

Breastfeeding in Women With Type 1 Diabetes

Exploration of predictive factors

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OBJECTIVE—To identify predictive factors for initiation and maintenance of breastfeeding with a focus on mothers with type 1 diabetes.

RESEARCH DESIGN AND METHODS—This is a prospective observation survey, using a case-control design, comparing the outcomes of 108 mothers with type 1 diabetes with 104 mothers without diabetes that were matched for parity and gestational age. Mother and infant outcomes were collected from medical records and through telephone interviews 2 and 6 months after delivery. Predictive factors were calculated by logistic regression analyses.

RESULTS—Mothers with diabetes were less likely to partly or exclusively breastfeed their children at 2 months (OR 0.42 [95% CI 0.18–0.96], $P = 0.041$) and 6 months (0.50 [0.27–0.90], $P = 0.022$) than mothers without diabetes. On multivariable analysis, type 1 diabetes did not remain an independent predictive factor. Instead, higher education level and breastfeeding at discharge from hospital were predictive factors for breastfeeding at 2 months postpartum. These variables as well as delivery >37 weeks and early breastfeeding predicted breastfeeding 6 months postpartum.

CONCLUSIONS—Factors associated with maternal diabetes, such as problems with establishing breastfeeding in the early postpartum period, affects the likelihood of long-term breastfeeding.

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The benefits of breastfeeding are numerous for both mothers and infants (1), and with increased duration and exclusivity, the benefits are enhanced for infants (2). Therefore, exclusive breastfeeding duration for at least 4 months, preferably 6 months, is a global recommendation (3). For infants of mothers with type 1 diabetes, the advantages of longer breastfeeding are probably even greater (4,5). However, initiation of breastfeeding for mothers with diabetes often implies a challenge. This is due to increased occurrence of complicated pregnancy and labor, caesarean section, and instrumented vaginal deliveries (6) and neonatal morbidity, including growth deviations, congenital malformations,

prematurity, and respiratory distress (7,8). Neonatal hypoglycemia may also complicate the postpartum feeding regimen. This is related to fetal intrauterine hyperglycemia and hyperinsulinism as a response to maternal hyperglycemia (9). Furthermore early mother-child separation can further hinder breastfeeding (10). The lactation process is shown to be delayed in mothers with diabetes (11), and their infants have a more immature sucking pattern (12). Early initiation of breastfeeding can reduce neonatal borderline hypoglycemia and increase the mean level of blood glucose level (13).

Research on breastfeeding in women with type 1 diabetes is inconsistent; some studies show the initiation and duration

of breastfeeding to be comparable with those of background populations (11,14). Conversely, other studies report that they were less likely to initiate breastfeed, and if they did initiate, it was for a shorter time than mothers without diabetes (12,15). BMI and socioeconomic status have been identified as predictors for their breastfeeding duration (16). A recently conducted multicenter study found that more than 90% of mothers with type 1 diabetes breastfeed initially. However, the breastfeeding rates declined more steeply among these mothers. This was explained by an increased frequency of caesarean sections, delivery at earlier gestational age, lower maternal age, and education level (17).

In summary, there are contradictory results concerning the initiation and sustainability of breastfeeding in women with type 1 diabetes. It is still unknown whether it is maternal diabetes or other maternal and neonatal factors that affect the likelihood of breastfeeding. The aim of this study was therefore to identify predictive factors for initiation and maintenance of breastfeeding with a focus on mothers with type 1 diabetes.

RESEARCH DESIGN AND METHODS

A prospective observational survey with a case control design was used to compare breastfeeding outcomes of mothers with type 1 diabetes with mothers without diabetes. Mothers with type 1 diabetes (DG) were asked to participate after childbirth at four hospitals in Sweden, including one University hospital (during 2007–2009) and three rural hospitals (during 2008–2009) with a total of about 16,000 deliveries annually. The study was approved by The Regional Ethics Board (Dnr: 351-07). Mothers provided written informed consent prior to participation. For every included woman with type 1 diabetes, the next childbearing woman in the same gestational week and parity (primi- or multiparity) was approached for participation. Exclusion criteria for the reference group (RG) were type 1 diabetes, type 2 diabetes, or gestational diabetes. All participants had to understand and speak Swedish.

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To prevent neonatal hypoglycemia, DG infants were provided early feeding with either the mother's breast milk or formula milk and were fed every 3–4 h during the first 2–3 days of life. Mothers whose infants received formula feeding were encouraged to breastfeed before every feeding session, if possible. Infants of DG mothers had their blood glucose measured within 2 h after delivery, before every feeding the first 12 h, and then with decreasing frequency depending on the occurrence of hypoglycemia.

