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A Test of Kangaroo Care on Preterm Infant Breastfeeding

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Abstract

Objective—To test the effects of kangaroo care (KC) on breastfeeding outcomes in preterm infants compared to two control groups and to explore whether maternal-infant characteristics and the mother's choice to use KC were related to breastfeeding measures.

Design—Secondary analysis of a multisite, stratified, and randomized 3-arm trial. The treatment groups used KC, auditory-tactile-visual-vestibular (ATVV) intervention, or preterm infant care information.

Setting—Neonatal intensive care units from 4 hospitals in the United States from 2006–2011.

Participants—Racially diverse mothers (*N*=231) and their preterm infants born weighing < 1750 grams.

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Methods—Mothers and their infants were enrolled once the infants were no longer critically ill, weighed at least 1000 grams, and could be safely held outside of the incubator by parents. Participants were instructed by study nurses; those allocated to either KC or ATVV were asked to engage in these interactions for a minimum of 3 times a week in the hospital and at home until 2 months adjusted age.

Results—Feeding at the breast during hospitalization, the duration of post-discharge breastfeeding, and breastfeeding exclusivity after hospital discharge did not differ statistically among the treatment groups. Regardless of group assignment, married, older, and more educated women were more likely to feed at the breast during hospitalization. Mothers who practiced KC, regardless of randomly allocated group, were more likely to provide their milk than those who did not practice KC. Breastfeeding duration was greatest among more educated women.

Conclusion—As implemented in this study, assignment to KC did not appear to influence the measured breastfeeding outcomes.

Keywords

preterm infants; neonatal intensive care unit; infant feeding; NICU; mothers; massage; kangaroo care

Human milk is internationally recognized as the optimal nutrition for infants because of the plethora of benefits for infants and young children (American Academy of Pediatrics, 2012; Horta & Victora, 2013). Breastfeeding is particularly important for preterm infants, who have high rates of morbidity and mortality (Hamilton, Hoyert, Martin, Strobino, & Guyer, 2013). An exclusive human milk diet for preterm infants (mothers' milk and donor milk) is associated with shorter neonatal intensive care length of stay and lower hospitalization costs than a partial human milk diet (Johnson, Patel, Bigger, Engstrom, & Meier, 2014; Ganapathy, Hay, & Kim, 2012). Preterm infants with more than 50% breastmilk in enteral (tube) feedings at the time of feeding advancement have faster transitions to full enteral feedings than other preterm infants (Sisk, Lovelady, Gruber, Dillard, & O'Shea, 2008). More rapid feeding advancement of infants born very low birth weight is protective against late-onset sepsis and other health problems (Härtel et al., 2009; Krishnamurthy, Gupta, Debnath, & Gomber, 2010). Breastfeeding also promotes cognitive and motor development (Pinelli, Saigal, & Atkinson, 2003; Vohr et al., 2007) and is associated with a lowered incidence of necrotizing enterocolitis (Quigley & McGuire, 2014), which is a leading cause of death in preterm infants (Berrington, Heam, Bythell, Wright, & Embleton, 2012). However, only a few randomized trials of the effects of interventions administered by the mother in neonatal intensive care units (NICUs) on breastfeeding have been published. Therefore, the purpose of this secondary analysis of a randomized controlled trial was to test the effects of kangaroo care (KC) on measures of preterm infant breastfeeding.

A better understanding of factors that promote breastfeeding among mother-preterm infant dyads is needed because lactation also has health benefits for mothers, including a lower risk of cancer, hypertension, and myocardial infarction (Bartick et al., 2013; Stuebe et al., 2009, 2011). Further, many women report emotional closeness to their preterm infants when providing breastmilk (Sweet, 2008). Mothers described providing their milk to preterm

babies as worthwhile because of both the health benefits for infants (Miracle, Meier, & Bennett, 2004) and enhanced satisfaction with their role in infant care (Fenwick, Barclay, & Schmied, 2008).

Breastmilk expression by mothers of preterm infants is cost effective (Jeiger, Meier, Engstrom, & McBridge, 2010) and achievable (Hartmann, Cregan, Ramsay, Simmer, & Kent, 2003; Zachariassen et al., 2010) but challenging (Lee, Lee, & Kuo, 2009). Lactation success in this population varies by prenatal infant feeding plans (Sisk, Lovelady, Dillard, Gruber, & O'Shea, 2009), previous breastfeeding experience (Smith, Durkin, Hinton, Bellinger, & Kuhn, 2003), socioeconomic status (greater among those not eligible for Medicaid), race (less among African American women than in others; Pineda, 2011; Smith et al., 2003), and hospital (Davanzo, Ronfani, Brovedani, & Demarini, 2009). A number of practices are effective for promoting breastfeeding in NICUs (Renfrew et al., 2010). Breastfeeding preterm infants requires individualized support (Callen, Pinelli, Atkinson, & Saigal, 2005; Sisk, Quandt, Parson, Tucker, 2010) that addresses maternal emotional needs, mother-infant interactions, infant behavioral capabilities, infant oral feeding readiness, and changes in these factors over time (White-Traut & Norr, 2009). Lactation counseling is one approach to such support and has not been found to increase stress in mothers of preterm infants, including mothers who originally intended to formula feed (Sisk, Lovelady, Dillard, & Gruber, 2006). Further work is needed, however, to create an evidence base for enabling breastmilk feedings in NICUs (Meier, Patel, Bigger, Rossman, & Engstrom, 2013).

Kangaroo care, holding the undressed infant between the mother's breasts in skin-to-skin contact, is an intervention that has sometimes been found to promote breastfeeding (Moore, Anderson, Bergman, & Dowswell, 2012), but to date the evidence is mixed. For the infant, the positive effect is probably due to the ability to smell breastmilk, relax, organize body movements, and reach the nipple (Bystrova et al., 2003; Widström et al, 2011), in addition to promoting better temperature regulation and less crying than occurs when the infants are left in the incubators (Christensson et al., 1992). For the mother, physical contact around the breast as a part of KC may increase oxytocin levels (Winberg, 2005), promoting lactation and emotional connectedness with the infant (Uvnäs-Moberg, 1998).

