November 2003

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PERGAMON

Social Science & Medicine 57 (2003) 1421–1428

SOCIAL SCIENCE & MEDICINE

www.elsevier.com/locate/socscimed

Incidence and correlates of breast milk feeding in hospitalized preterm infants

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Abstract

The majority of epidemiological studies of breast feeding have been conducted in healthy, fullterm infant samples. Little is known about the incidence and correlates of breast milk feeding in preterm infants, particularly in those born outside of metropolitan areas. Therefore, hospital medical charts of 151 consecutively admitted preterm infants ($\leqslant 34$ weeks gestational age), in the US, were reviewed and daily feeding, maternal demographic, pregnancy, and infant medical condition information was recorded. About half of the preterm infant sample was fed breast milk, receiving at least one breast milk feeding per day for 44% of their hospital stay. Although maternal demographic variables were important predictors of breast milk feeding, perinatal medical condition of the infant played a unique role in feeding practices in preterm infants. Specific interventions could be targeted to families with preterm infants to modestly increase population breast feeding rates.

Keywords: Preterm infant; Breast feeding; Incidence; USA

Introduction

Despite evidence that breastfed fullterm infants suffer from fewer infections (Cushing et al., 1998; Paradise & Rockette, 1997; Wright, Bauer, Naylor, Sutcliffe, & Clark, 1998), only about 60% of infants in the United States are ever breastfed (Ryan, 1997). Recently, mothers of preterm infants have been encouraged to feed their infants breast milk, including an official policy statement by the American Academy of Pediatrics (1997) that recognizes the benefit of human milk for preterm infants. Mothers of preterm infants, however, are more likely to be economically disadvantaged, unmarried, less educated, and to smoke during pregnancy when compared to mothers of fullterm infants (Chomitz, Cheung, & Lieberman, 1995). In comparison to fullterm infants, preterm infants are at greater medical risk and require prolonged hospitalization, both of which may affect the likelihood of breast milk feeding in this population. Both maternal and infant factors may play unique roles in determining the incidence and correlates of breast milk feeding in preterm infants. Estimates of breast feeding initiation rates in those born preterm and of low birth weight (<2500 g) vary considerably, ranging from 48% (Furman, Minich, & Hack, 1998; Ryan, 1997) to 73% (Furman, Minich, & Hack, 2002) in the US. These breast feeding initiation rates for preterm and low birth weight infants are lower than rates for full term infants (Lefebvre & Ducharme, 1989; Ryan, 1997; Starbird, 1991). Although breast feeding initiation rates have increased in recent years, particularly among subgroups of women who historically are less likely to breastfeed, such as mothers of low birth weight infants (Ryan, 1997), rates remain well below the goals of Healthy People 2010 (Department of Health and Human Services, 2000).

The percentage of mothers who choose to feed their infants breastmilk differs systematically among subgroups of women, with those who are older, married, more educated (DaVanzo, Starbird, & Leibowitz, 1990; Grossman, Fitzsimmons, Larsen-Alexander, Sachs, & Harter, 1990; Ryan, Wysong, Martinez, & Simon, 1990),

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0277-9536/03/$ - see front matter © 2003 Elsevier Ltd. All rights reserved.
doi:10.1016/S0277-9536(02)00542-7

Caucasian, or more advantaged economically more likely to breast feed than those who are not (Grossman et al., 1990; Kennedy & Visness, 1997; Ryan, 1997; Ryan et al., 1990). Women who smoke during pregnancy, on the other hand, are less likely to breast feed (Grossman et al., 1990), and are more likely to terminate breast feeding early (Hill & Aldag, 1996). Interestingly, parity (e.g., Kuan et al., 1999; Littman, Medendorp, & Goldfarb, 1994) and maternal employment (e.g., Lindberg, 1996; Lizarraga, Maehr, Wingard, & Felice, 1992) have been related inconsistently to breast feeding.