Data on obstetrical and neonatal outcomes and health care consumption were collected from medical records. Maternal outcomes included the incidence of pre-eclampsia, interventions related to risk of fetal asphyxia, hemorrhage, and length of stay in maternal/neonatal care. Neonatal outcomes included hypoglycemia, defined as plasma glucose <2.2 mmol/L and categorized as more severe hypoglycemia (i.e., lasting for >6 h postpartum) or mild hypoglycemia (i.e., lasting <6 h), and prematurity (<37 gestational weeks). Other neonatal outcomes included congenital malformation, respiratory distress implying need of observation and/or medical treatment in neonatal care, antibiotic treatment, and feeding problems.

Further data were collected through telephone interviews with the mothers 2 and 6 months after childbirth. The interviews followed a structured questionnaire including questions on sociodemographic factors and breastfeeding pattern. Exclusive breastfeeding was defined as no supplementation of formula milk, and partial breastfeeding was defined as a combination of breastfeeding and formula feeding or exclusively formula feeding, thus allowing for introduction of introductory portions of food. A pilot test was conducted in 20 women for face validity of the questionnaire after which there were minor changes made. General well-being was measured by using the Psychological Health and Well-Being Index (PGWB) (18,19). This tool includes 22 items in the following six dimensions: anxiety, depressed mood, positive well-being, self-control, general health, and vitality. The score range is 0–110, and responses are rated on a 6-point Likert scale where 0 reflects the most distress and 5 reflects the highest level of well-being (18).

Data analysis

Analyses were conducted using the SPSS software, version 16.0 (Chicago, IL), and SAS, version 9.2 (Cary, NC). When reporting descriptive statistics, mean, standard

deviation (SD), median, and range (min–max) were used for continuous variables and *n* (%) was used for categorical and dichotomous variables. For comparisons between two groups, Fisher exact test was used for dichotomous categorical variables, Pearson χ^2 test was used for non-ordered categorical variables, and Mann Whitney *U* test was used for continuous variables.

Exploration of predictive factors for breastfeeding at 2 and 6 months was conducted by bivariate logistic regression analyses. Variables showing significant association with breastfeeding were entered into a stepwise multiple logistic regression model with partly or exclusive breastfeeding (yes/no) as the dependent variable. The accuracy of the selected model from the logistic procedure was evaluated with the area under the receiver operating characteristic (ROC) curve. The probability for breastfeeding at 6 months was calculated for different scenarios of the predictors as $e^{lc}/(1 + e^{lc})$, where *lc* is the linear combination of the significant independent predictors obtained from

the stepwise logistic regression analyses. All tests were two-tailed and conducted at 5% significance level.

RESULTS

Study group characteristics

Of 128 potential participants, a total of 108 women with type 1 diabetes (84%) entered the study; 82 women participated from the university hospital, and 26 women participated from the other hospitals. DG women who declined to participate or were lost for inclusion did not differ from the included women with diabetes regarding age, gestational week, and mode of delivery, or birth weight. A total of 104 RG women participated in interviews at 2 months postpartum, and 99 women participated in interviews at 6 months postpartum.

Fifty-three percent of participants were first-time mothers. There were no differences in sociodemographic factors between the two groups (Table 1). Two mothers at 2 months and four mothers at 6 months postpartum were working or

Table 1—Demographics and birth outcomes for women in the diabetic (DG) and reference (RG) groups

Demographics and birth outcomes	Type 1 diabetic mothers (DG)	Reference mothers (RG)	P for DG vs. RG
<i>n</i>	108	104	
Age			
Mean (SD)	31.2 (4.8)	31.1 (5.14)	
Median (range)	31 (22–41)	32 (19–45)	0.880†
Educational level			0.930‡
University	60 (56.1)	60 (58.3)	
Secondary school	47 (39.3)	39 (37.9)	
Primary school	5 (4.7)	4 (3.9)	
Parity (primipara)	58 (53.2)	57 (54.3)	
Induction	66 (60.6)	31 (29.5)	<0.001§
Gestational age (week)			
Mean (SD)	37.9 (1.9)	38.0 (1.7)	
Median (range)	38 (30–41)	38 (32–41)	0.893†
Mode of delivery*			<0.001‡
Vaginal	47 (43.1)	78 (74.3)	
Instrumental	10 (9.2)	8 (7.6)	
Elective caesarean	19 (17.4)	9 (8.6)	
Emergency caesarean	33 (30.3)	10 (9.5)	
Hours in maternity care			
Mean (SD)	94.6 (39.4)	63.8 (38.0)	
Median (range)	84 (28–107)	52 (7–213)	<0.001†
Separation mother/child			<0.001‡
Exclusively cocare	59 (55.0)	88 (84.6)	
Partly separated	37 (34.3)	7 (6.7)	
Exclusively separated	12 (11.0)	9 (8.7)	

Data are *n* (%) unless otherwise indicated. *One mother in each group had twins. †Mann-Whitney *U* test, ‡Pearson χ^2 test, §Fisher exact test.

studying outside the home; all of the others were on maternity leave. Mean age for diabetes onset was 15.5 years (SD 8.27, range 2–38); 76% used an insulin pen, and 24% used an insulin pump.

