Maternal Education Is Associated with Disparities in Breastfeeding at Time of Discharge but Not at Initiation of Enteral Feeding in the Neonatal Intensive Care Unit

Lena Carolin Herich, PhD[1], Marina Cuttini, PhD[1], Ileana Croci, MSc[1], Francesco Franco, MSc[2], Domenico Di Lallo, MD[2], Dante Baronciani, MD[3], Katia Fares, MD[4], Giancarlo Gargano, MD[5], Massimiliano Raponi, MD[6], and Jennifer Zeitlin, PhD[7], on behalf of the Italian Effective Perinatal Intensive Care in Europe (EPICE) Network*

Objective To investigate the relationship between maternal education and breastfeeding in very preterm infants admitted to neonatal intensive care units.

Study design This prospective, population-based cohort study analyzed the data of all very preterm infants admitted to neonatal care during 1 year in 3 regions in Italy (Lazio, Emilia-Romagna, and Marche). The use of mothers' own milk was recorded at initial enteral feedings and at hospital discharge. We used multilevel logistic analysis to model the association between maternal education and breastfeeding outcomes, adjusting for maternal age and country of birth. Region was included as random effect.

Results There were 1047 very preterm infants who received enteral feeding, and 975 were discharged alive. At discharge, the use of mother's own milk, exclusively or not, and feeding directly at the breast were significantly more likely for mothers with an upper secondary education or higher. We found no relationship between maternal education and type of milk at initial enteral feedings. However, the exclusive early use of the mother's own milk at initial feedings was related significantly with receiving any maternal milk and feeding directly at the breast at discharge from hospital, and the association with feeding at the breast was stronger for the least educated mothers.

Conclusion In this population-based cohort of very preterm infants, we found a significant and positive association between maternal education and the likelihood of receiving their mother's own milk at the time of discharge. In light of the proven benefits of maternal milk, strategies to support breastfeeding should be targeted to mothers with less education. *(J Pediatr 2017;182:59-65).*

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Maternal education has been linked consistently with the initiation and duration of breastfeeding in many studies and different populations, even after accounting for other socioeconomic indicators.[1-11] Most of this research has focused primarily on the healthy term or moderately preterm infants, but studies on very preterm infants (those born before 32 weeks' gestation) are scarce. A Swedish study reported a positive association between maternal university education and breastfeeding duration, but the result was attenuated after adjustment for social welfare benefits.[12] In the same country, Omarsdottir et al[13] found that maternal university education increased the likelihood of breast milk feeding for babies born before 28 weeks' gestation during the first 6 weeks of life, but not at discharge. Two additional studies found that mothers' higher social class and education were significant predictors of breastfeeding, but specific results for education[14] and very preterm infants[15] were not shown.

Very preterm infants represent <2% of all births, but contribute to a large part of overall infant mortality and morbidity.[16] Survivors show increased risk of chronic neuromotor and sensory disabilities, as well as cognitive and behavioral problems.[17] Breastfeeding these babies is challenging, but the rewards may be substantial.[18] Maternal milk feeding confers protection against late-onset infections and necrotizing enterocolitis, and promotes brain growth, neurodevelopment, and cognitive function.[18-21] Long-term benefits include reduced rates of meta-

EPICE	Effective Perinatal Intensive Care in Europe
GA	Gestational age
NICU	Neonatal intensive care unit

From the [1]Research Unit of Perinatal Epidemiology, Clinical Care and Management Innovation Research Area, Bambino Gesù Children's Hospital, IRCCS, Rome, Italy; [2]Hospital Network Planning and Research Area, Lazio Regional Health Authority, Rome, Italy; [3]Hospital Care Services, General Directorate for Health and Social Policies, Emilia Romagna Region, Bologna, Italy; [4]Neonatal Intensive Care Unit, Salesi Children's Hospital, Ancona, Italy; [5]Neonatal Intensive Care Unit, Department of Obstetrics and Pediatrics, Arcispedale Santa Maria Nuova, IRCCS, Reggio Emilia, Italy; [6]Clinical Care and Management Innovation Research Area, Bambino Gesù Children's Hospital, IRCCS, Rome, Italy; and [7]INSERM, Obstetrics, Perinatal and Paediatric Epidemiology Research Team, Center for Epidemiology and Biostatistics (U1153), and DHU Risks in Pregnancy, Paris Descartes University, Paris, France

*List of additional Italian EPICE Network members is available at www.jpeds.com (**Appendix**).

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bolic syndrome, reduced blood pressure, and improved cardiovascular health.[22] Breastfeeding has benefits for the mother too, including a significantly reduced risk of maternal cardiovascular and metabolic diseases and ovarian and breast cancers,[18] as well as increased confidence in her role as a caregiver.[23]

This study aimed to describe the use of mothers' own milk at initial feedings and at discharge from the neonatal intensive care unit (NICU) in a population-based cohort of very preterm infants in 3 regions in Italy, and to investigate the association between maternal education and breastfeeding outcomes. Additionally, we explored the interaction between maternal education and the use of mother's milk at initial feedings in explaining the type of feeding at discharge.