The demographic correlates of breast feeding preterm or low birth weight infants rarely have been investigated. In the US, maternal demographic correlates of breast milk feeding very low birth weight (weighing <1500 g at birth) infants were similar to those of breast feeding fullterm infants; that is, mothers who were older, married, and Caucasian were more likely to initiate pumping (Furman et al., 1998). Older, married, more highly educated, Caucasian mothers also were more likely to continue to provide their very low birth weight infants with breastmilk beyond 40 weeks corrected age, compared to mothers who initiated but discontinued breastmilk feeding before 40 weeks (Furman et al., 2002). In contrast, in studies conducted with low birth weight infants outside of the US, there was no relation between breast feeding and maternal age (Yu, Jamieson, & Bajuk, 1981) or maternal education (Boo & Goh, 1999).

Interestingly, infant medical risk variables, such as birth weight and gestational age, are unrelated to breast feeding in unselected samples of healthy, largely term infants (DaVanzo et al., 1990; Kuan et al., 1999; Ryan et al., 1990). In unselected samples, however, few infants with birth weights below 2500 g are included (Grossman et al., 1990; Lizarraga et al., 1992). Because the incidence of medical complications in infants who weigh over 2500 g at birth is quite low, the ability to detect the influences of perinatal status on breast feeding in this group is limited with such designs.

In preterm and low birth weight infants, where there is large variability in medical risk, infant health and breast feeding may be related more strongly. In Australian preterm infants, those born at later gestational ages were more likely to be breastfed than those born at earlier gestational ages (Yip, Lee, & Sheehy, 1996). Similarly, very low birth weight infants in Malaysia were more likely to be breastfed if they weighed more at birth, began enteral feedings at an earlier age, and were ventilated for fewer days (Boo & Goh, 1999). In contrast, very low birth weight infants in a large, metropolitan, US hospital were more likely to be breast fed if they were born at earlier gestational ages and weighed less at birth (Furman et al., 2002). Others found no association between birth weight or gestational age and breast feeding in very low birth weight infants in the US (Furman et al., 1998) and Australia (Yu et al., 1981).

In preterm infants in particular, the correlates of breast milk feeding initiation may differ from the continuation, or duration, of breast milk feeding, as the barriers to maintaining breast milk feeding a hospitalized, sick infant, differ from that of healthy fullterm peers in the home environment, such as the need to express and store breast milk and transport it to the hospital, and the neurophysiological immaturity of the infant that often precludes nursing directly from the breast. Among mothers who chose to breast milk feed their very low birth weight infants, fewer apnea episodes, fewer hospital days, and fewer days of oxygen therapy were associated with continued breastmilk provision at hospital discharge (Furman et al., 1998). However, infant health variables were unrelated to breast milk feeding at 40 weeks corrected age (Furman et al., 2002), approximately 2 weeks after sample mean discharge date.

There remains a paucity of studies examining breast milk feeding in preterm infants, without a clear consensus of the correlates of breast milk feeding. By identifying the correlates of feeding, intervention programs can be targeted to the needs of specific populations to increase the likelihood of success (Freudenberg et al., 1995). Interestingly, higher medical risk was related to a greater incidence of breast milk feeding initiation and breast milk feeding at hospital discharge in mother-infant pairs in a large, urban US hospital, where in those studies conducted outside the US, breast milk feeding was related to variables signifying lower medical risk. Even in the US, it is likely that breast milk feeding rates for preterm infants differ considerably. Because of the regionalization of modern neonatal care to decrease mortality, NICUs serve patients who differ dramatically in demographic characteristics that may, in turn, affect breast milk feeding rates. Residents of rural, more economically disadvantaged areas are less likely to engage in health promoting behaviors (e.g., exercise) and are more likely to engage in behaviors that are deleterious to pregnancy health, such as smoking, poor diet, and late initiation of prenatal care (e.g., Alexy, Nichols, Heverly, & Garzon, 1997; Miller, Clarke, Albrecht, & Farmer, 1996). Therefore, the purpose of this study was to determine the incidence and correlates of breast milk feeding patterns in preterm infants from non-metropolitan NICU. The rates of breast milk feeding preterm infants born to residents of such areas were postulated to be lower than that reported from urban US medical centers. Furthermore, both maternal and infant correlates were postulated to be related to breast milk feeding patterns, with preterm infants at greater medical risk who required more prolonged or intensive treatment being less likely to be breast milk fed.