Maternal and newborn outcomes

DG women showed a higher frequency of complications or interventions in relation to birth outcomes compared with RG women (Table 1 and 2). DG newborns were more likely to develop hypoglycemia and require intravenous glucose treatment, despite supplemental feeding (Table 2). The lowest mean plasma glucose level in the DG neonates within the first 24 h was 2.05 mmol/L (SD 0.93, range 0.1–4.7).

Comparison of breastfeeding pattern

Breastfeeding within 2 h after birth was reported by 55% of DG women and 87% of RG women ($P < 0.001$). Reasons for not breastfeeding early in the DG mothers included mothers' own health (30%), infants' condition (11%), or both (5%). At the time of discharge from maternity or neonatal care, 55% of DG women breastfed compared with 76% of RG women ($P = 0.003$). DG infants were less likely

to be breastfeeding at 2 and 6 months of age than RG infants (Table 2). No differences regarding exclusive breastfeeding were found between the two groups.

Predictive factors for breastfeeding

In the bivariate analyses, maternal diabetes, educational level, delivery mode, gestational age, early breastfeeding, and breastfeeding at discharge were associated with breastfeeding at 2 and 6 months postpartum, as well as maternal complications or interventions at 6 months (Table 3). PGWB measured 2 months after childbirth was examined and showed a mean total score of 82.8 (SD 12.4, median 84, range 44–104), and identifying a potential predictive factor for breastfeeding at 6 months postpartum (OR 1.03 [95% CI 1.01–1.05], $P = 0.019$).

Only higher education level and breastfeeding at discharge from the hospital remained independent predictive factors for breastfeeding at 2 months postpartum. The area under the ROC curve for this model was 0.73. Independent predictive factors for breastfeeding at 6 months were higher education level, prematurity, early breastfeeding, and breastfeeding at discharge with an area under the ROC curve of 0.80 (Table 4).

This model has been used to calculate the probability of breast feeding at 6 months. Table 5 shows that a mother with a low education level who delivers her infant before the 37th week and does not breastfeed her infant during first 2 h of life and is not breastfeeding by the time she is discharged from the hospital has only an 8% chance of breastfeeding at 6 months. Conversely, a mother with a high education level who delivers her child after the 37th week and initiates breastfeeding within 2 h after delivery and who is breastfeeding at the time of discharge had a 94% chance of breastfeeding 6 months postpartum.

CONCLUSIONS—The findings from this study add to the growing body of research exploring breastfeeding patterns in mothers with type 1 diabetes. Our findings are consistent with studies that have found decreased breastfeeding duration in this group (12,15,17) but are inconsistent with studies that did not find differences (11,14). However, maternal type 1 diabetes was not a predictive factor for long-term breastfeeding. High education level, full-term vaginal delivery, and early initiation of breastfeeding as predictive factors for breastfeeding 6 months postpartum confirms findings in a recently published study (17). All these studies have used different designs and partly during different time periods, and the general breastfeeding rates and societal attitudes toward breastfeeding in the countries differ. As shown in Table 2, the breastfeeding rates in this study were higher than in the general population (20). However, national statistics report considerable variations between regions. It is possible that our definition of breastfeeding has been more inclusive, but the case-control design allows for comparison. Sociodemographic factors are well known to influence breastfeeding initiation and duration, not only in mothers with diabetes (16,17) but in mothers to preterm babies (21), as well as in the general population (22). This factor seems to transcend different cultures with more or less government-financed parental leave, as mothers working outside the home have been found to breastfeed more than mothers who stay at home (23).

