multiple regression analysis showed a significantly negative influence of smoking ($p = 0.01$) and of hospitalization of the infants during the first year of life ($p = 0.02$) and a significantly positive influence of maternal age ($p = 0.02$) and birthweight ($p = 0.03$) on the length of breastfeeding. The breastfeeding curves for non-smokers and smokers were mainly divergent in the first month after birth, suggesting that the effect of smoking on breastfeeding is mainly exerted during that period.

Conclusion: Smoking exerted a strong, negative, dose-dependent influence on breastfeeding duration in mothers with IDDM. Given the hazards of smoking, the advantages of breastfeeding and the possible link between being breastfed and later development of diabetes mellitus, these results should be taken into consideration when counselling pregnant women with IDDM about smoking.

Key words: *Breastfeeding, IDDM, smoking*

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The benefits of breastfeeding are numerous and authorities strongly advocate its implementation as the optimal form of nutrition for infants after birth (1). Several demographic, social, biomedical and personal factors affect the initiation and continuation of breastfeeding, emphasizing that the process leading to successful breastfeeding is multifactorial in nature (2–6). Smoking is an important determinant of successful breastfeeding. Its negative influence on breastfeeding (7) is usually ascribed to subsequent decreased serum prolactin levels (8, 9). In women with insulin-dependent diabetes mellitus (IDDM), delayed lactogenesis and reduced neonatal suckled milk volume have been found (10, 11) possibly due to reduced prolactin levels (12, 13). Accordingly, also influenced by frequent mother–child separation owing to admission of the child to neonatal intensive care units in the neonatal period, lower rates of breastfeeding in mothers with IDDM compared with non-diabetic mothers have been reported (14). The effect of smoking on breastfeeding in IDDM has not been studied before and, thus, the present study was undertaken to study the breastfeeding patterns in insulin-dependent diabetic women with a special focus on the influence of smoking.

Patients and methods

The study material comprised consecutive registered pregnant women with IDDM (White class B or higher) referred to the Department of Obstetrics, Aarhus Kommune Hospital/Skejby Hospital for subsequent treatment and delivery during the period 1985–1995. The White classification of pregnant women with diabetes mellitus reflects the well-known relation between perinatal outcomes and the patient's age at the onset of diabetes, the duration of the disease and the presence of vasculopathy. Class B includes patients with onset of the disease after age 20 y who have had the disease for less than 10 y. Class C patients have had diabetes for between 10 and 19 y or had onset of the disease between the ages 10 to 19 y. Class D includes women whose disease is of 20 y duration or more or whose onset of the disease occurred before age 10 or

Table 1. Characteristics of smokers and non-smokers.

	Non-smokers	Smokers	*p*-Value
Median maternal age (y)	28	27	0.44
White group D, F or R (%)	48	55	0.43
Delivery before term (d)	21	20	0.35
Caesarian section rate (%)	46	39	0.49
Median birthweight (kg)	3.7	3.5	0.02
Gender ratio (F/M)	1.0	0.9	0.80
Infants hospitalized in the first year after discharge (%)	17	24	0.30

Values are median or rates, compared using Mann–Whitney *U*-test or Fisher's exact test as appropriate.

who have benign retinopathy. Class F refers to patients with nephropathy and class R refers to patients with proliferative retinopathy.

All were managed according to a centralized regimen with close follow-up in the outpatient clinic after the first admission (15). As part of that regimen, a detailed history including information on smoking habits during pregnancy was taken by one of the authors. From this series data were extracted on women fulfilling the following criteria: (i) singleton pregnancy; (ii) after delivery the infant was alive, without malformations and the birthweight was above 2200 g; (iii) Danish descent (in order to avoid problems with understanding the questionnaire); and (iv) only one inclusion per patient. If a patient had more than one pregnancy in the period, only data from the first were included. A total of 265 patients met these criteria. After a search in the national Danish register, 13 patients were excluded as it was not possible to find their address or the child in question at the same address. In 1996–1997 a questionnaire was sent out to the remaining 252 patients, and after 4 mo a remainder was mailed to the patients who did not respond to the first letter. In total, 219 patients (87%) returned the questionnaire, of whom 2 refused to participate in the study, leaving 217 questionnaires for analysis.