Methods

This study was carried out in 3 regions in Italy (Lazio, Emilia Romagna, and Marche) that participated in the European Effective Perinatal Intensive Care in Europe (EPICE) project on the use of evidence-based interventions for the care of very preterm infants.[24] EPICE recruited a population-based cohort of all births occurred at a gestational age (GA) of 22^{+0} to 31^{+6} weeks between June 2011 and May 2012. Data on maternal education at delivery were collected only in Italy, where 1134 live births, including 572 in Lazio, 458 in Emilia Romagna, and 104 in Marche, were recruited. The Ethics Committee of the Paediatric Hospital Bambino Gesù approved the study and informed consent was obtained from the parents.

Data were collected using a standardized questionnaire with common definitions agreed by the EPICE consortium. GA was recorded as the best obstetrical estimate from information on the last menstrual period and ultrasound measures. We recorded the date of first enteral feed, including "trophic" or "minimal" enteral feeding, and type of milk (mother's own milk, donor milk, or formula) administered in the subsequent 24 hours. Data collected at discharge included type of milk and whether the infant was suckling at the mother's breast.

Maternal education was recorded as the highest qualification obtained at time of delivery (none, primary school only, lower and upper secondary, and university degree or higher). In Italy, primary school graduation usually takes place after 5 years of school, a lower secondary degree requires 3 more years, and an upper secondary degree requires 3-5 additional years, for a total of 11-13 years of education.

For initial feeding, we analyzed exclusive maternal milk at initial feedings (ie, administration of mother's own milk only in the first 24 hours after first enteral feed) and exclusive maternal milk starting within the first 3 days of life (ie, first enteral feed within 3 days of life followed by exclusive maternal milk feedings in the next 24 hours). Because the exact time of the first feed was not recorded, it was set at 12:00 p.m.

Outcomes at discharge from the NICU were any maternal milk feeding, exclusive or mixed, independent of mode of feeding; exclusive maternal milk feeding, independent of mode of feeding; and any direct breastfeeding, defined as suckling directly at the mother's breast, exclusively or together with bottle and/or formula.

Statistical Analyses

We carried out multivariable multilevel logistic regression analyses to explore the relationship between maternal education and outcomes, taking into account the hierarchical structure of the data. To identify the covariates to be included in the model, we drafted a causal diagram (directed acyclic graph) representing the hypothesized causal relations relevant to our main research question (**Figure 1**; available at www.jpeds.com). As suggested by Williamson et al,[25] we considered as potential confounders the common causes of both exposure, maternal education, and breastfeeding outcomes. Thus, we adjusted for maternal age and country of birth (coded as Italy, Western Europe and US, or other countries); region was included as a random effect in multilevel models. As a subsequent step, we introduced in the multivariable models predicting outcomes at discharge a composite variable based on the 2 early feeding outcomes, coded as no exclusive maternal milk at initial enteral feedings, exclusive maternal milk started after the first 3 days of life, and exclusive maternal milk started within the first 3 days, exploring its interaction with maternal education.

We carried out multiple imputation with chained equations to generate values for missing maternal education data (9% for infants admitted to the NICU and 8% for those discharged alive).[26] Data were assumed to be "missing at random."[26] All variables included in the models as predictors or outcomes were used to predict missing values.[26,27] Ten datasets were imputed to match with the maximum proportion of missing values in the exposure variable.[26] Outcomes were not imputed.[26]

To investigate the extent to which the association between maternal education and breastfeeding outcomes was mediated by other variables, we carried out mediator analyses for the 4 relevant intermediates identified in our causal diagram (**Figure 1**): parity, multiple birth, GA, and small for GA status. Small for GA status was identified using the intrauterine fetal weight percentiles by GA obtained from the Hadlock et al's fetal growth equation[28] as modeled by Gardosi et al,[29] and adapted to the Italian population using the sex-specific mean and standard deviation of birth weight at 40 weeks gestation for births in Italy in 2010. Because the independence of effects could not be assumed, the 4 mediators were considered together according to the inverse odds weighting approach.[30] The bootstrap method was used to derive *P* values and 95% CIs for direct and indirect effects.[30] Because weighted multilevel logistic regression analysis after multiple imputation with chained equations is not available in STATA (StataCorp, College Station, Texas), mediation analysis involved only cases for which all the relevant data were available (complete cases). For parsimony, upper secondary and university education were combined into a single category.

Sensitivity analyses were performed. First, multilevel models were run with complete cases only. Second, the analyses with imputed data were repeated, including only 1 randomly se-