Unfortunately, we did not record BMI in early pregnancy, which is why this factor could not be included as a potential predictive factor. We excluded women with type 2 diabetes, because they are (yet) quite rare in Sweden, and women

Table 2—Neonatal outcome, care, and breastfeeding of infants of women in the diabetic (DG) and reference (RG) groups

Birth outcomes	Infants of type 1 diabetic mothers (DG)	Infants of reference mothers (RG)	<i>P</i> for DG vs. RG
<i>n</i>	109*	105*	
Apgar score <7 at 5 min	4 (3.8)	1 (1.0)	0.369‡
Birth weight (g) mean (SD)	3,862 (680)	3,256 (508)	<0.001†
Supplemental feeding			
Day 1	98 (89.9)	34 (32.4)	<0.001‡
Day 2	105 (96.3)	31 (29.5)	<0.001‡
Day 3	84 (77.1)	31 (29.5)	<0.001‡
Neonatal morbidity**	35 (32.1)	12 (11.4)	<0.001‡
Neonatal hypoglycemia <2.2			<0.001§
>6 h	33 (30.3)	1 (1.0)	
Transitory (<6 h)	25 (22.9)	1 (1.0)	
No	51 (46.8)	103 (98.1)	
Neonatal care	49 (45.0)	13 (12.4)	<0.001‡
Glucose i.v.	34 (31.2)	2 (1.9)	<0.001‡
Breastfed			
2 months postpartum	88 (80.7)	95 (91.3)***	0.045‡
Exclusively	72 (80.0)	82 (86.3)	0.325‡
6 months postpartum	67 (61.5)	79 (76.7)***	0.025‡
Exclusively	28 (44.4)	30 (40.5)	0.729‡

Data are *n* (%) unless otherwise indicated. *One mother in each group had twins. **Hypoglycemia excluded, reported separately; prematurity excluded due to matched control subjects. ***To be compared with national statistics on breastfeeding (Sweden, infants born 2008); 2 months, 88.9% and 6 months, 66.5% (The National Board of Health and Welfare). †Mann-Whitney *U* test, ‡Fisher exact test, §Pearson χ^2 test.

Table 3—Potential predictors of breastfeeding at 2 and 6 months: bivariate analysis

Predictive factors	Breastfeeding at 2 months postpartum			Breastfeeding at 6 months postpartum		
	n (%)	OR (95% CI)	P	n (%)	OR (95% CI)	P
Educational level						
Low	70 (77.8)	1.0		47 (42.8)	1.0	
High	111 (92.5)	3.52 (1.52–8.18)	0.003	97 (80.8)	3.77 (2.04–6.98)	<0.001
Maternal diabetes						
None	95 (91.3)	1.0		79 (76.7)	1.0	
Type 1 diabetes	88 (81.5)	0.42 (0.18–0.96)	0.041	67 (62.0)	0.50 (0.27–0.90)	0.022
Parity						
Primiparous	98 (85.2)	1.0		83 (72.2)	1.0	
Multiparous	85 (87.6)	1.23 (0.56–2.72)	0.611	63 (65.6)	0.74 (0.41–1.32)	0.306
Delivery mode						
Vaginal	127 (90.1)	1.0		107 (76.4)	1.0	
Caesarean	56 (78.9)	0.41 (0.19–0.91)	0.028	39 (54.9)	0.38 (0.20–0.69)	0.002
Maternal complications*						
No	124 (89.2)	1.0		102 (73.9)	1.0	
Yes	59 (80.8)	0.51 (0.23–1.13)	0.095	44 (60.3)	0.54 (0.29–0.98)	0.043
Neonatal morbidity**						
No	142 (86.1)	1.0		116 (70.3)	1.0	
Yes	41 (87.2)	1.11 (0.42–2.90)	0.836	30 (65.2)	0.79 (0.40–1.58)	0.509
Neonatal hypoglycemia**						
No	132 (86.8)	1.0		102 (67.5)	1.0	
Yes	51 (85.0)	0.86 (0.37–2.01)	0.725	44 (73.3)	1.32 (0.68–2.57)	0.412
Gestational age (weeks)						
>37	153 (89.0)	1.0		125 (72.7)	1.0	
<37	30 (75.0)	0.37 (0.16–0.88)	0.024	21 (53.8)	0.44 (0.22–0.90)	0.024
Early breastfeeding (<2h)						
Yes	130 (89.7)	1.0		111 (77.1)	1.0	
No	51 (78.5)	0.42 (0.19–0.93)	0.033	33 (50.8)	0.31 (0.17–0.57)	<0.001
Breastfeeding at discharge						
Yes	128 (91.4)	1.0		110 (78.6)	1.0	
No	46 (73.0)	0.25 (0.11–0.57)	0.001	30 (48.4)	0.27 (0.14–0.49)	<0.001

*Including preeclampsia, interventions related to risk of fetal asphyxia, and hemorrhage. **Other than neonatal hypoglycemia and prematurity.

with gestational diabetes, because this condition mostly disappears after delivery. However, one study found mothers with gestational diabetes to be less likely to breastfeed long term than healthy mothers, especially those who are insulin dependent or obese (24).

