Long-Term Breast-Feeding in Women With Type 1 Diabetes

EDNA STAGE, RN[1]
HANNE NØRGÅRD, RN[1]
PETER DAMM, MD, DMSC[1]
ELISABETH MATHIESEN, MD, DMSC[2]

OBJECTIVE — Breast-feeding may be more difficult in women with diabetes because of neonatal morbidity and fluctuating maternal blood glucose values. The frequency of long-term breast-feeding and the possible predictors for successful breast-feeding were investigated.

RESEARCH DESIGN AND METHODS — One hundred two consecutive women with type 1 diabetes were interviewed about breast-feeding using a semistructured questionnaire 5 days and 4 months after delivery. Clinical data were collected from the medical records.

RESULTS — Five days after delivery, 86% of the women were breast-feeding. Four months after delivery, 55 (54%) women were exclusively, 14 (14%) were partly, and 33 (32%) were not breast-feeding compared with 50, 26, and 24% in the background population (NS). Mothers exclusively breast-feeding at 4 months were characterized by previous experience with breast-feeding, a higher educational level, and vaginal delivery and included a high proportion of nonsmokers, whereas there were no associations with diabetes-related parameters such as white classes, duration of diabetes, HbA_{1c}, and insulin dose at conception. Breast-fed offspring had a significantly higher birth weight and gestational age and were less often receiving glucose intravenously compared with the remaining offspring. Independent predictors of exclusive breast-feeding at 4 months were previous experience with breast-feeding (odds ratio 6.3 [95% CI 2.4–17]) and higher educational level (7.1 [2.4–21]). Cessation of breast-feeding was mainly due to common nursing problems, such as perceived milk supply, and not related to maternal diabetes status.

CONCLUSIONS — The majority of the women with type 1 diabetes initiated breast-feeding, and the prevalence of breast-feeding at 4 months was comparable to that in the background population. Independent predictors of exclusive breast-feeding at 4 months were previous experience with breast-feeding and higher educational level.

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In Denmark, as well as globally, exclusive breast-feeding is recommended for the first 4–6 months of life (1,2). Health care workers are encouraged to play a role in promoting breast-feeding and providing mothers with the appropriate information and support (1). In women with diabetes, much attention is given during pregnancy to preventing morbidity for both mother and child (3), whereas less attention is paid to breast-feeding (4). Breast-feeding is suggested to prevent future diseases and may prevent future obesity (2,5). Breast-feeding probably protects against the development of both type 1 diabetes (6,7) and type 2 diabetes (8) in offspring. Therefore, it is of special importance to encourage women with diabetes to breast-feed for at least 4–6 months and to prevent early exposure of their offspring to cow's milk. Breast-feeding in women with type 1 diabetes may be more difficult to establish and of shorter duration compared with the background population because of increased maternal and neonatal morbidity. Fluctuating maternal blood glucose values with frequent episodes of symptomatic hypoglycemia have been claimed to force women into early weaning. The aim of this study was therefore to evaluate the prevalence of breast-feeding for >4 months in a Danish population of women with type 1 diabetes. Furthermore, we aimed to identify possible reasons for successful breast-feeding.

RESEARCH DESIGN AND METHODS

— Of 107 consecutive Danish-speaking women with type 1 diabetes delivering one living infant at the obstetric department during the period from May 2001 to February 2003, 102 (95%) were included in the study. Two women did not want to participate, two were not asked to participate due to the investigator's vacation, and one could not be identified 4 months after delivery.