Methods

Subjects

Hospital medical charts were reviewed of all preterm infants consecutively admitted to a Neonatal Intensive Care Unit (NICU) of a regional hospital in the US, from January 1, 1997 through December 31, 1998. The NICU, an Advanced Care Level II unit with an exemption to treat infants down to 750 g who do not require major surgery, has a catchment area that extends roughly to the southern 21 counties of Illinois (radius of approximately 100 miles). In the catchment area, the range of the county population density was 20–101 persons/square mile, median household income was from $26,000 to $33,000, and the percentage of persons below poverty was from 13% to 30% (US Census Bureau, 2000). All preterm infants born during the 24-month study period at ⩽34 weeks gestational age were included in this study ($N = 151$, range 25.0–34.5 weeks). Preterm infants with birth gestational ages ⩾35 weeks and fullterm infants with neonatal complications (e.g., for antibiotics due to maternal infection, presence of meconium in lungs, initial breathing difficulties) who were admitted to the NICU were excluded from participation in this study ($n = 276$) because of the reduced risk of medically related differences in outcome (Hack et al., 1994) and because the typically brief hospital stay of these infants reduces the opportunity to reliably measure feeding practices. There were 2 infants who were excluded as outliers, one with an unconfirmed gestational age of 34 weeks with a birth weight of 3960 g and another whose number of days on oxygen was more than 7 SD from the mean.

Infants were categorized by feeding groups based on information obtained from the charted hospital daily feeding records. During hospitalization, nursery staff recorded daily any fluid intake, including the time of feeding, amount ingested, and type of fluid. Because of the rural location of the NICU, many women had to travel long distances to the NICU to nurse or deliver expressed milk, which often resulted in some formula supplementation for infants. An unambiguous, easily replicable definition of breast milk feeding was chosen here. Breast milk feeding (BF) in preterm infants was defined as receiving any breast milk during hospitalization. Formula fed (FF) preterm infants were those who were fed formula exclusively.

Procedure

Infant hospital medical record numbers were obtained from the NICU admission log. All charts were reviewed by 3 trained graduate students who were blind to the study hypotheses. All maternal and infant information was recorded from the preterm infant hospital medical charts because maternal medical records were unavailable.

Measures

Maternal and infant variables available most commonly across hospital infant medical charts were collected for analysis. Sample descriptor and feeding information was recorded, in addition to pertinent maternal and infant variables that have been demonstrated to be related to breast feeding previously. Maternal variables of interest were: (1) Age at delivery (<21 vs. ⩾21), (2) Race (Caucasian vs. minority), (3) Insurance status (private vs. Medicaid or none), (4) Prenatal smoking (present or absent), (5) Parity (primiparous vs. multiparous), and (6) Marital status. Insurance status was used as a proxy for maternal socioeconomic status, as maternal income and education were not available in most hospital charts. Infant variables were: (1) Birth weight, (2) Apgar score at 5 min (⩽6 vs. ⩾7), (3) Number of days hospitalized, and (4) Number of days on any oxygen. The high correlation of birth weight and gestational age ($r = 0.82$) did not permit the use of both of these variables in the multivariate analyses. Birth weight, rather than gestational age, was used as an infant characteristic because it is measured more precisely, is a more robust predictor of outcome, and it was hypothesized that parents would use infant weight, an observable characteristic, when determining feeding practices to a greater extent than relative maturity. Apgar score at 5 min was used as a summary measure of medical risk, as it was available on all charts and did not require prenatal records for quantification (e.g., Hobel, Hyvarinen, Okada, & Oh, 1973).