The ability of a postal questionnaire to provide reliable and valid data is highly correlated to the questions presented in it (16). As a consequence, in the present study, asking for information on breastfeeding patterns up to 10 y ago, it was necessary to ask very simple questions and compromise on obtaining details to allow presentation of the data in the format recommended by the World Health Organization (WHO) (17). To complete the questionnaire, the patients were to tick in the form whether they breastfed their infant or not and if yes, to give information on the length of breastfeeding: <1, 1–3, 4–6, 7–9, 10–12 or >12 mo. Furthermore, to be able to correct for a possible bias due to the reported relations among smoking, infant morbidity and breastfeeding (18, 19), subjects were asked whether the infants had been hospitalized in the first year of life after discharge, the initial hospitalization in relation to the delivery being disregarded.

The breastfeeding curves were constructed using the Kaplan–Meier method and the curves were compared by the log-rank test. The following variables were considered as potential confounders on the relation between smoking and breastfeeding: maternal age, White group, gestational age, delivery by Caesarian section, birthweight, birth year, gender and hospitalization during the first year after birth. The possible independent influence of these factors on the breastfeeding length was analysed by the Cox proportional hazard regression model. Both bivariate analysis testing

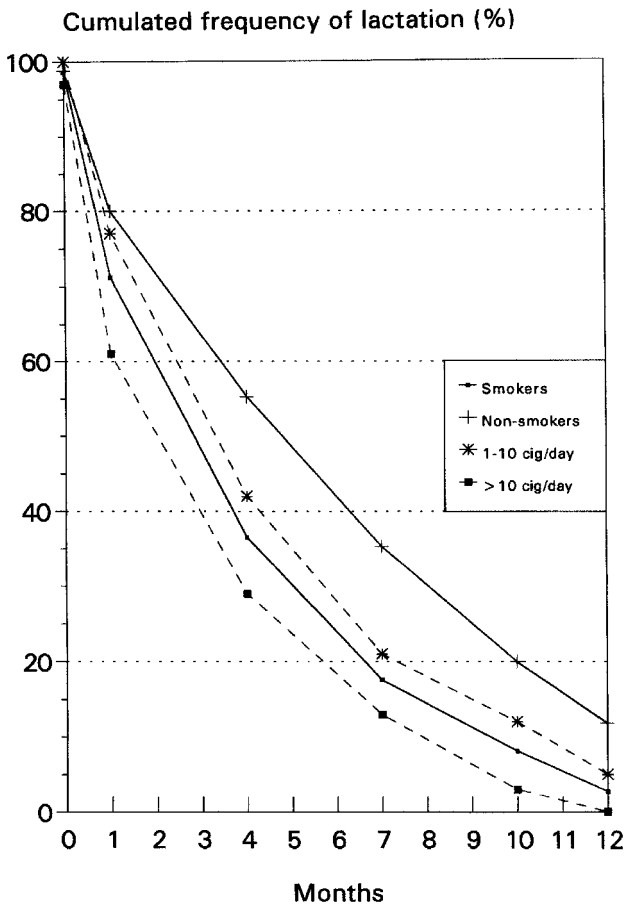

Fig. 1. Cumulated frequency of lactation for the non-smoking group, for all smokers, the smoking group with a consumption of 1–10 cigarettes per day and the smoking group with a consumption above 10 cigarettes per day.

Table 2. Results of bivariate Cox regression analysis.

	β	SE (β)	p-Value	RR	CI for RR
Tobacco (1 cigarette)	0.031	0.011	0.006	1.03	1.01–1.06
Maternal age (y)	−0.030	0.016	0.063	0.96	0.94–1.00
White group D, F or R[a]	0.005	0.066	0.93	1.00	0.88–1.14
Delivery time (d)	−0.001	0.007	0.89	0.99	0.98–1.01
Caesarian section[a]	0.03	0.05	0.54	1.03	0.94–1.14
Birthweight (kg)	−0.26	0.12	0.029	0.77	0.60–0.97
Birth year	0.005	0.032	0.64	1.03	0.94–1.08
Gender: M[a]	−0.091	0.17	0.58	0.91	0.66–1.27
Hospitalized first year[a]	0.36	0.18	0.05	1.61	1.00–2.03

The units used when entering the values are given in parentheses for continuous variables.
[a] Indicates nominal variables (yes vs no). The rate ratio (RR) estimates refer to withdrawal of breastfeeding.
CI: confidence interval.

each factor separately and multivariate analysis with all the variables entered in the model were performed. It was assumed that the possible influence of the continuous variables on withdrawal of breastfeeding was linear. The regression coefficient (β) and the corresponding rate ratio (RR) and 95% confidence interval (CI) were estimated for each variable. The RR estimates calculated refer to the risk of withdrawal of breastfeeding. Violation of the proportional hazard assumption was tested graphically. The SPSS 10.0 statistical package for Windows (SPSS, Chicago, IL, USA) was used in the calculations. The level of significance was chosen at 5%. The study was approved by the local ethics committee.