Surveys have found that 70–80% of NICUs in the United States practice KC at least occasionally (Engler et al., 2002; Franck, Bernal, & Gale, 2002). Kangaroo care has been recommended as a step to promote breastfeeding for preterm infants (Spatz, 2004). However, Roberts, Paynter, and McEwan (2000) found that infants receiving KC as part of a randomized trial did not experience longer breastfeeding duration than dressed infants who were held while swaddled.

The purpose of this secondary analysis, therefore, was to explore the effect of KC on breastfeeding outcomes (feeding at the breast during hospitalization, the duration of post-discharge breastfeeding, and breastfeeding exclusivity after hospital discharge) in comparison with two control groups of mothers, one allocated to ATVV and the other to receive instruction on home preterm infant care. The developmental science perspective on the mother-infant dyad (Miles & Holditch-Davis, 2003) was the theoretical framework for this study. In this framework, breastfeeding practices are mother-infant system outcomes

that involve reciprocal interactions between mother and infant behaviors and characteristics (Thoman, Acebo, & Becker, 1983). Kangaroo care has the potential to alter the mother and infant dyad by positively affecting both mother and infant relevant variables, and thus might result in better breastfeeding outcomes.

Methods

We conducted a secondary analysis of a randomized controlled trial that was conducted from 2006 to 2011 in four hospitals, two in Illinois and two in North Carolina. Information on the primary study outcomes have been published: infant behaviors during the KC or ATVV sessions (White-Traut, Wink, Minehart, & Holditch-Davis, 2012), maternal satisfaction with administering KC or ATVV in the neonatal intensive care units (Holditch-Davis et al., 2013), and maternal psychological well-being and mother-infant relationships over time (Holditch-Davis et al., 2014).

Participants

Following Institutional Review Board approval, mothers and their infants were enrolled once the infant was no longer critically ill, weighed at least 1000 grams, and could be safely held outside of the incubator by parents. Infants with congenital neurological problems (e.g., congenital hydrocephalus, neuronal migrational disorders, genetic disorders with neurologic involvement) or symptoms of substance exposure were excluded. All other infants, including those with postnatal neurological insults or substance exposure without symptoms, were eligible. Multiple birth infants were included; one infant from each set was randomly selected for study. Mothers were excluded if they did not have custody of the infant, if their situations would affect the ability to administer the intervention (age less than 15; history of HIV, psychosis, or bipolar disease; current diagnosis of major depression; ongoing critical illness; or non-English speaking), or if follow-up for 12 months was unlikely (out-of-state visitors).

For our analysis, a sample size of 35 in each group was required to detect a difference in breastfeeding duration. The parameters for the power calculation were based on the findings of Hake-Brooks and Anderson (2008), in which preterm mother-infant dyads allocated to KC breastfed for a mean of 5.08 months (range 0–18 months) compared to 2.05 months (range 0–7) among the control dyads. The value for sigma, 4.5, was approximated from the range found by Hake-Brooks and Anderson (18) divided by 4 (as recommended by Mendenhall, Beaver, and Beaver (2009). The calculation was for a two-sided test, with a value of .05 for alpha and .80 power. A CONSORT diagram is provided in Figure 1.

Characteristics of the mothers and infants in the groups are presented in Tables 1 and 2. By chance, the KC and ATVV groups had more first-time mothers than the information group, so all group comparisons controlled for this difference. The groups did not differ on recruitment state (North Carolina or Illinois), other maternal characteristics, infant characteristics, or the pre-enrollment characteristic of whether mothers provided their milk in the hospital.

Control groups

Auditory-tactile-visual-vestibular intervention—The auditory-tactile-visual-vestibular (ATVV) intervention involves infant stimulation over the course of 15 minutes. The intervention involves maternal talking to the infant, then adding stroking or massage, with eye contact when the infant is alert, for about 10 minutes, and then withdrawing the tactile component and adding horizontal rocking of the infant for an additional 5 minutes (Burns, Cunningham, White-Traut, Silvestri, & Nelson, 1994). The massage progresses from the least to the most sensitive infant areas, including the top and back of the head, back, chest, abdomen, arms, legs, and forehead (Burns et al., 1994; White-Traut & Norr, 2009).

ATVV has been found to improve maternal sensitivity to infant cues (White-Traut et al., 2002) and elicit more engagement and disengagement behavior in the infants than shown by infants experiencing KC (White-Traut et al., 2012). It also has been shown to elicit alertness in the infant (White-Traut, Nelson, Silvestri, Cunningham, & Patel, 1997; White-Traut, Rankin, Pham, Li, & Lu, 2014), the state most often observed before a successful feeding in preterm infants (White-Traut, Nelson, Silvestri, Patel, & Kilgallon, 1993), and to increase the frequency of orally directed behaviors leading to improved oral feeding efficiency (ml/min oral intake) (White-Traut et al., 2002; White-Traut, Berbaum, Lesssen, McFarlin, & Cardenas, 2005; White-Traut et al., 2014). However, to our knowledge, ATVV has never been studied in relationship to breastfeeding outcomes and was therefore not hypothesized to have an effect on these measures. In this study, the ATVV intervention was used as a control for maternal involvement with the infant and improved infant feeding ability.

Information on preterm infant care—The third treatment group is an attention control group in which the mothers met weekly with a study nurse discussing needs for preterm infant care at home. Specific topics covered were diapers, infant clothing and blankets, car safety seats, breastfeeding supplements, formula, and toys. Since the intervention groups saw their study nurse once a week, the study nurse also saw the attention control mothers weekly to allow the mothers to ask questions or have information clarified.