Design

Pertinent percentages were calculated to determine the pattern of breast milk feeding during hospitalization. Univariate ANOVA's were conducted to examine feeding group differences on sample descriptor variables, as well as on the maternal and infant variables of interest. Follow-up comparisons among breast milk fed preterm infants were conducted, comparing those who were fed breast milk more consistently or less consistently during hospitalization (⩾45% vs. <44% of hospital days; determined by median split). To investigate the correlates of breast milk feeding in preterm infants, two hierarchical logistic regression analyses were conducted. The first model included the maternal variables only, entered as a block. In the second model, infant variables were entered as a second block, to determine the contribution of preterm infant medical condition to breast milk feeding beyond that of maternal characteristics. Finally, follow-up percentages were

calculated and univariate ANOVA's comparing those who were fed breast milk within 2 days of milk feeding initiation and within 2 days of hospital discharge were conducted to investigate feeding patterns across hospitalization. A 2-day window was used to allow for variability in providing milk to the NICU for initial feeding and variability of timing of discharge on the last hospital day. For all inferential statistical analyses, a p-value of 0.05 was used to establish significance.

Table 1
Sample characteristics

Variable	Breast milk fed		Formula fed	
	M/n	SD/%	M/n	SD/%
Infant gestational age (weeks)	31.8	2.2	31.6	2.5
Infant sex				
Males	36		40	
Females	39		35	
Chronological age at 1st milk feeding (days)	3.2	2.5	3.0	2.0
Conceptional age at discharge (weeks)	36.1	1.6	35.8	1.2

Note: p-values for feeding group comparisons with pertinent F or χ^2 statistics were >0.51.

Results

There were 75 preterm infants (49.7%) who were fed any breast milk (BF) during hospitalization, and 76 preterm infants (51.3%) who were fed exclusively formula (FF). BF preterm infants received breast milk for at least 1 feeding per day on an average duration of 43.6% of the days they were hospitalized. The number of days hospitalized ranged from 3 to 79 ($M = 29.0$; SD 18.9). On those days, the mean percentage of feedings at which they received breast milk was 36.3%. One quarter of BF preterms were fed breast milk on more than 66% of hospital days, whereas 27% were fed breast milk for less than 25% of hospital days. In table 1 is the sample descriptor information. BF and FF groups were comparable in gestational age, sex, age at first feeding, and conceptional age at hospital discharge.

Table 2
Maternal and infant variables by feeding group

Variable	Breast milk fed		Formula fed		F/χ^2	p
	M/n	SD/%	M/n	SD/%		
Maternal age (yrs)	26.2	6.0	23.1	5.5	10.78	$<0.01^{*}$
Maternal race					0.05	>0.82
Caucasian	63	84	64	85		
Minority	12	16	11	15		
Marital status					0.34	>0.55
Married	38	60	37	55		
Non-married	25	40	30	45		
Prenatal smoking					7.36	$<0.01^{*}$
Yes	19	28	33	52		
No	48	72	31	48		
Insurance					15.16	$<0.0001^{**}$
Private	36	58	16	24		
Public/none	26	42	50	76		
Parity					0.87	>0.35
First	44	68	51	75		
Multiple	21	32	17	25		
Birth weight (kg)	1.74	0.46	1.76	0.57	0.06	>0.80
Hospital stay (days)	30.2	19.2	28.5	19.6	0.01	>0.91
Oxygen (days)	5.0	10.7	6.4	13.4	0.94	>0.33
Apgar-5 min					5.24	$<0.03^{***}$
$\leqslant 6$	4	5	13	17		
$\geqslant 7$	71	95	63	83		

Note: Not all subjects have complete data on all variables.
$^{*}p<0.05$.
$^{**}p<0.01$.
$^{***}p<0.001$.

