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Breastfeeding patterns of mothers with type 1 diabetes: Results from an infant feeding trial

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Abstract

Background—Both the initiation and maintenance of breastfeeding have been reported to be negatively affected by maternal type 1 diabetes (T1D).

Aims—To prospectively examine the breastfeeding patterns among mothers with and without T1D participating in a large international randomized infant feeding trial (TRIGR).

Design—Families with a member affected by T1D and with a newborn infant were invited into the study. Those who had HLA-conferred genetic susceptibility for T1D tested at birth with gestation > 35 weeks and were healthy were eligible to continue in the trial. Among the 2160 participating children, 1096 were born to women with T1D and 1064 to unaffected women. Information on infant feeding was acquired from the family by frequent prospective dietary interviews.

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Results—Most (>90%) of the infants of mothers with and without T1D were initially breastfed. Breastfeeding rates declined more steeply among mothers with than without T1D being 50% and 72% at 6 months respectively. Mothers with T1D were younger, less educated and delivered earlier and more often by caesarean section than other mothers ($p<0.01$). After adjusting for all these factors associated with the termination of breastfeeding, there was no difference in the duration of breastfeeding amongst mothers with and without T1D.

Conclusions—Maternal diabetes status per se was not associated with shorter breast feeding. The lower duration of breastfeeding in mothers with T1D is largely explained by their more frequent caesarean sections, earlier delivery and lower age and education.

Keywords

type 1 diabetes; breastfeeding; mode of delivery

Introduction

Exclusive breastfeeding is recommended worldwide for infants during the first 6 months of life [1, 2] based on scientific evidence of health benefits in breastfed infants and advantages to the mothers [3]. During this period it is recommended that children should not be given any other type of milk or infant formula, water, juice or food [1]. Short duration of breastfeeding and early introduction of supplementary foods may be associated with the development of respiratory and gastrointestinal infections, obesity [4], and, in some studies, chronic diseases such as cardiovascular diseases [7] and T1D [5, 6]. The findings regarding early weaning and the risk of T1D, asthma and allergies are controversial [5, 8] but exclusive breastfeeding for at least 4 months and delay of introduction of complementary foods until 4-6 months have been recommended in high-risk infants [9].

Maternal age [12–14], level of maternal education [12–15], and early infant-to-breast contact [16] have been consistently positively associated with both the initiation and duration of breastfeeding. It is well accepted based on a number studies that women with T1D are less likely to breastfeed their children or breastfeed for a shorter period of time than non-diabetic mothers [17, 18]. In order to resolve this issue we evaluated determinants of breastfeeding duration in the large international randomized double blinded Trial to Reduce IDDM in the Genetically at Risk (TRIGR) in which the primary goal is to assess whether weaning to a highly hydrolysed infant formula reduces the risk of T1D in genetically susceptible children.

Materials and methods

Study population

Newborn infants with a biological parent or a full sibling with T1D as defined by the World Health Organization were eligible for the study. The families were recruited when the mother was in late pregnancy (duration of gestation 35 weeks or more) or immediately after the delivery. The infant's parents or legal guardians signed an informed consent form to take part in the trial. HLA genotyping was performed on cord blood or a blood sample obtained before the age of 8 days and only those mothers of infants with increased HLA-conferred

susceptibility for T1D were eligible to continue in the TRIGR study. The infant was excluded from the study in cases of multiple gestation, an older sibling was a TRIGR participant, recognizable severe illness, gestational age, <35 weeks, > 7 days old at randomization or no HLA sample had been drawn before the age of 8 days. If the infant had received any infant formula other than Nutramigen® (Mead Johnson Nutritionals, Evansville, IN) prior to randomization, the infant was also excluded. Also the families where the parents were unwilling or unable to feed the infant cow's milk based products for any reason (e.g., religious, cultural) were excluded [19]. Nutramigen® contains hydrolysed casein and it was used to avoid exposure to intact cow's milk proteins if mothers own breast milk or banked breast milk was not available.