Procedures

Potential participants were informed that the study involved mothers either conducting safe and potentially beneficial interventions for their infants when they visited or receiving education on needs of preterm infants. Mothers were enrolled during a hospital visit by a research team member. Immediately after a mother provided written informed consent, the baseline questionnaires were administered. The questionnaires took less than 20 minutes to complete. Randomization to the KC, ATVV, or information group was stratified by the four study hospitals and by singleton versus multiple births. The randomization schedule was predetermined by the statistician, using random numbers.

Mothers in each group were provided a written description about their treatment group and instructed in their protocol by study nurses, who had been trained in teaching and supporting participants by the investigators and the consultant. Participants assigned to one of the maternally administered interventions were asked to practice either KC or ATVV for a

minimum of 3 times a week in the hospital and at home until 2 months adjusted age. The KC sessions were each to last at least 15 minutes, and preferably more. Mothers were instructed to recognize when the infant was not tolerating the intervention (e.g., bradycardia, apnea, distress behavior; Burns et al., 1994) and told to check with the NICU nurses during each visit to make certain that no medical set-back had occurred that would make the intervention inappropriate on that day.

Nurses in the NICUs were instructed in the protocols for all three groups so that they could monitor infants before and during the interventions. NICU nurses were not directly involved with the interventions beyond assisting women upon maternal request, such as getting into KC or putting a privacy screen around the mother-infant dyads. NICU nurses and other staff were also instructed about the importance of not expressing a preference for a treatment group to any parent. Although mothers received guidance only on their treatment group, they were free to engage with their infants in any form of holding.

To promote fidelity, the participants were videotaped weekly, during intervention administration, by study nurses to assess KC and ATVV technique and to insure that the study nurses effectively supported the participants. Study investigators reviewed the about 30-minute videos during biweekly teleconferences and discussed any modifications to implement. When not present in the nurseries, study nurses were also available by phone to answer questions from either mothers or NICU nurses. The information group spent time in the hospital with study nurses for instruction on equipment needed for infant care at home. The study nurses also videotaped the information group mothers weekly while they held their infants to insure their study experiences were equivalent to that of the KC and ATVV mothers.

Participants were asked to complete infant bedside checklists about their activities during each visit. A range of activities including feeding, singing, and rocking were listed on the checklists along with KC and the components of ATVV to minimize drawing mothers' attention to the study activities. The checklist items had representative pictures so that mothers with low literacy could use them as visual cues. Other investigators have used similar procedures to have mothers record intervention usage (White-Traut et al., 2013) and mothers have also successfully completed more complex diaries on infant symptoms, sleep, and feeding patterns (Ely, Dampier, Gilday, O'Neal, & Brodecki, 2002; Thomas, 2000). The study nurses collected the checklists at least weekly. However, sometimes mothers failed to complete them, and sometimes the completed checklists were lost in the NICU.

Each participant was in the study for about 14–15 months (from 2–3 months prior to term to 12 months adjusted age). Data were obtained while the infant was in the hospital at enrollment and discharge, at home at 2 and 6 months of age adjusted for prematurity, and at a follow-up clinic visit at 12 months. Mothers were paid $10 each time they completed questionnaires. The infant was given a small gift at each home visit.

Measures

Infant feeding outcomes—Data on maternal breastmilk provision in the hospital and feeding at the breast were obtained by a review of the infant's medical records. For analyses,

the provision of breastmilk and feeding at the breast were both coded as dichotomous variables, at least one occurrence or none. At 2, 6, and 12 months adjusted for prematurity, mothers completed questionnaires that asked if they were currently breastfeeding and when, if at all, this changed since the last study contact. Maternal questionnaires at the 2 and 6 month data collection points also assessed breastfeeding exclusivity. Exclusive breastfeeding was defined as the infant not receiving any substance other than breastmilk, vitamins, or medicines.

Maternal and infant characteristics—The mothers completed a demographic information form that included questions on maternal age, race, ethnicity, education, and whether or not the family was receiving public assistance. Infant medical records were reviewed weekly from enrollment until NICU discharge to obtain the obstetric history and the infant's medical course. Information from the medical record at infant discharge was scored on the Neurobiologic Risk Scale (NBRS; Brazy, Goldstein, Oehler, Gustafson, & Thompson, 1993) that measures potential insults to the brain through direct injury or inadequate blood flow, nutrients, or oxygenation. Seven neurological insults are scored for severity on a 4-point scale, with higher scores indicating more severe insults. NBRS scores were correlated with measures of neurological development, including the Bayley Mental Development Index and Psychomotor Development Index at 6–24 months adjusted age with neurological examinations at 6 and 15 months (Brazy et al., 1993). Inter-rater reliability was reported as 97% (Brazy et al., 1993) and the Cronbach's alpha estimate of internal consistency was .71 for our data.

Measures of maternal psychological well-being—Five aspects of maternal psychological well-being were assessed at study enrollment: depressive symptoms, anxiety, post-traumatic stress symptoms, worry about the child's health, and NICU-related stress.

Depression symptoms—The Center for Epidemiologic Studies Depression Scale (CESD; Radloff, 1977) is used to measure the frequency of 20 depression symptoms that are rated on a 4-point Likert-type scale. Scores range from 0 to 60, with higher scores indicating more symptoms. The CESD is highly correlated with other measures of depression (Radloff, 1977; Weissman, Sholomskas, Pottenger, Prusoff, & Locke, 1977) and CESD scores of mothers of preterm infants were related to other indicators of psychological distress, including hospital environmental stress, worry about the child's health, and post-traumatic stress symptoms (Mew, Holditch-Davis, Belyea, Miles, & Fishel, 2003; Miles, Holditch-Davis, Scher, & Schwartz, 2007). The CESD has a test-retest reliability of .54 over a 3–12 month period (Radloff, 1977). The Cronbach's alpha estimate of internal consistency was .90 at enrollment in the current study.