The literature is consistent regarding the higher occurrence of maternal and neonatal complications in mothers with diabetes (6–8), which was also confirmed in our study. It seems to be the higher frequency of birth-related complications that affects the breastfeeding duration. Interestingly, the TRIGR Study Group (17) found that among all mothers who were delivered by caesarean section, those with maternal diabetes actually breastfed longer. This can be compared with our findings where delivery mode did not remain as a predictive factor either at 2 or 6 months postpartum. It is possible that our findings can be related to insufficient

statistical power. A limitation of the current study is the limited number of participants with diabetes. However, the prospective case-control design allowed for more valid group comparisons than studies using background populations.

In line with the TRIGR Study Group (17), we claim that early breastfeeding should be considered as the most important factor to approach in clinical practice. Consequently, supporting mothers with type 1 diabetes to initiate milk production

Table 4—Predictive factors for breastfeeding 2 and 6 months postpartum: multiple logistic regression analyses

Predictive factors	Breastfeeding 2 months postpartum		Breastfeeding 6 months postpartum	
	Adjusted OR (95% CI)	Adjusted P	Adjusted OR (95% CI)	Adjusted P
High educational level	3.34 (1.40–7.96)	0.006	5.94 (2.79–12.63)	<0.001
Delivery <37 weeks	—		0.36 (0.15–0.86)	0.021
No early breastfeeding	—		0.31 (0.15–0.68)	0.003
No breastfeeding at discharge	0.25 (0.11–0.58)	0.001	0.31 (0.15–0.65)	0.002

Area under the ROC curve for prediction of breastfeeding: 0.73 at 2 months postpartum and 0.80 at 6 months postpartum.

Table 5—Probability for breastfeeding at 6 months as a function of education level, prematurity, early breastfeeding, and breastfeeding at discharge

Education level	Delivery (weeks)	Early breastfeeding	Breastfeeding at discharge	Probability of breastfeeding at 6 months (%)*
Low	>37	Yes	Yes	0.71 (71)
Low	>37	Yes	No	0.44 (44)
Low	>37	No	Yes	0.44 (44)
Low	>37	No	No	0.20 (20)
Low	<37	Yes	Yes	0.48 (48)
Low	<37	Yes	No	0.22 (22)
Low	<37	No	Yes	0.22 (22)
Low	<37	No	No	0.08 (8)
High	>37	Yes	Yes	0.94 (94)
High	>37	Yes	No	0.82 (82)
High	>37	No	Yes	0.82 (82)
High	>37	No	No	0.59 (59)
High	<37	Yes	Yes	0.84 (84)
High	<37	Yes	No	0.63 (63)
High	<37	No	Yes	0.63 (63)
High	<37	No	No	0.35 (35)

*Probability is obtained from: $\exp(\text{lc})/[1 + \exp(\text{lc})]$, where lc is linear combination: $0.9149 + (\text{high educational level}) \times 1.7814 - (\text{delivery} < 37 \text{ weeks}) \times 1.0119 - (\text{no early breastfeeding}) \times 1.1557 - (\text{no breastfeeding at discharge}) \times 1.1625$. The coefficients are estimated from the multivariate logistic model.

so that they breastfeed at the time of discharge from maternity/neonatal care seems to be optimal. The high frequency of neonatal hypoglycemia can however make this challenging. The CEMACH report (10) claims the significance of early breastfeeding in mothers with diabetes. This has led to recommendations of a more flexible approach toward blood glucose check-ups early postpartum and to postpone supplemental feeding if not necessary. Increased glycemic stability in neonates has been found when breastfeeding begins in the delivery room (12) and when mothers with diabetes room-in with their newborn infants (25). Although hypoglycemia was not found to affect long-term breastfeeding directly, those factors could influence conditions for early initiation of breastfeeding as an underlying factor. Encouraging mothers to prenatally start stimulation of milk production in order to reduce the time period till milk production postpartum needs to be evaluated regarding effect on breastfeeding outcome.

In conclusion, our findings indicate that type 1 diabetes in mothers is not an independent risk factor for shorter duration of breastfeeding. However, factors associated with maternal diabetes, such as problems with establishing breastfeeding early postpartum due to the higher degree of maternal and neonatal complications, affects the likelihood of long-term

breastfeeding. Supportive interventions for early initiation of breastfeeding need to be developed and evaluated. Future research needs to explore factors other than birth related that might influence long-term breastfeeding in mothers with type 1 diabetes.

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C.S.-L. collected and researched data and wrote the manuscript. M.W. reviewed and edited the manuscript. A.E. reviewed and edited the manuscript. M.B. researched data and wrote the manuscript.

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