The study included a prospective semistructured questionnaire, and the women were interviewed 5 (range 4–8) days after delivery before discharge from the hospital and again by telephone 4 months later. During pregnancy the women were offered midwife-led antenatal classes including information on breast-feeding and a visit to the neonatal intensive care unit (NICU). Furthermore, individual counseling by a diabetes nurse specialist on the benefits of breast-feeding was offered, and during this session the women were asked whether they intended to breast-feed and informed of the possibility of using a breast pump if the child's ability to suck was impaired. The neonates stayed routinely with their mothers for the first 2 h of life, and, if possible, they were offered the breast. At 2 h of age they were admitted to the NICU for the next 24 h. Early feeding with either mother's milk or low immunogen formula milk (Nutramigen; Mead Johnson) either by cup or by nasogastric tube every 3rd h was initiated to prevent hypoglycemia; in infants with severe hypoglycemia, treatment with intravenous glucose was given. The mother was encouraged to be present with the infant in the NICU as much as possible and to nurse before early feeding. The infant's blood glucose was measured 2 h after delivery and subsequently every 3rd h. Neonatal hypogly-

From the [1]Department of Obstetrics, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark; and the [2]Department of Medical Endocrinology, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark.

Address correspondence and reprint requests to Edna Stage, RN, Department of Obstetrics, 4001, Rigshospitalet, Copenhagen University Hospital, Blegdamsvej 9, DK-2100 Copenhagen, Denmark. E-mail: estage@rh.dk.

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Abbreviations: NICU, neonatal intensive care unit.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Maternal characteristics of 102 women with type 1 diabetes in relation to exclusive breast-feeding 4 months after delivery*

	Exclusively breast-feeding	Not exclusively breast-feeding
n	55	47
Age (years)	32 ± 4	29 ± 4
Duration of diabetes (years)	15 ± 8	15 ± 8
White class B + C/D + R)	27/28 (49/51)	20/27 (43/67)
A1C at conception (%)	7.3 ± 0.9	7.6 ± 1.3
A1C at delivery (%)	6.2 ± 0.6	6.3 ± 0.7
Insulin dose before conception (IU/24 h)	49 ± 13	51 ± 18
Insulin dose at discharge (IU/24 h)	32 ± 11	35 ± 17
Insulin dose 4 months after delivery (IU/24 h)	44 ± 15	51 ± 21
Hypoglycemia 4 months after delivery (*n*/week)	2.1 (0–10)	1.8 (0–10)
Smoking	5 (9)	14 (39)*
School attendance >10 years	47 (85)	24 (51)*
Parity >1	37 (67)	16 (34)*
Previous experience with breast-feeding	35 (64)	12 (26)*
Cesarean section	31 (56)	36 (77)*
Received information about breast-feeding during pregnancy	26 (47)	27 (57)
Use of breast pump during the 1st week	26 (47)	28 (60)
Reasons for stopping breast-feeding: lactating problems/fluctuating blood glucose/others (*n*)		41/3/3

Data are means ±SD, mean (range), or *n* (%). *$P < 0.05$.

cemia was defined as at least one blood glucose value <2.5 mmol/l within the first 24 h.

Neonatal morbidity was defined as the presence of at least one of the following conditions: a need for continuous positive airway pressure for >1 h, antibiotic treatment, intravenous glucose, or phototherapy. Prematurity was defined as gestational age <37 weeks based on early ultrasound examination.

The women received rapid-acting insulin three to four times daily and intermediate-acting insulin one to two times daily. Within the first 4 h after delivery, the women were asked to continue insulin treatment with a dose approximately one-third of the dose the day before delivery. The insulin dose was adjusted daily according to self-monitored blood glucose levels.

From the medical records, we collected the following data on the mothers: age, smoking, parity, mode of delivery, duration of diabetes, white class status, HbA_{1c} (A1C) at conception and at delivery, and insulin dose at conception and at discharge from the hospital after delivery. From the interviews, we collected the following data: educational background, previous experience with breast-feeding, information on breast-feeding during pregnancy from the medical caretakers, time interval from delivery to the first breast-feeding, use of a breast pump, status of exclusive breast-feeding at 5 days and 4 months after delivery, reasons for stopping breast-feeding, insulin dose, and the number of mild hypoglycemic episodes during the last week before the interview 4 months after delivery. From the medical records, we collected the following data on the infant: gestational age, birth weight, the lowest blood glucose value within the first 24 h of life, the possible use of continuous positive airway pressure, phototherapy or antibiotics, other complications or malformations, type of early feeding, and treatment with intravenous glucose.