Anxiety—Maternal situational anxiety was measured with the state anxiety sub-scale of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorusch, Lushene, Vagg, & Jacobs, 1983). The state sub-scale includes 20 items and has shown to be reliable and valid in numerous studies (Dennis, Coghlan, & Vigod, 2013; Holditch-Davis et al., 2009; Spielberger et al., 1983). The Cronbach's alpha estimate of internal consistency was .93 at enrollment in the current study.

Post-traumatic stress symptoms—The Perinatal PTSD Questionnaire (PPQ) measures the extent to which mothers experience post-traumatic stress symptoms in response to the birth of a high-risk infant and the NICU experience (Callahan & Hynan, 2002; Quinnell, & Hynan, 1999). The PPQ has 14 yes-no items that measure intrusive thoughts, avoidance or numbing, and increased arousal. The "yes" answers are summed. The Cronbach's alpha estimate of internal consistency was .79 at enrollment in the current study. Scores on this tool have been positively correlated with scores on general PTSD scales (not specific to perinatal events) and with the severity of infant complications (DeMier et al., 2000; Quinnell & Hynan, 1999).

Worry about child health—The Worry Index (Miles & Holditch-Davis, 1995) measures the degree to which mothers worry about their preterm infant (e.g., rehospitalization, medical problems, the infant getting enough to eat). The 7 items are rated on a 5-point scale. Worry scores of mothers of preterm infants were positively related to depressive symptoms and other measures of distress (Miles et al., 2007; Holditch-Davis et al., 2009; Holditch-Davis, Schwartz, Black, & Scher, 2007). The Cronbach's alpha estimate of internal consistency was .88 at enrollment in the current study.

Parenting stress—The mother's perception of the stress related to the NICU experience due to alterations in their parental role, the appearance and behavior of their child, and NICU sights and sounds was measured with the Parental Stressor Scale:NICU (PSS:NICU; Miles, Funk, & Carlson, 1993). On the PSS:NICU, parents rate 28 items on a 5- point scale. It has three subscales, two of which (infant appearance and illness and parental role alteration) were used in this study. PSS:NICU scores of mothers of preterm infants have been positively related to other measures of psychological distress--daily hassles, depressive symptoms, anxiety, and worry about the child's health--and to positive parenting (Holditch-Davis et al., 2007, 2009; Miles et al., 1993). Internal consistency in this sample at enrollment was .91 for the infant appearance and illness subscale and .90 for the parental role alteration subscale.

Kangaroo care practice—Because preventing mothers from engaging in any particular intervention with their infants would have been unethical, we encouraged them to focus on the activity for their treatment group. We analyzed the practice of KC whether or not the mother was assigned to this group because in other studies, mothers who chose to do KC were also more likely to breastfeed (Furman, Minich, & Hack, 2002; Hake-Brooks & Anderson, 2008). Among mothers who completed the checklist (47.6% of the sample), 93.3% of the KC group, 32.1% of the ATVV group, and 40.9% of the information group reported doing KC (Table 1). For our analysis, maternal report of doing KC was dichotomized into at least one occurrence during hospitalization or none.

Analysis

The major purpose of this analysis was to determine whether feeding at the breast during hospitalization, the duration of post-discharge breastfeeding, and breastfeeding exclusivity after hospital discharge differed significantly by randomized treatment groups. Exploratory analyses were also conducted to determine whether study recruitment state, maternal

characteristics (race and ethnicity, marital status, public assistance, parity, age, education, psychological well-being at enrollment: depressive symptoms, anxiety, post-traumatic stress, worry, parenting stress), infant characteristics (sex, singleton or multiple birth, gestational age at birth, birth weight, size for gestational age, head circumference at birth, length at birth, Apgar scores, mechanical ventilation, and neurobiological risk score, time between birth and study enrollment), or maternal report of practicing KC in the hospital were associated with the breastfeeding outcomes.

The study groups were primarily compared using intent-to-treat analyses, in which each mother–infant dyad was analyzed in the group to which they were assigned. Between group differences on the provision of maternal breastmilk in the hospital and, among those who provided their milk in the hospital, on feeding the infant at the breast during hospitalization were tested using the Cochran-Mantel-Haenzel Test, t-test, and Wilcoxon Two-Sample Test. Analyses were not appropriate for the breastfeeding exclusivity measure due to very limited variation. Longitudinal data on the duration of breastfeeding after hospital discharge were analyzed with a modified intent-to-treat basis using survival analysis. Only mothers with data on post-discharge breastfeeding were included. Fixed effects were study state (North Carolina or Illinois) and group (KC, ATVV, or information). The incidence of any maternal breastmilk provision during hospitalization was assessed among the groups to determine if there were pre-enrollment differences. Exploratory analyses the Cochran-Mantel-Haenzel Test, t-test, and Wilcoxon Two-Sample Test and survival analysis examined whether mother-infant characteristics or choosing to practice KC were related to breastmilk provision, feeding at the breast during hospitalization, or breastfeeding duration.

Results

Characteristics of Mothers and Their Infants

By chance, significantly more first-time mothers were in the KC and ATVV groups, 58.1% of KC and 66.2% of ATVV, compared to 43.6% of the information group (Table 1). Mothers from the three groups were equally likely to have provided their milk for the infants during hospitalization (74.3% of KC mothers, 79.5% of ATVV mothers, and 68.4% of information mothers; Table 1).

Feeding at the Breast During Hospitalization

Among those who provided their milk in the hospital, the treatment groups differed on whether or not feeding at the breast occurred during the neonatal hospitalization (33.3% of KC mothers, 46.7% of ATVV mothers, and 20.0% of information mothers; Table 3), but this difference ceased to be statistically significant when parity was controlled.