The 2160 participating children born between May 2002 and February 2007 were recruited from 12 countries in Europe and from Canada, the United States, and Australia. About half of the infants (51%, n=1096) were born to women with T1D with 1055 having only an affected mother and 41 at least one additional family member with T1D. Among the offspring of non-diabetic mothers, 724 infants had an affected father, 307 an affected sibling and 33 had both a father and at least one sibling with T1D. Randomization to a conventional or hydrolysed weaning milk formula was blinded using a centralized Automated Patient Registration and Treatment Randomization System. Ethical approval was obtained at each study centre.

Collection of dietary data

The subjects were randomized either before pregnancy or as soon as possible after birth so that if the mothers' own breast milk was not available, any elective supplementation consisted of the appropriate study formula. All recruited mothers were encouraged to breastfeed. The duration of the infant feeding intervention with study formula was until at least 6 months of age. If the child had not received the study formula for at least 60 days by that age, the study formula was continued when the child needed milk feeding other than breast milk. At the age of 8 months the intervention period ended irrespective the duration of exposure to the study formula.

Infant feeding practices were altered as little as possible by the trial, other than encouragement to breast feed. Dietary advice was given at the delivery hospital by a member of the study team. Parents were given a pamphlet which describes the sequence and amounts of food recommended at specific ages, according to each country's national guidelines. Parents were advised to avoid contamination with sources of cow's milk protein (including milk products, beef, and veal) contained in foods ingested by the infant and were provided with a list of solid foods giving the choices of potential brand names that did not contain cow's milk protein; they were also provided with a list of "non-recommended" foods which did contain cow's milk protein. Dietary advice leaflets, dietary forms and questionnaires were translated into relevant languages and adapted to national practices by local nutritionists.

The diet of the infant and the compliance with the avoidance of cow's milk proteins were assessed in the delivery hospital by interview, by a telephone interview when the infant was 2 weeks, 1, 2, 4 and 5 months old, and by a structured interview by a study dietician during

the visits at the age of 3, 6, and 9 months. Those families whose infants continued in the intervention beyond the age of 6 months were in addition interviewed by phone, when the infant was 7 and 8 months old. The TRIGR dietary interview questionnaire comprised questions about breastfeeding and study formula use. Parents were asked whether their child was being breastfed, what type of milk the child primarily received at the time of the interview and whether the child received anything other than breast milk or water. Furthermore the age at the end of exclusive breastfeeding, the age at the end of overall breastfeeding, the age at starting study formula, the duration of study formula feeding, and the average amount of study formula used per feeding during the previous month were asked [20]. The definition of exclusive breastfeeding was ingestion of only breast milk (banked or mother's own), supplementary vitamins or minerals or water. The second part of the interview was a food frequency questionnaire, which included foods that were allowed during dietary intervention according to the study protocol as well as foods that contained cow's milk protein and were not recommended during the dietary intervention [20].

Statistics

Baseline demographic characteristics were compared by maternal T1D status. Categorical variables were tested with the Chi-Square or Fisher's exact test (depending on cell size). Continuous variables were compared with the t-test. Kaplan-Meier methods and the Log-Rank test were used to compare time to end of breastfeeding by maternal T1D status. Cox proportional hazards regression was used to analyse the association between explanatory socio-demographic and clinical variables and time to the end of breastfeeding. For region the following variables were used in the analysis as dummies: Northern Europe comprising Finland and Sweden; Central Europe I comprising Czech Republic, Estonia, Hungary and Poland (transition economies); Central Europe II comprising Germany, Luxembourg, Netherlands and Switzerland; Southern Europe comprising Italy and Spain; Australia; Canada; and USA. The assumption of proportionality was not violated. All statistical analyses were two-tailed and analysed via SAS. Logistic regression analysis was used to study covariates associated with exclusive breastfeeding during the first 3 days of life.

Results

During the first 3 days of life 69% of the infants were fed mostly breast milk (Table 1). Fewer mothers with T1D (28.8%) exclusively breast fed their babies during the first 3 days after delivery than unaffected mothers (61.7%) (Table 1). At the age of 1 month 14.3% of infants born to T1D mothers and 43.0% born to unaffected mothers were exclusively breastfed, and at 4 months the respective proportions were 7.6% and 24.2%, and at 6 months 1.4% and 3.4% (Figure 1).