Results

Forty-six percent of the women were smokers with a median consumption of 10 cigarettes per day. The smoking group was comparable to the non-smoking group concerning maternal age, White-group distribution, gestational age, delivery by Caesarian section, gender and hospitalization during the first year after birth, while the birthweight was significantly lower in the smoking group (Table 1). In the whole material 31% were classified as White group B, 16% White group C, 37.3% White group D and 15.7% White group F or R.

The breastfeeding frequencies for the smoking and non-smoking group are depicted in relation to time after delivery in Fig. 1. For example, it can be read from the figure that for smokers 37% breastfed their infants for 4 mo or more versus 55% for non-smokers. Similarly, after 12 mo 2.7% of smokers were breastfeeding versus 12% of non-smokers (Fig. 1). For the whole group, 99% initiated breastfeeding, 76% were breastfeeding for 1 mo or more, 47% for 4 mo or more, 28% for 7 mo or more, 15% for 10 mo or more and 7% were breastfeeding for more than 1 y (not depicted). The lactation curves for the smoking and the non-smoking group were significantly different ($p = 0.004$) It is evident from inspection of the lactation curves (Fig. 1) that the breastfeeding curves for non-smokers and smokers were mainly divergent in the first month after birth.

Stratifying the smokers into 2 groups, corresponding to smoking, 1–10 or > 10 cigarettes per day, and constructing the lactation curves for these groups (Fig. 1) revealed a significant dose–response relationship

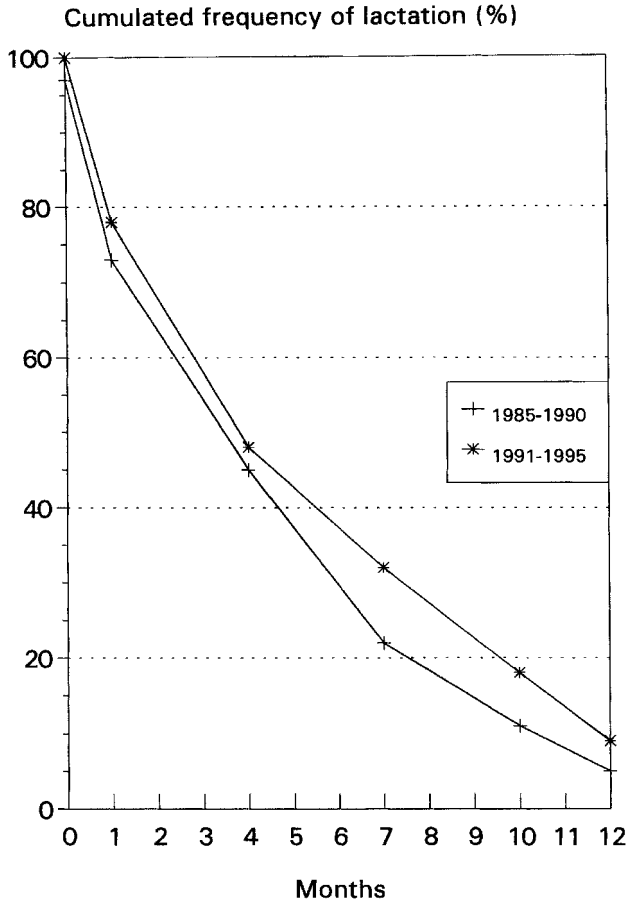

Fig. 2. Cumulated frequency of lactation for the whole group, in the first period of the study (1985–1990) and in the last part of the study (1991–1995).

Table 3. Results of multivariate Cox regression analysis with all variables in the model.

	β	SE (β)	p-Value	RR	CI for RR
Tobacco (1 cigarette)	0.03	0.013	0.01	1.03	1.01–1.06
Maternal age (y)	−0.046	0.020	0.02	0.96	0.92–0.99
White group D, F or R[a]	−0.039	0.079	0.62	0.96	0.83–1.12
Delivery time (d)	−0.001	0.009	0.92	0.99	0.98–1.02
Caesarian section[a]	0.079	0.064	0.21	1.08	0.96–1.23
Birthweight (kg)	−0.35	0.16	0.03	0.70	0.52–0.96
Birth year	0.008	0.026	0.78	1.01	0.96–1.06
Gender: M[a]	0.068	0.17	0.69	1.07	0.76–1.50
Hospitalized first year[a]	0.47	0.22	0.03	1.61	1.04–2.48

The units used when entering the values are given in parentheses for continuous variables.
[a] Indicates nominal variables (yes vs no). The rate ratio (RR) estimates refer to withdrawal of breastfeeding.
CI: confidence interval.