Breastfeeding Duration after Infant Hospital Discharge

Of the 209 mothers for whom post-discharge infant feeding data were obtained (86.7%), 62 (29.7%) reported breastfeeding at home. The Cox proportional hazards (survival) analyses of this subsample are presented in Table 4. Among those who breastfed after discharge, participants assigned to KC averaged 12.8 weeks (SD = 11.3); participants assigned to ATVV averaged 10.1 weeks (SD = 9.7); and information participants averaged 8.5 weeks

(SD = 8.2) of post-discharge breastfeeding. However, duration of breastfeeding after discharge did not differ statistically by group.

Breastfeeding Exclusivity after Infant Hospital Discharge

Of the 186 mothers for whom data on post-discharge breastfeeding exclusivity were obtained at 2 months adjusted for prematurity (77.1%), 4 (2.2%) reported breastfeeding exclusively. At 6 months adjusted for prematurity, none of the 163 who reported on breastfeeding exclusivity did so.

Maternal Characteristics and Breastfeeding Outcomes

Women who provided breastmilk in the hospital were more likely to be married, be first-time mothers, have more education, and to have practiced KC, whether or not they were assigned to the KC group, than those who did not (see Table 5). Women who provided their milk and fed their infants at the breast during hospitalization were more likely to be married, to have more education, and to be older than those who provided their milk but did not feed at the breast during hospitalization (see Table 3). Maternal education was positively associated with post-discharge breastfeeding duration such that mothers with more education tended to breastfeed longer (see Table 4). Providing breastmilk in the hospital was positively associated with breastfeeding after hospital discharge (Fisher's exact test, $p < .001$), but mothers' reports of practicing KC were not (see Table 4). Maternal psychological well-being at enrollment was not associated maternal provision of breastmilk during hospitalization (see Table 5), feeding at the breast during infant hospitalization (see Table 3), or with breastfeeding duration (see Table 4).

Discussion

In this study, we followed preterm infants and their mothers beginning in the hospital when the infant was no longer critically ill until the infant was 12 months adjusted age. Both the KC and ATVV groups were more likely to feed at the breast during neonatal hospitalization than the information group, but the difference was not statistically significant when parity was controlled. By chance, more participants in the KC and ATVV groups were first-time mothers than the information group, and all group comparisons controlled for this difference. At-breast feeding, the duration of post-discharge breastfeeding, and post-discharge breastfeeding exclusivity were not associated with treatment group. Thus, any effect of these treatment groups on these breastfeeding outcomes was small. Maternal provision of breastmilk during infant hospitalization was positively associated with the practice of KC, as assessed by a bedside checklist. However, the checklists were only completed by 46.7% of the sample. Mothers usually had started expressing breastmilk prior to study enrollment, so this association supports that maternal characteristics, such as being married, a first-time mother, and educated, play key roles in preterm infant breastfeeding. Further, as expected, the mothers' providing their milk during hospitalization strongly predicted breastfeeding after discharge.

In this study, maternal characteristics were associated with infant feeding outcomes: breastmilk provision in the hospital, feeding at the breast in the hospital, and breastfeeding

duration after discharge. First-time motherhood, marriage, greater age, and more years of education were positively associated with feeding at the breast during hospitalization and breastfeeding duration after hospital discharge. These findings are consistent with those of other studies of mothers who were able to establish breastfeeding in preterm infants (Zachariassen et al., 2010) and with the duration of breastfeeding of preterm infants (Mulready-Ward & Sackoff, 2013). Further, our findings are consistent with the general barriers to breastfeeding in the United States: lack of knowledge, social norms, poor family and social support, and employment and childcare constraints (U.S. Department of Health and Human Services, 2011). Comprehensive breastfeeding support may be most needed for mothers of preterm infants who have other children, are young, unmarried, and have completed less education. Findings of another study similarly showed that mothers of very low birth weight infants were most likely to provide breastmilk and to feed at the breast if they were married (Smith, Jamerson, Bernaix, Schmidt, & Seiter, 2006). Being in a marital relationship may result in more consistent spousal support for breastfeeding, which can be a family process (Redshaw & Henderson, 2013). Maternal educational attainment is a consistent predictor of positive infant feeding outcomes; recent findings show that women with greater knowledge of breastfeeding benefits are more likely to intend, initiate, and sustain breastfeeding than others (Kornides & Kitsantas, 2013; Stuebe & Bonuck, 2011).

Although random assignment to KC was not associated with the breastfeeding outcomes we measured, mothers who chose to practice KC, whether or not it was their assigned group, were more likely to provide their milk during infant hospitalization than mothers who did not perform KC. Mothers who breastfeed preterm infants may share characteristics with mothers who choose to practice KC, such as infant caretaking preferences and the availability to be engaged in the NICU. Mothers with the resources to cope with their experiences of preterm childbirth, to understand their preterm infants' health status, and to navigate the NICU environment may be best positioned to communicate and collaborate with neonatal staff to establish lactation during infant hospitalization.

Our findings may help explain some of the contradictions in previous research findings about the relationship of KC with breastfeeding. In observational research designs, investigators have found positive effects of KC (e.g., Flacking, Ewald, & Wallin, 2011; Furman et al., 2002), while in some randomized trials, others have found no effect (e.g., Roberts et al., 2000). Our findings suggest that mothers who choose to do KC may also be more likely to breastfeed. However, just being randomly assigned to the group with support for KC did not appear to affect whether infants were fed at the breast, the duration of any post-discharge breastfeeding, or breastfeeding exclusively post-discharge. Maternal availability for KC and other forms of physical contact, such as engaging in ATVV, may be critical. The importance of maternal commitment to NICU involvement such as infant holding was also suggested by Roberts et al. (2000) when these researchers were interpreting the lack of difference in infant outcomes they found after comparing KC to maternal holding of swaddled preterm infants. Although in our study, ATVV was not associated with more feeding at the breast during hospitalization, breastfeeding duration, or breastfeeding exclusivity after hospital discharge in this study, it was also not associated with worse outcomes for these measures.