Mothers with T1D were very slightly younger and less educated than the unaffected mothers. The infants of the mothers with diabetes were born at earlier gestational age, more often by caesarean section, and had a higher birth weight and ponderal index (weight/height³) compared with the babies of unaffected mothers (Table 1).

Mothers with T1D (OR 0.29, 95%CI 0.22-0.37) and caesarean section (OR 0.61, 95%CI 0.49-0.76) were less likely to exclusively breastfeed during the first 3 days, whereas higher

infant ponderal index (OR 1.27, 95%CI 1.03-1.56) was associated with increased exclusive breastfeeding in the multivariate analysis. Region, maternal age, gestational age and gender were not associated with early exclusive breastfeeding (data not shown).

Shorter duration of breastfeeding was associated with maternal T1D, shorter parental education, younger parental age, shorter gestational age, caesarean section and lack of both exclusive and primary breastfeeding during the first 3 days in univariate analyses (Table 2). When all the factors associated with the end of breastfeeding were considered simultaneously, only parental education, maternal age, gestational age and initial breastfeeding remained significantly associated with the duration of breastfeeding (Table 2). After removal of early feeding variables from the model, caesarean section became positively associated with shorter duration of breastfeeding (HR 1.26, 95%CI 1.09-1.45).

When the analysis was restricted to the women who delivered vaginally shorter duration of breastfeeding was associated with fewer years of parental education, younger maternal age, and lack of breastfeeding during the first days of life and shorter gestational age (Table 2). These results did not change by removal of early feeding variables. Among women who delivered by caesarean section, shorter duration of breastfeeding was associated with fewer years of parental education, shorter gestational age, and lack of initial breastfeeding, and inversely with maternal T1D (Table 2). After removal of early feeding variables from the model, maternal T1D was no longer significant (HR 1.08, 95%CI 0.85-1.35).

Discussion

Our findings confirm the earlier observations that the duration of both exclusive and overall breastfeeding is shorter among mothers with T1D than among non-diabetic mothers [18]. However, our observations strongly suggest that this difference in the duration of overall breastfeeding is due to differences in the mode of delivery, length of gestation, parental age and education, and early infant feeding. After adjustment for potential confounding factors, maternal T1D status was not related to shorter duration of breastfeeding. Rather among all mothers who delivered by caesarean section, maternal T1D was associated with longer breastfeeding. As expected, based on earlier studies, fewer years of maternal and paternal education, younger maternal age, lower gestational age and initial breastfeeding remained important determinants of the duration of breastfeeding. Lack of exclusive breast-feeding during the first days of life was related to maternal T1D s, caesarean section and the ponderal index of the child.

The TRIGR study has exceeded all of its planning parameters in terms of subject retention and follow-up [19], thus the amount of missing information and loss to follow-up was very low. We found that the ability of our food frequency questionnaire to rank infants according to frequency of food consumption is excellent for breast milk and study formula [20].

It is possible that the participation in an intervention trial might have influenced families' choice of feeding, especially since some were familiar with the evidence that breastfeeding may protect from T1D [5–6]. Because of this and the inclusion and exclusion criteria, our findings cannot be directly extrapolated to the general population. However, our observation

that maternal T1D is not an independent risk factor for shorter duration of breastfeeding after adjustment for other determinants of breastfeeding is supported by observations in some other studies. In an Australian study, women with T1D breastfed at least as frequently and for as long as unaffected women, despite the fact that the offspring of the diabetic women were formula fed more often and began to receive breast milk later than infants in the control group [21]. In a Danish study, the majority of the women with T1D initiation of breastfeeding and the prevalence of breastfeeding at 4 months were comparable to that in the background population. In that study the independent predictors of exclusive breastfeeding at 4 months were higher educational level and previous experience with breastfeeding [22]. In our study maternal diabetes was, unexpectedly, inversely associated with ending of breastfeeding among those mothers who delivered by caesarean section.

In accordance with previous surveys, the women with T1D were more likely to deliver by caesarean section and to deliver earlier [21]. Caesarean delivery is associated with a reduced likelihood of exclusive breastfeeding [23, 24]. Consistently with previous reports [24, 23] caesarean section was related to shorter overall breastfeeding duration in the present study compared to vaginal delivery. However, when other putative determinants of breastfeeding were considered, caesarean section was no longer a risk factor for shorter duration of breastfeeding.