Exclusive breast-feeding was defined as breast-feeding without any supply of formula milk. Early feeding with low immunogenic formula milk according to our treatment regimen to prevent neonatal hypoglycemia the first few days of life was allowed. Women who were not exclusively breast-feeding included women combining breast-feeding and formula-feeding and women exclusively formula-feeding.

For comparison, data from 9,654 randomly selected Danish women who participated in a nationwide study on lactation were used. A local health visitor asked all women about breast-feeding 4 months after delivery in the period of 2000–2002 (9).

Statistics

Data are given as means ± SD, mean (range), or *n* (%). The χ^2 test, Fisher's exact test, and unpaired and paired *t* tests were used as appropriate for comparisons of group frequencies and means. Multiple logistic regression analysis with backward selection (SPSS 13.0 for Windows) was performed with parity (0 or ≥1), previous breast-feeding (+ or −), educational level (≤10 or >10 years of school attendance), smoking (+ or −), delivery mode (vaginal or cesarean), gestational age (<37 or ≥37 weeks), infants receiving intravenous glucose (+ or −), and birth weight (continuous) as independent variables and exclusive breast-feeding at 4 months as the dependent variable. A two-sided *P* value <0.05 was considered statistically significant.

RESULTS — Of all women, 86% initiated breast-feeding. Fifty-five (54%) women with type 1 diabetes were exclusively breast-feeding, 14 (14%) were partly breast-feeding, and 33 (32%) were not breast-feeding 4 months after delivery compared with 50, 26, and 24%, respectively, in the nationwide study (NS).

Mothers exclusively breast-feeding were characterized by a higher proportion with previous experience with breast-feeding, a higher educational level, nonsmoker status, and vaginal delivery (Table 1). Diabetes-related parameters such as white classes, duration of diabetes, A1C at conception, and insulin dose before conception were comparable in women exclusively breast-feeding at 4 months and the remaining women. The prevalence of hypoglycemia 4 months after delivery was also similar (Table 1). The daily insulin dose (international units per 24 h) in exclusively lactating women 4 months after delivery was 13% lower (range −52 to +40%) ($P < 0.0001$) than prepregnancy, whereas the insulin dose in the bottle-feeding women was 2% higher (range −86 to +53%, NS; Table 1). Offspring exclusively breast-fed at 4 months were characterized by a significantly higher gestational age and birth weight and were less often receiving intravenous glucose compared with the remaining offspring (Table 2). However, as many as 40% of the offspring born preterm were exclusively breast-fed at 4 months. Forty-seven percent of all neonates were nursed within the first 2 h. All neonates received

Table 2—*Fetal characteristics and nutrition in the neonatal period in relation to exclusive breast-feeding 4 months after delivery in woman with type 1 diabetes.*

	Exclusively breast-feeding	Not exclusively breast-feeding
Gestational age at birth (weeks)	37.6 ± 11.6	36.0 ± 6.2*
Preterm delivery	14 (25)	20 (42)
Birth weight (g)	3,618 ± 595	3,147 ± 996*
Infants with neonatal morbidity	25 (45)	30 (73)
Neonatal hypoglycemia	31 (58)	33 (70)
Intravenous glucose treatment	12 (22)	19 (40)*
First nursing <2 h after birth	32 (58)	16 (34)
Number of feedings during first 24 h	2 (0–8)	2 (0–8)
Exclusive breast-feeding at day 5	54 (98)	34 (72)

Data are means ±SD, *n* (range), or *n* (%). *$P < 0.05$.