All infants in this study required NICU care, and though their illness severity differed, all were critically ill at one or more points. Infant morbidity characteristics did not, however, affect either feeding at the breast during hospitalization, breastfeeding duration, or breastfeeding exclusivity after hospital discharge. Thus, mothers of preterm infants were as likely to overcome infant neurological insults, infections, surgeries, mechanical ventilation and other medical challenges to breastfeeding as they were to breastfeed in the absence of such problems.

Strengths of the present study include the robust sample size of 231 dyads, the multi-site design, and the racially diverse sample. Additionally, the random assignment of mothers and infants to KC, ATVV, or information permitted direct comparison of group outcomes that were relatively free of bias due to differences in maternal and infant characteristics as well as comparing KC in mothers who chose to adopt KC versus those who did not, which has been more typically been done in other studies. Inclusion of the infants born at different gestational ages adds ecological validity to the study since the variation would also occur any time KC or ATVV is implemented clinically.

Our study is limited by the lack of information about the proportion of infant feeds that were breastmilk, both during hospitalization and following discharge, data recommended by Meier et al. (2013). Hake-Brooks and Anderson (2008) found that, among mothers who intended to breastfeed, KC assignment was associated with a greater proportion of breastmilk for infant feeds and with greater breastfeeding exclusivity over time compared to dyads who had standard nursery care. In our study, the definition of breastfeeding posed in the home questionnaires may have been unclear to some mothers. Mothers were asked to report whether they were breastfeeding, without distinguishing the substance (breastmilk) from the method (at-breast, bottle, or other). Some participants therefore may have reported that they were not breastfeeding at home when they were in fact feeding human milk by bottles. However, the research protocol was identical across the study groups, so any biases in this answer should have been equally distributed. The need for the reporting of complete breastfeeding definitions and consistency of terms across studies has been addressed (Hector, 2011; Thulier, 2010).

The exploratory question of the effect of choosing to practice KC on breastfeeding outcomes was limited by missing data on the hospital visitation checklists. Mothers who completed the bedside checklists may have differed on their practice of KC during infant visits and breastfeeding outcomes compared to mothers who did not complete the forms or did not visit. Further, this study did not collect data on the duration of KC sessions, which Flacking et al. (2011) found to be positively associated with breastfeeding incidence after hospital discharge. We provided participants guidelines and encouraged them to engage in KC as frequently and for as long much as possible through infant hospitalization and at least until the infants were two months adjusted age at home. While it is possible that a higher incidence and duration of KC would have an effect on the measured breastfeeding outcomes, mothers have to be willing and able to do it. Anderson and colleagues (2003) found that mothers typically engaged in KC with their hospitalized infants, born between 32 to 36 gestational weeks, for less time during the first 48 hours postpartum than the researchers thought that the dyads would. Anderson and colleagues summarize,

"Implementing early and continuous KC is difficult, depending on what mothers are willing to do and what physicians are willing and able to support" (2003, p. 609). Flacking et al. (2011) similarly caution that their study findings on the positive relationship between KC dosage and breastfeeding outcomes may have been biased due to the self selection of mothers into the KC study because these mothers may be "more positive toward breastfeeding" than those who do not opt to engage in this practice (p. 194).

Finally, the low rate of breastfeeding after infant discharge limited the power of our analyses of the duration of breastfeeding and prohibited meaningful analyses of breastfeeding exclusivity. The low rates were likely a reflection of the high percentage of African Americans in our sample, as this population has the lowest rate of breastfeeding in the U.S. (Centers for Disease Control and Prevention, 2010). The low overall rates of both any and exclusive breastfeeding we found post-discharge are concerning for infant and maternal health and might be improved through peer counselors and other evidence-based lactation support for this population (Miracle et al., 2004; Rossman et al., 2011).

In our study, maternal psychological well-being at enrollment was not associated with either feeding at the breast during hospitalization or breastfeeding duration. Previous research found that high maternal anxiety, depressive symptoms, and distress after late preterm childbirth were associated with less at-breast feeding at hospital discharge (Zanardo et al., 2011); greater postpartum anxiety was associated with reduced breastfeeding duration (Paul, Downs, Schaefer, Beiler, & Weisman, 2013); and high maternal anxiety and depressive symptoms correlated with low oxytocin during breastfeeding and expressing sessions (Stuebe, Grewen, & Meltzer-Brody, 2013). Findings for mothers in this study may have differed because of the indirect effects of receiving confirmation of the infants' stability from the hospital staff prior to each occasion of KC or ATVV. Repeated assessment of relative well-being may have reduced maternal distress in a context in which the preterm infants were critically ill and their health could fluctuate over the course of hospitalization (Holditch-Davis & Miles, 2000).

Conclusions

Overall, the findings suggest that KC assignment did not appear to have an effect on increasing feeding at the breast during hospitalization, breastfeeding duration, or breastfeeding exclusivity after hospital discharge in preterm infants in the absence of other support mechanisms. The findings do support the use of randomized controlled trials in assessing the effectiveness of KC with preterm infants. More efforts are needed to promote maternal-infant interactions that facilitate breastfeeding in the NICU, and these will need to go beyond just recommending skin-to-skin contact.

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Callouts

1. Limited randomized study of maternally administered interventions for infants in NICUs on breastfeeding has occurred.
2. The effect of kangaroo care on breastfeeding outcomes was compared to other supportive activities in which mothers may engage, including the auditory-tactile-visual-vestibular intervention.
3. Mothers who practiced kangaroo care, regardless of randomly allocated group, were more likely to provide their milk than those who did not practice kangaroo care.