Table 3
Relations among predictors and breast feeding status

Construct	$R^2\Delta$	Adjusted odds ratio	CI	χ^2	p
Maternal variables	16.6%				$<0.03^*$
Age		3.70	1.2–11.5	5.10	$<0.03^*$
Race		1.05	0.3–3.7	0.01	>0.93
Marital status		1.50	0.5–4.8	0.47	>0.49
Insurance status		2.69	0.9–8.1	3.06	<0.09
Primiparous		0.68	0.2–2.1	0.48	>0.48
Smoking		0.51	0.2–1.4	1.61	>0.20
Infant variables	10.3%				$<0.05^*$
Birth weight		0.96	0.5–6.2	0.0	>0.96
Apgar score-5 min		0.08	0.0–0.8	4.79	$<0.03^*$
Days of hospitalization		1.02	1.0–1.1	0.57	>0.44
Days on oxygen		0.94	0.9–1.0	1.22	>0.26

Note: $N = 83$ with complete data on all variables.
$^*p<0.05$.

In table 2 are the maternal and infant variables of interest as a function of feeding group. On average, mothers of BF infants were older at delivery, were more likely to have private insurance, and were less likely to smoke during pregnancy than FF infant mothers. Feeding groups did not differ in marital status, primiparity, or race. BF infants were less likely to have an Apgar score of $\leqslant 6$ at 5 min than FF infants, but were comparable in birth weight, length of hospitalization, and days on oxygen, consistent with a similar hospital course between feeding groups.

Among BF infants, mothers of those who received breast milk more consistently during hospitalization were older at delivery by an average of 3.18 years ($t[73] = 2.32$, $p<0.03$) than mothers of infants who received breast milk less consistently. There were no differences in the other maternal variables. Infants who received breast milk more consistently during hospitalization also were comparable in birth weight, days of hospitalization, and days on oxygen to those who received breast milk less consistently.

The results from the logistic regression models are depicted in Table 3. Both maternal demographics and infant medical condition, as blocks, accounted for significant variability in breast milk feeding odds. Among maternal predictors, women 21 years of age and older were 3.70 times more likely to use breast milk to feed their preterm infant than younger women, whereas privately insured women were 2.69 times more likely to use breast milk to feed their preterm infant than those with Medicaid or no health insurance ($p<0.09$). Among infant medical condition variables, preterm infants at greater biologic risk (Apgar scores $\leqslant 6$ at 5 min) were 92% less likely to be fed breast milk during hospitalization than were lower risk infants. Marital status, maternal race, prenatal smoking, and parity were not associated significantly with breast milk feeding odds, nor were birth weight, days of hospitalization, or oxygen therapy.

There were 10 BF preterm infants (15.3% of infants fed breast milk) who were fed breast milk within 2 days of milk feeding initiation, too small to make meaningful comparisons to those who did not receive breast milk in this time period. Within 2 days of hospital discharge, there were 55 BF preterm infants (73.3%) fed breast milk. These BF infants were born later in gestation ($M_{diff} = 2.8$ weeks, $F[1,73] = 31.99$, $p<0.0001$), weighed more at birth ($M_{diff} = 0.6$ kg, $F[1,73] = 34.77$, $p<0.0001$), were hospitalized for fewer days ($M_{diff} = -23.5$ days, $F[1,73] = -34.31$, $p<0.0001$), and received oxygen therapy for fewer days ($M_{diff} = -7.7$ days, $F[1,66] = 7.47$, $p<0.01$) than BF preterm infants whose last breast milk feeding was more than 2 days prior to hospital discharge. Maternal demographic and pregnancy variables did not differ by breast milk feeding status within 2 days of hospital discharge.

Discussion

About half of preterm infants in this study were breast milk fed during hospitalization. These rates are lower than what is found at our hospital across all infants during the study period (63%) and nationally (Ryan, 1997), although these rates are not directly comparable as the rate for fullterm infants represents feeding status at day of life 2–4 (i.e., at discharge), rather than at an average day of life 30 for preterm infants (sample mean length of hospitalization). These findings from a rural catchment area are consistent with those of other researchers who also found a lower rate of breast milk feeding in preterm infants internationally (Yip et al., 1996) and in low birth weight infants in the US (Ryan,

1997). Interestingly, the magnitude of the difference between the percentage of breast milk fed preterm and fullterm infants was similar in this study and those conducted internationally, even though the base rates of breast feeding healthy infants differ significantly across countries. The consistency of these findings across nations highlights the important differences between preterm and fullterm infants that affect feeding practices.