early feeding every 3rd h during the first 24 h, mainly by nasogastric tube (89 vs. 85% in the two groups of infants). During the first 24 h of life, the infants were, on average, breast-fed two times in both groups with none of the feedings occurring during the night. In both groups, ~50% of the mothers used a breast pump to promote milk production in the first few days after delivery (Table 1). Five days after delivery the majority of the women (86%) were breast-feeding. Multiple logistic regression analysis revealed previous experience with breast-feeding (odds ratio 6.3 [95% CI 2.4–17]) and higher educational level (7.1 [2.4–21]) as the only independent predictors for long-term exclusive breast-feeding ($P < 0.01$). The reasons for giving up exclusive breast-feeding within the first 4 months after delivery were mainly related to common nursing problems, such as perceived milk supply, and only three women reported frequent symptomatic hypoglycemia as contributing to the decision (Table 1).

Despite regular early feeding, many infants experienced hypoglycemia, and 30% of all children received intravenous glucose because of severe hypoglycemia (Table 2). A high proportion of the infants fulfilled our criteria for neonatal morbidity (Table 2). One child was born with a ventricle septal defect, and one had syndactyly of two toes and clubfoot and later a benign tumor in the trachea was found.

CONCLUSIONS — Of all women with type 1 diabetes, 86% initiated breast-feeding, and the prevalence of breast-feeding 4 months after delivery was comparable to that of the background population and reached the goal previously set (10). Unsuccessful breast-feeding was related to common nursing problems.

Of the diabetic mothers, 86% were breast-feeding 5 days after delivery, and this successful rate of breast-feeding was obtained despite expected difficulties in initiating breast-feeding due to increased morbidity of the infant. The infants were all given artificial feedings mainly by nasogastric tube every 3rd h in the first 24 h, and >50% were not offered the breast within the first few hours of life. Despite early oral feeding, as many as 30% required intravenous glucose, and one could speculate whether another routine feeding procedure would have been more efficient in avoiding hypoglycemia. Successful breast-feeding despite delayed initiation has been described earlier (11), but others have found it a reason for early weaning (12). The infants were in the NICU the first 24 h and during this period normally only breast-fed a few times and never during the night. This is in contrast to the recommendation of nursing 8–12 times every 24 h for newborns (2). Rooming-in might be a tool to increase the numbers of feedings during the first 24 h and thus improve the success of breast-feeding in the long run.

In an attempt to overcome these various obstacles to successful breast-feeding, a focused effort was made that included different steps. We believe that the antenatal classes and individual counseling about benefits and difficulties in initiating breast-feeding offered to the women were valuable. Furthermore, the health care professionals were determined to support breast-feeding and encourage the mothers to initiate breast-feeding of the neonates within the first 2 h of life and to breast-feed as frequently as possible. The use of a breast pump to stimulate milk production in the early phase was recommended if the infant was suckling insufficiently. Our strategy of informing expecting mothers about the benefits of breast-feeding might have had a positive impact on the women's intention to breast-feed as shown by Donath et al. (13). Successful breast-feeding is of psychological importance to many women, and they often equate breast-feeding with their overall ability to mother their child. Another reason for the successful initiation of breast-feeding could be the mother's intention to breast-feed (14). Operative delivery was not an independent predictor of reduced breast-feeding in our study, probably due to similar postbirth practices in all infants of diabetic women (15,16).