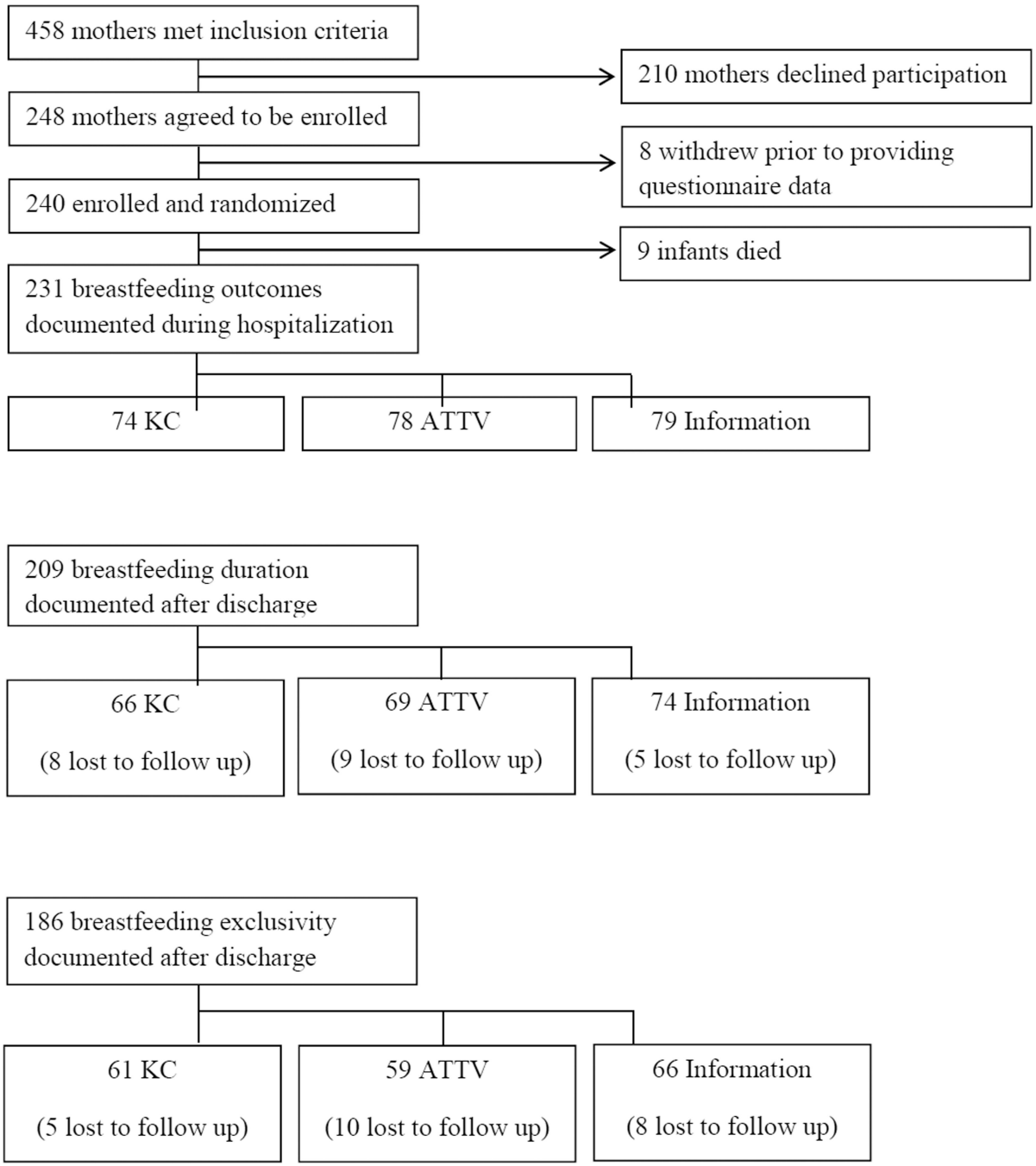

Figure 1.
CONSORT Diagram of Participants and Data on Breastfeeding Outcomes.

Table 1

Maternal Characteristics, Overall and By Randomized Treatment Group

	Over all N=231	**KC *n*=74**	**ATTV *n*=78**	**Information *n*=79**
	% (N)	**% (*n*)**	**% (*n*)**	**% (*n*)**
Race and ethnicity				
White, Hispanic, or Asian	27.7 (64)	28.4 (21)	34.6 (27)	20.3 (16)
Black non-Hispanic	72.3 (167)	71.6 (53)	65.4 (51)	79.7 (63)
Married	32.0 (73)	31.5 (23)	37.7 (29)	26.9 (21)
Public assistance	20.4 (47)	20.3 (15)	18.0 (14)	22.8 (18)
First-time mother*	55.9 (128)	58.1 (43)	66.2 (51)	43.6 (34)
Recruited from North Carolina	65.8 (152)	63.5 (47)	65.4 (51)	68.4 (54)
Provided breastmilk in the hospital	74.0 (171)	74.3 (55)	79.5 (62)	68.4 (54)
Practiced KC*	59.0 (117)	93.3 (45)	32.1 (28)	40.9 (44)
	M (SD)	M (SD)	M (SD)	M (SD)
Education in years	13.5 (2.3)	13.7 (2.5)	13.6 (2.1)	13.1 (2.3)
Age in years	27.1 (6.1)	28.0 (6.3)	26.4 (5.6)	26.9 (6.5)
Maternal psychological wellbeing at enrollment				
Depressive symptoms	16.4 (11.5)	14.3 (10.1)	17.4 (10.7)	17.3 (13.3)
State anxiety	41.0 (13.3)	39.2 (11.5)	42.2 (13.5)	41.1 (14.6)
Post-traumatic stress symptoms	4.6 (3.3)	4.5 (3.4)	4.7 (2.9)	4.7 (3.6)
Worry about child	20.0 (7.83)	20.1 (7.7)	19.8 (7.8)	20.1 (8.0)
NICU parenting stress: Infant illness	42.3 (21.5)	43.9 (21.4)	42.7 (20.9)	40.5 (22.3)
NICU parenting stress: Parental role alteration	34.7 (14.0)	36.3 (12.5)	34.6 (13.1)	33.2 (16.0)

Note. Kangaroo care=KC; auditory-tactile-visual-vestibular=ATVV. Reflects a bivariate 2-degrees of freedom omnibus test for distribution over 3 treatment groups (Cochran-Mantel-Haenzel Test for proportions, OLS ANOVA for continuous measures).