In the small study by Gagne et al. mothers affected by T1D did not perceive that diabetes influenced their breastfeeding experiences, but they did report that maintenance of good glycemic control required greater effort during breastfeeding [25]. Elevated serum glucose concentrations in maternal T1D may affect the secretion of prolactin, the principal lactogenic hormone. Early breastfeeding activity, increased breastfeeding frequency, and good glycemic control enhance prolactin secretion and should be promoted during lactation in women with diabetes [26].

In the TRIGR study there was an association between more years of parental education and longer duration of breastfeeding, and primary or exclusive breastfeeding during the first 3 days of life. In our study paternal education was associated with breastfeeding initiation and duration independently of maternal education. A Finnish study [14] reported recently that longer duration of breastfeeding was associated with more years of parental education and older age of the mother. In a Czech study, higher maternal education was associated with longer duration of exclusive breastfeeding [27].

Almost all mothers both with and without T1D initiated breastfeeding which is similar to or slightly exceeds earlier findings among the general population. According to a review by Callen and Pinelli [28], breastfeeding initiation in Europe ranged from 74 to 99%. In the United States breastfeeding initiation was close to 75% [29]. Maternal T1D was not an independent risk factor for shorter duration of breastfeeding. Differences in the breastfeeding rates between diabetic mothers and non-diabetic mothers were explained by the differences in the mode of delivery, the length of gestation, maternal age and education, paternal education, and early postpartum feeding. Our data show that early initiation of breastfeeding was the strongest factor predicting long term breastfeeding in infancy. The question is whether it is possible to encourage earlier breastfeeding and thus foster the

benefits of breastfeeding for all infants with c-section and early delivery and thus improve the exclusive breastfeeding rates in mothers, with T1D,

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Abbreviations

TRIGR	Trial to Reduce IDDM in the Genetically at Risk
T1D	type 1 diabetes

References

1. American Academy of Pediatrics. Work Group on Breastfeeding: Breastfeeding and the use of human milk. *Pediatrics*. 2005; 115:496–506. [PubMed: 15687461]
2. World Health Organization. [accessed 15 October 2008] The global strategy for infant and young child feeding. Internet: <http://whqlibdoc.who.int/publications/2003/9241562218.pdf>
3. Ip S, Chung M, Raman G, et al. Breastfeeding and maternal and infant health outcomes in developed countries. *Evid Rep Technol Assess*. 2007;1–186.
4. Wilson AC, Forsyth JS, Greene SA, Irvine L, Hau C, Howie PW. Relation of infant diet to childhood health: seven year follow up of cohort of children in Dundee infant feeding study. *BMJ*. 1998; 316:21–25. [PubMed: 9451261]
5. Virtanen SM, Knip M. Nutritional risk predictors of beta cell autoimmunity and type 1 diabetes at a young age. *Am J Clin Nutr*. 2003; 78:1053–1067. [PubMed: 14668264]
6. Malcova H, Sumnik Z, Drevinek P, Venhacova J, Lebl J, Cinek O. Absence of breast-feeding is associated with the risk of type 1 diabetes: a case-control study in a population with rapidly increasing incidence. *Eur J Pediatr*. 2006; 165:114–119. [PubMed: 16211397]
7. Fall CH, Barker DJ, Osmond C, Winter PD, Clark PM, Hales CN. Relation of infant feeding to adult serum cholesterol concentration and death from ischaemic heart disease. *BMJ*. 1992; 304:801–805. [PubMed: 1392706]
8. Greer FR, Sicherer SH, Burks AW. Effects of early nutrition interventions on the development of atopic disease in infants and children: the role of maternal dietary restriction, breastfeeding, timing of introduction of complementary foods, and hydrolyzed formulas. *Pediatrics*. 2008; 121:183–191. [PubMed: 18166574]
9. Thyagarajan A, Burks AW. American Academy of Pediatrics recommendations on the effects of early nutritional interventions on the development of atopic diseases. *Curr Opin Pediatr*. 2008; 20:698–702. [PubMed: 19005338]
10. McLaughlin JR, Risch HA, Lubinski J, et al. Reproductive risk factors for ovarian cancer in carriers of BRCA1 or BRCA2 mutations: a case-control study. *Lancet Oncol*. 2007; 8:26–34. [PubMed: 17196508]

11. Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and breastfeeding: collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50302 women with breast cancer and 96973 women without the disease. *Lancet*. 2002; 360:187–195. [PubMed: 12133652]
12. Dubois L, Girard M. Social inequalities in infant feeding during the first year of life. The Longitudinal Study of Child Development in Quebec (LSCDQ 1998-2002). *Public Health Nutr*. 2003; 6:773–873. [PubMed: 14641948]
13. Michaelsen KF, Larsen PS, Thomsen BL, Samuelson G. The Copenhagen cohort study on infant nutrition and growth: duration of breast feeding and influencing factors. *Acta Paediatr*. 1994; 83:565–571. [PubMed: 7919750]
14. Erkkola M, Pigg HM, Virta-Autio P, et al. Infant feeding patterns in the Finnish type I diabetes prediction and prevention nutrition study cohort. *Eur J Clin Nutr*. 2005; 59:107–113. [PubMed: 15354198]
15. Hornell A, Aarts C, Kylberg E, Hofvander Y, Gebre-Medhin M. Breastfeeding patterns in exclusively breastfed infants: a longitudinal prospective study in Uppsala, Sweden. *Acta Paediatr*. 1999; 88:203–211. [PubMed: 10102156]
16. Ekström A, Widstrom AM, Nissen E. Duration of breastfeeding in Swedish primiparous and multiparous women. *J Hum Lact*. 2003; 19:172–178. [PubMed: 12744534]
17. Murtaugh MA, Ferris AM, Capacchione CM, Reece EA. Energy intake and glycemia in lactating women with type 1 diabetes. *J Am Diet Assoc*. 1998; 98:642–648. [PubMed: 9627620]
18. Hummel S, Winkler C, Schoen S, et al. Breastfeeding habits in families with Type 1 diabetes. *Diabet Med*. 2007; 24:671–676. [PubMed: 17403118]
19. The TRIGR Study Group. Study design of the Trial to Reduce IDDM in the Genetically at Risk (TRIGR). *Pediatr Diabetes*. 2007; 8:117–137. [PubMed: 17550422]
20. Vähätalo L, Bärlund S, Hannila ML, et al. Relative validity of a dietary interview for assessing infant diet and compliance in a dietary intervention trial. *Matern Child Nutr*. 2006; 2:181–187. [PubMed: 16881930]
21. Webster J, Moore K, McMullan A. Breastfeeding outcomes for women with insulin dependent diabetes. *J Hum Lact*. 1995; 11:195–200. [PubMed: 7669239]
22. Stage E, Norgard H, Damm P, Mathiesen E. Long-term breast-feeding in women with type 1 diabetes. *Diabetes Care*. 2006; 29:771–774. [PubMed: 16567813]
23. Merten S, Ackermann-Liebrich U. Exclusive breastfeeding rates and associated factors in Swiss baby-friendly hospitals. *J Hum Lact*. 2004; 20:9–17. [PubMed: 14974696]
24. Scott JA, Binns CW, Graham KI, Oddy WH. Temporal changes in the determinants of breastfeeding initiation. *Birth-Issues in Perinatal Care*. 2006; 33:37–45.
25. Gagne MP, Leff EW, Jefferis SC. The breast-feeding experience of women with type I diabetes. *Health Care Women Int*. 1992; 13:249–260. [PubMed: 1399865]
26. Ostrom KM, Ferris AM. Prolactin concentrations in serum and milk of mothers with and without insulin-dependent diabetes mellitus. *Am J Clin Nutr*. 1993; 58:49–53. [PubMed: 8317389]
27. Kudlova E, Rames J. Food consumption and feeding patterns of Czech infants and toddlers living in Prague. *Eur J Clin Nutr*. 2007; 61:239–247. [PubMed: 16929247]
28. Callen J, Pinelli J. Incidence and duration of breastfeeding for term infants in Canada, United States, Europe, and Australia: A literature review. *Birth-Issues in Perinatal Care*. 2004; 31:285–292.
29. Li R, Darling N, Maurice E, Barker L, Grummer-Strawn LM. Breastfeeding rates in the United States by characteristics of the child, mother, or family: the 2002 National Immunization Survey. *Pediatrics*. 2005; 115(1):e31–e37. [PubMed: 15579667]

Figure 1.