Our findings of previous experience with breast-feeding and higher educational level as predictors of successful breast-feeding and the tendency for smoking and low gestational age to be predictors of unsuccessful breast-feeding are in agreement with previous findings (17,18). The number of smokers in our study was relatively small, and this may have reduced the likelihood of finding a significant association between smoking and lactation. To our knowledge, the present study includes the largest population of nursing mothers with type 1 diabetes investigated prospectively, and our findings are in accordance with the findings of a small prospective study of 19 diabetic women (11). The most common reason for introducing artificial feeding in the diabetic mothers was perceived milk supply, as is often the case in the general population (14). Medical reasons such as fluctuating maternal blood glucose values with frequent episodes of symptomatic hypoglycemia were only seen on a few occasions. Lactating mothers generally reduced their insulin dose appropriately, which resulted in an acceptable number of hypoglycemic episodes. In the literature, only a few articles describe changes in insulin treatment during lactation. Some found a reduced insulin requirement of 16–25% during lactation (19) compared with 0–10% in bottle-feeding women (19), whereas others found comparable reductions in insulin dose in lactating and bottle-feeding women (20,21) or even no reduction in insulin dose compared with the prepregnancy insulin dose (22,23). However, these studies included only a relatively small number of women and were mainly performed before modern insulin treatment with multiple insu-

lin injections and home blood glucose monitoring were available. In our study the number of included women exceeded 100, and modern multiple insulin injection treatment was given using home blood glucose monitoring and self-adjustment of insulin dose. Unfortunately, we did not record A1C or body weight at 4 months of follow-up. Aiming for exclusive breast-feeding is of importance for obtaining the full benefit of breast-feeding (5,7,8). Owing to the high prevalence of severe hypoglycemia in the infants, we continue to recommend early feeding for the infants of diabetic mothers. Because of the lack of supply of original breast milk, an artificial formula with low immunogeneity is chosen for the early feeding in our department. It is probably important to avoid antigens from cow's milk in the early feeding period to minimize the risk of development of type 1 diabetes in these infants with an increased genetic risk of developing type 1 diabetes (7).

Offspring born to women with pregnancies complicated by diabetes are at risk of developing obesity and impaired glucose tolerance (3,8). In population-based studies, breast-feeding has been suggested to be protective against obesity and diabetes in later life (5,7,8). Whether this is the case in a population of diabetic women has been questioned (24,25). Breast milk of diabetic mothers is characterized by increased glucose and insulin concentrations, as seen particularly in the analysis of colostrum samples (24). The impact of early ingestion of diabetic breast milk on later development of psychomotor and cognitive development has been a matter of debate (26), and additional studies are needed to assess the long-term consequences that might result from neonatal nutrition of diabetic breast milk. Because of the expected association between the maternal blood glucose level and the level of glucose in the breast milk, women with diabetes should be encouraged to continue good blood glucose control during breast-feeding. At this time breast-feeding should remain the preferred type of infant feeding, even in infants of diabetic women (26).

In summary, the majority of the women with type 1 diabetes initiated breast-feeding and the prevalence of breast-feeding at 4 months was comparable to that in the background population despite increased morbidity of the infants. Independent predictors of exclusive breast-feeding at 4 months were previous experience with breast-feeding and higher educational level.