Similar to results from studies of unselected healthy infants (Grossman et al., 1990; Kuan et al., 1999; Ryan et al., 1990), maternal demographic and pregnancy variables were related strongly to breast milk feeding in preterm infants, including older maternal age, non-smoking status, and private insurance status, a proxy for socioeconomic status. Furthermore, even among women who fed their preterm infants breast milk, older age was related to more consistent breast milk feeding during hospitalization. These women may better recognize the advantages of breast milk and may have more resources at their disposal that make it easier to express milk or to make milk available to the infant more consistently. Other studies with low birth weight infants have found that employment status (Hill & Aldag, 1996) and education (Boo & Goh, 1999) were related to breast milk feeding odds. These variables were not available in most preterm hospital charts, and therefore, were not included here. However, demographic variables typically are inter-correlated. The blocked statistical entry strategy capitalized on these inter-relations among maternal predictors to understand the contribution as a whole; however, the influence of any single predictor was attenuated as the odds ratio is adjusted for all other variables in the model.

Relative to preterm infants delivered in urban, tertiary care medical centers, similar maternal demographic correlates of breast milk feeding were observed in those infants from a non-metropolitan catchment area, namely, maternal age (Furman et al., 1998) and insurance status (Furman et al., 2002). Interestingly, smoking status differed between mothers of breast milk and formula fed infants, but did not in infants delivered in urban centers. Smoking during pregnancy is more prevalent in Caucasian women, those who are disadvantaged economically, and those who are younger at delivery (Vega, Kolody, Hwang, & Noble, 1993). Smoking status may be a more important factor in breast feeding in the rural setting. However, its role was not unique, as it was not an independent predictor when considered in the model with other maternal demographic factors.

Unlike results from studies with healthy infants (DaVanzo et al., 1990; Kuan et al., 1999), infant medical condition during hospitalization clearly plays a role in feeding practices, even beyond that of maternal characteristics. In preterm infants, there is sufficient variability in medical condition to examine effects on feeding practices. Infants who were more biologically at-risk, defined by a 5-min Apgar score of $\leqslant 6$, were less likely to be breast milk fed during hospitalization. These findings differ from those of Furman et al. (2002), who found that earlier gestational age and lower weight at birth was related to an increased likelihood of breast feeding. Furman et al.'s study, however, focused on very low and extremely low birth weight preterm infants, and therefore, excluded those with weights above 1500 g, thereby attenuating the differential influence of low Apgar scores on breast milk feeding.

Medical staff may view infants with low Apgar scores as more compromised or stressed and not as neurologically equipped to directly breast feed eventually, and therefore recommend early formula feeding to avoid future difficulties. Alternatively, parents may overestimate the fragile nature of their preterm infant, which may interfere with lactation due to maternal anxiety or predispose parents to choose the more easily measurable formula feeding. Unfortunately, because so few breast milk fed infants were at risk ($n = 4$), it was not possible to determine whether biologic risk, as quantified by low 5-min Apgar scores, differentially impacts breast milk feeding initiation or premature termination during hospitalization. Further studies that include maternal and medical staff perceptions of risk, in addition to biologic risk measures, would be useful to investigate these alternatives.

Interestingly, days of hospitalization and days of oxygen did not differ between breast milk and formula fed groups and did not contribute to breast feeding odds, indicating that duration of treatment and hospitalization did not contribute uniquely to breast feeding likelihood. Among breast milk fed preterm infants, there also were no differences in these infant variables between those who received breast milk more consistently during hospitalization and those who did not. In contrast, these variables were related to the timing of breast milk feeding during hospitalization. Preterm infants who were fed breast milk within 2 days of hospital discharge spent fewer days on oxygen, were of older gestational age and greater birth weight, and were hospitalized for a shorter duration, consistent with findings by Furman et al. (1998). Taken together, these findings suggest that mothers of earlier born preterm infants who require more intensive neonatal care either are not encouraged or assisted in persisting in breast feeding, or have more trouble sustaining breast milk use during the prolonged hospitalization. Mothers of sicker preterm infants naturally have more health concerns than mothers of healthier preterm infants, and anxiety affects milk supply (Nissen, Gustavsson, Widstrom, & Uvnas-Moberg, 1998). All of these factors may lead to less inclination to continue to use breast milk or early, unplanned termination of breast milk feeding in sicker preterm infants.