between smoking and breastfeeding ($p = 0.009$). The results of the bivariate Cox regression analysis are given in Table 2 and were almost identical to the results of the multiple Cox regression analysis (Table 3), which showed a significant negative influence of smoking (RR = 1.031, $p = 0.01$) and of hospitalization of the infants during the first year of life (RR = 1.605, $p = 0.02$) on the duration of breastfeeding. In contrast, maternal age (RR = 0.955, $p = 0.02$) and birthweight (RR = 0.704, $p = 0.03$) correlated positively to the breastfeeding length. The other factors investigated had no independent influence on the lactation curve. The proportional hazard assumption was not violated.

Dichotomizing the material according to delivery year, 1985–1990 or 1991–1995, demonstrated a trend, though not significant ($p = 0.11$), towards longer breastfeeding length in the later period (Fig. 2). Significant declines in smoking frequency (60% vs 34%) and median maternal age (29 vs 27 y) were observed (Table 4). The median birthweight was significantly lower in the first period.

The 46 patients in the material who either did not return the questionnaire ($n = 33$) or could not be located ($n = 13$) did not differ significantly from study group concerning maternal age, White-group distribution, gestational age, Caesarian section rate, birthweight or smoking frequency.

Discussion

The breastfeeding rates found in this study of insulin-dependent diabetic mothers are comparable to those in Danish studies of non-diabetic women (3, 20). This is consistent with recent studies showing that diabetic mothers, despite having delayed lactogenesis, can achieve breastfeeding rates equivalent to non-diabetic mothers (21, 22). The distribution of the White groups in the present material is comparable to that in other published Danish studies.

There was a strong, independent association between breastfeeding and smoking. Furthermore, a significant dose–response relationship was established. The breastfeeding curves for non-smokers and smokers were mainly divergent in the first month after birth, suggesting that the effect of smoking on breastfeeding is mainly exerted during that period. Diabetic women have reduced prolactin levels after birth (12, 13), which may be further accentuated by smoking (8, 9), thus decreasing the chance of successful breastfeeding. Once breastfeeding is well established, the influence of smoking on breastfeeding gradually seems to disappear.

Owing to the study design some reservations have to be made. First, no distinction could be made between mothers exclusively breastfeeding and those giving supplements. Secondly, no information was obtained on

Table 4. Homogeneity of the material over the years.

	Years		
	1985–1990	1991–1995	p-Value
Smokers (%)	60	34	0.001
Maternal age (y)	29	27	0.002
White group D, F or R (%)	47	56	0.34
Delivery (days before term)	20	21	0.93
Caesarian section rate (%)	41	45	0.63
Birthweight (kg)	3.4	3.8	0.01
Gender ratio (F/M)	1.0	1.0	0.00
Infants hospitalized in the first year after discharge (%)	20	20	0.00

Values are median or rates, compared using Mann–Whitney U-test or Fisher's exact test as appropriate.

smoking during the breastfeeding period. Thirdly, there was no information on the amount of environmental tobacco smoke, which has also been found to be related to breastfeeding (23). However, it seems justified to assume that lactation is well established if it continues beyond 1–3 mo and that the patients (or spouses) who smoked during the pregnancy continued to smoke after pregnancy. Self-reported smoking during pregnancy has been found accurate (24). As to the mechanism that smoking exerts on breastfeeding, the present study does not allow conclusions to be drawn as to whether biological inhibition of milk production takes place or whether confounders not accounted for were active. Social mechanisms are probably important (7).

The finding in the present study of a positive association between maternal age and the duration of breastfeeding have been described before and are, like the negative association between birthweight and breastfeeding, often ascribed to psychosocial factors. The independent influence of hospital stays on breastfeeding may be explained by severe illness of the infant.

During the study period the smoking rate declined from 60% to 34%, compared with a decrease from 50% (1985) to 42% (1993) (25) for the Danish population in general. Given the relation between smoking and breastfeeding, a simultaneous increase in breastfeeding length was to be expected. That only a minor and non-significant increase was observed (Fig. 2) ($p = 0.10$) probably reflects inhomogeneity in the material over the years (Table 4) and the multifactorial nature of breastfeeding.

In conclusion, smoking exerted a strong, negative, dose-dependent influence on breastfeeding duration in mothers with IDDM. Given the hazards of smoking in general, the many advantages of breastfeeding, and the possible link between being breastfed and later development of diabetes mellitus (26), the findings of the present study should be taken into consideration when counselling pregnant women with IDDM about smoking.

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