Breastfeeding (BF) and exclusive breastfeeding (EBF) in mothers with type 1 diabetes (mT1D) and mothers without type 1 diabetes (no mT1D).

Table 1

Characteristics of the study population by maternal type 1 diabetes (mT1D).

	mT1D ^I	No mT1D	Difference p-value
Mean (SD) maternal age, years	30.2 (5.0)	31.4 (4.9)	<0.001
Mean (SD) length of maternal education, years	14.6 (3.2)	14.9 (3.2)	0.009
Mean (SD) length of paternal education, years	14.5 (3.3)	14.8 (3.5)	0.015
Gestational age, weeks, % (N) ²			
1. quartile 35 – 37.5	38.0 (417)	7.5 (80)	<0.001
2. quartile 37.6 – 38.6	39.8 (436)	15.4 (164)	
3. quartile 38.7 – 39.9	16.5 (181)	28.7 (305)	
4. quartile 40	5.7 (62)	48.4 (515)	
Mode of delivery			
Caesarean section, % (N)	61.9 (678)	24.8 (264)	<0.001
Mean (SD) birth weight, g	3615.8 (727.1)	3515.7 (634.1)	<0.001
Mean (SD) birth length, cm	50.0 (7.1)	50.6 (6.0)	0.054
Mean (SD) ponderal index, kg/m ³	2.8 (0.6)	2.6 (0.5)	<0.001
Only breast milk during the first 3 days, % (N)	28.8 (316)	61.7 (657)	<0.001
Mainly breast milk during the first 3 days, % (N)	55.6 (609)	83.7 (891)	<0.001

^I mT1D: Maternal type 1 diabetes² Infants born at <35 weeks were excluded from the TRIGR study and therefore not included in these analyses.

Table 2

Determinants of short duration of breastfeeding among all women and among women who delivered vaginally and with caesarean section [hazard ratio (HR) and 95% CI by univariate analysis].

Variable	All women			Vaginal delivery		Caesarean section	
	HR	95% CI	Adjusted HR	Adjusted HR	95% CI	Adjusted HR	95% CI
Maternal T1D ³ , yes vs. no	1.59	1.41–1.79	0.85		0.72–1.00	0.97	0.77–1.22
Maternal education, years	0.92	0.90–0.93	0.93		0.91–0.95	0.92	0.89–0.95
Paternal education, years	0.92	0.90–0.93	0.95		0.93–0.97	0.96	0.93–1.00
Maternal age, years	0.96	0.95–0.97	0.98		0.97–1.00	0.97	0.94–0.99
Paternal age, years	1.01	1.00–1.01	1.0		0.99–1.01	1.01	1.00–1.03
Gestational age, weeks	0.85	0.82–0.88	0.92		0.87–0.96	0.93	0.87–1.00
Caesarean section, yes vs. no	1.47	1.31–1.66	1.11		0.96–1.28		
Gender of the offspring: male vs. female	1.09	0.97–1.22	1.04		0.91–1.18	1.13	0.94–1.35
Ponderal index, kg/m ³	1.03	0.92–1.15	0.97		0.86–1.10	0.95	0.79–1.16
Only breast milk during the first 3 days, yes vs. no	0.49	0.43–0.55	0.61		0.53–0.71	0.56	0.46–0.68
Mainly breastfeeding during the first 3 days, yes vs. no	0.43	0.38–0.49	0.54		0.46–0.62	0.54	0.43–0.68

¹ from Cox proportional hazard regression

² Adjusted for variables in the table and the regions: Northern Europe (Finland and Sweden); Central Europe I (Czech Republic, Estonia, Hungary and Poland) (transition economies); Central Europe II (Germany, Luxembourg, the Netherlands and Switzerland); Southern Europe (Italy and Spain); Australia; the USA; and Australia.

³ T1D: type 1 diabetes