Unfortunately, it is precisely these infants who may benefit more from the immunuologic properties of breast milk. The early perinatal period may be a particularly important time for the lactation consultant, NICU nursing staff, and neonatalogists to intervene to promote breast feeding in these families. In comparison to fullterm infants, medical staff play a more prominent role in feeding decisions for preterm infants due to expertise in the medical condition and caretaking of the infant. While there are many barriers to successfully breast milk feeding preterm infants, many women can initiate feeding with sufficient education, hands-on skill teaching, and ongoing support, although they may not appear as capable in the stressful NICU environment. Programs that provide such comprehensive assistance are not available routinely (e.g., Meier et al., 1993); therefore, ongoing verbal communication between medical staff and patients is important.

Identification of the variables that affect breast feeding in special populations can be used to develop and implement unique interventions that serve to modestly increase breast feeding rates as a whole. Because nearly 10% of all deliveries are preterm, interventions to increase breast feeding in this population have the potential to make important strides towards meeting public health goals. Especially in the context of limited public health dollars, targeted breast feeding intervention campaigns can be successful and cost effective (Wright, Naylor, Wester, Bauer, & Sutcliffe, 1997). For example, younger women who smoke during pregnancy could be targeted prenatally to promote breast feeding. Interestingly, breast feeding also has been related to delayed post-natal resumption of smoking (O'Campo, Faden, Brown, & Gielen, 1992). Therefore, pre- and post-natal interventions to increase breast feeding intention and behavior in smoking mothers could positively impact both maternal and infant health. Breast feeding interventions designed for healthy infants need to be tailored specifically to the needs of families with preterm infants and must address the specific barriers that these families face, including infant medical complications, the need to express milk and travel to the hospital for feeding, coordination with hospital policies and procedures, and the lack of reinforcement from infant contact that usually occurs during nursing.

The present study has several limitations. First, as is typical of most regional NICUs in non-metropolitan areas, infants are not served with the most severe illnesses that routinely occur in extremely low birth weight infants who require surgery. Given the relation between low 5-min Apgar scores and breast feeding, these infants would be less likely to be breast fed. Mothers of extremely low birth weight infants also are of greater social risk. Inclusion of these women would depress breast milk feeding rates and increase the relation between the maternal and infant variables and breast feeding. In addition, an inclusive criterion for breast milk feeding was employed in the present study because of the special barriers that mothers of preterm infants face when choosing to feed breast milk in the NICU. The definition of "breast fed" varies across studies and a more stringent criterion may have affected results. Despite these caveats, about half of all preterm infants were fed breast milk during hospitalization. Similar to healthy, largely fullterm infants, breast milk feeding was related to maternal factors in these preterm infants from a non-metropolitan catchment area. However, infant medical condition was a unique determinant of breast milk feeding in preterm infants. Subgroups of families can be targeted for intervention to modestly increase population breast milk feeding rates.

Acknowledgements

This research was supported in part by a grant from the Central Research Committee, Southern Illinois University School of Medicine to the first author. We would like to thank Rudolph Foy, M.D., Medical Director, the Neonatal Intensive Care Unit staff, and the Medical Records staff at Memorial Hospital of Carbondale for their assistance in conducting this study. The assistance of Jesse Brennan, M.A. and Sylvia Jones, M.A. in data collection also is recognized. The comments from three anonymous reviewer are appreciated. Portions of this paper were presented at the meeting of the International Conference for Infant Studies, July 14–17, 2000.

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