References

1. World Health Organization: *Protecting, Promoting and Supporting Breastfeeding: The Special Role of Maternity Services*. Geneva, World Health Org., Geneva, 1989
2. American Academy of Pediatrics, Work Group on Breastfeeding: Breastfeeding and the use of human milk. *Pediatrics* 100: 1035–1039, 1997
3. Dornhorst A: Maternal hyperglycaemia: food for thought. *Pract Diabetes Int* 8:283–288, 2003
4. O'Sullivan DF: Diabetes and breast-feeding (Letter). *BMJ* 311:123, 1995
5. Bergmann KE, Bergmann RL, von Kries R, Böhm O, Richter R, Dudenhausen JW, Wahn U: Early determinations of childhood overweight and obesity in a birth cohort study: role of breastfeeding. *Int J Obes Relat Metab Disord* 2:162–172, 2003
6. Borch-Johnsen K, Joner G, Mandrup-Poulsen T Christy M, Zachau-Christiansen B, Kastrup K: Relation between breastfeeding and incidence rates of insulin-dependent diabetes mellitus: a hypothesis. *Lancet* 2:1083–1086, 1984
7. Kimpimaki T, Erkkola M, Korhonen S Kupila A, Virtanen SM, Ilonen J, Simell O, Knip M: Short-term exclusive breastfeeding predisposes young children with increased genetic risk of type 1 diabetes to progressive β-cell autoimmunity. *Diabetologia* 44:63–69, 2001
8. Pettitt DJ, Forman MR, Hanson RL Knowler WC, Bennettt PH: Breastfeeding and incidence of non-insulin-dependent diabetes mellitus in Pima Indians. *Lancet* 350:166–168, 1997
9. Ammeundersøgelse år 2000–2002. Publikation fra fagligt forum for amtssundhedsplejersker m. fl. Vejle 2003 (in Danish)
10. Department of Health and Human Services: *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*. Washington, DC, U.S. Govt. Printing Office, 1990, p. 379–380 (U.S. DHHS publ. no. PHS 91-50212)
11. Webster J, Moore K, McMullan A: Breastfeeding outcomes for women with insulin dependent diabetes. *J Hum Lact* 11:195–200, 1995
12. Buxton K, Gielen AC, Faden RR, Brown CH, Paige DM, Chwalow AJ: Women intending to breastfeed: predictors of early infant experiences. *Am J Prev Med* 7:101–106, 1991
13. Donath SM, Amir LH; ALSPAC Study Team: Relationship between prenatal infant feeding intention and initiation and duration of breastfeeding: a cohort study. *Acta Paediatr* 92:352–356, 2004
14. Lawson K, Tulloch MI. Breastfeeding duration: prenatal intentions and postnatal practices. *J Adv Nurs* 22:841–849, 1995
15. Rowe-Murray HJ, Fisher JRW: Baby friendly hospital practices: caesarean section is a persistent barrier to early initiation of breast-feeding. *Birth* 29:124–136, 2002
16. Vestermark V, Høgdall CK, Plenov G Birch M, Toftager-Larsen K: The duration of breast-feeding: a longitudinal prospective study in Denmark. *Scand J Soc Med* 19:105–109, 1991
17. Knudsen A, Pedersen H, Klebe Jg: Impact of smoking on the duration of breastfeeding in mothers with insulin-dependent diabetes mellitus. *Acta Paediatr* 90:926–930, 2001
18. Dix D: Why women decide not to breast-feed. *Birth* 18:222–225, 1991
19. Davies HA, Clark JDA, Dalton KJ, Edwards OM: Insulin requirements of diabetic women who breast feed. *BMJ* 298: 1357–1358, 1989
20. Saez-de-Ibarra L, Gaspar R, Obessa A Herranz L: Glycaemic behaviour during lactation: postpartum practical guidelines for women with type 1 diabetes. *Pract Diab Int* 20:271–275, 2003
21. Wichelow MJ, Doddridge MC: Lactation in diabetic women. *BMJ* 287:649–650, 1983
22. Murtaugh MA, Ferris AM, Capacchione CM, Reece EA: Energy intake and glycemia in lactating women with type 1 diabetes. *J Am Diet Assoc* 98:642–648, 1998
23. Rayburn W, Piehl E, Lewis E, Schork A, Sereika S, Zabrensky K: Changes in insulin therapy during pregnancy. *Am J Perinatol* 2:271–275, 1985
24. Plagemann A, Harder T, Franke K Kohlhoff R: Long-term impact of neonatal breastfeeding on body weight and glucose tolerance in children of diabetic mothers. *Diabetes Care* 25:16–22, 2002
25. Kerssen A, Evers IM, de Valk HW, Viser GHA: Effect of breast milk of diabetic mothers on bodyweight of the offspring in the first year of life. *Eur J Nutr* 58:1429–1431, 2004
26. Plagemann A, Harder T, Kohlhoff R, Fahrenkrog S, Rodekamp E, Franke K, Dudenhausen JW: Impact of early neonatal breast-feeding on psychomotor and neuropsychological development in children of diabetic mothers. *Diabetes Care* 28: 573–578, 2005