* $p<.05$

Table 2

Infant Characteristics, Overall and By Randomized Treatment Group

	Over all N=231	**KC *n*=74**	**ATTV *n*=78**	**Information *n*=79**
	% (N)	**% (*n*)**	**% (*n*)**	**% (*n*)**
Infant female	54.4 (125)	54.1 (40)	55.1 (43)	53.9 (42)
Infant size for gestational age				
Large	1.7 (4)	4.1 (3)	0.0 (0)	1.3 (1)
Appropriate	80.4 (185)	77.0 (57)	84.4 (65)	79.8 (63)
Small	17.8 (41)	18.9 (14)	15.6 (12)	19.0 (15)
Was a multiple birth	17.8 (41)	17.6 (13)	19.2 (15)	16.5 (13)
Infant had one or more infections	77.4 (178)	73.0 (54)	80.5 (62)	78.5 (62)
Necrotizing enterocolitis	14.4 (33)	14.9 (11)	11.7 (9)	16.7 (13)
Intraventricular hemorrhage	32.6 (75)	37.8 (28)	27.3 (21)	32.9 (26)
	M (SD)	M (SD)	M (SD)	M (SD)
Gestational age in weeks	27.2 (2.9)	27.2 (3.0)	27.0 (2.8)	27.5 (3.1)
Apgar at 1 minute	5.1 (2.5)	5.1 (2.4)	4.8 (2.7)	5.4 (2.5)
Apgar at 5 minutes	7.3 (1.6)	7.2 (1.6)	7.1 (1.7)	7.5 (1.6)
Head circumference at birth in centimeters	24.7 (2.7)	24.8 (2.6)	24.5 (2.7)	24.9 (2.8)
Length at birth in centimeters	35.7 (4.2)	35.6 (4.5)	35.7 (3.8)	35.9 (4.3)
Birth weight in grams	1012.9 (328.4)	1018.7 (323.1)	991.5 (325.2)	1028.6 (339.3)
Mechanical ventilation in Days	16.1 (26.1)	14.3 (16.2)	19.1(36.9)	14.8 (20.1)
Number of surgeries	0.7 (1.3)	0.7 (1.1)	0.6 (1.4)	0.8 (1.3)
Neurobiological risk score	4.0 (3.8)	4.3 (3.9)	4.2 (3.9)	3.5 (3.4)

Note. Kangaroo care=KC; auditory-tactile-visual-vestibular=ATVV. Reflects a bivariate 2-degrees of freedom omnibus test for distribution over 3 treatment groups (Cochran-Mantel-Haenzel Test for proportions, OLS ANOVA for continuous measures).

Table 3

Feeding at the Breast in the Hospital among Mothers who Provided Breastmilk in the Hospital by Treatment Group and Maternal and Infant Characteristics

	Provided breastmilk and fed at the breast in the hospital *n*=60	**Provided breastmilk but did not feed at the breast in the hospital *n*=101**
	% (*n*)	**% (*n*)**
Treatment group		
KC	33.3 (20)	32.7 (33)
ATVV	46.7 (28)	30.7 (31)
Information	20.0 (12)	36.6 (37)
Maternal race and ethnicity		
White, Hispanic, or Asian	33.3 (20)	28.7 (29)
Black non-Hispanic	66.7 (40)	71.3 (72)
Marital status**		
Not married	47.5 (28)	68.3 (69)
Married	52.5 (31)	31.7 (32)
Public assistance		
Not receiving public assistance	83.3 (50)	80.2 (81)
Receiving public assistance	16.7 (10)	19.8 (20)
Parity		
First-time mother	64.4 (38)	58.4 (59)
Not a first-time mother	35.6 (21)	41.6 (42)
Study recruitment		
From North Carolina	73.3 (44)	59.4 (60)
From Illinois	26.7 (16)	40.6 (41)
Infant sex		
Female	56.7 (34)	56.0 (56)
Male	43.3 (26)	44.0 (44)
Infant size for gestational age		
Large	3.3 (2)	1.2 (2)
Appropriate	80.0 (48)	76.2 (77)
Small	16.7 (10)	21.8 (22)
Infant birth		
Was a singleton	76.7 (46)	83.2 (84)
Was a multiple birth	23.3 (14)	16.8 (17)
Infant infections		
None	20.0 (12)	27.7 (28)
One or more	80.0 (48)	72.3 (73)
Necrotizing enterocolitis		
Not present	86.7 (52)	86.0 (86)

	Provided breastmilk and fed at the breast in the hospital *n*=60	Provided breastmilk but did not feed at the breast in the hospital *n*=101
	% (*n*)	% (*n*)
Present	13.3 (8)	14.0 (14)
Intraventricular hemorrhage		
Not present	66.7 (40)	64.4 (65)
Present	33.3 (20)	35.6 (36)
KC		
Not practiced	66.7 (40)	67.3 (68)
Practiced	33.3 (20)	32.7 (33)
	M (SD)	M (SD)
Education in years**	14.6 (2.5)	13.2 (2.0)
Age in years*	29.0 (5.7)	26.7 (6.4)
Maternal psychological wellbeing at enrollment		
Depressive symptoms	15.3 (11.7)	16.4 (11.0)
State anxiety	41.0 (13.6)	40.5 (13.4)
Post-traumatic stress symptoms	4.6 (3.4)	4.7 (3.3)
Worry about child	19.6 (7.8)	19.8 (6.9)
NICU parenting stress: Infant illness	41.9 (20.4)	43.1 (22.3)
NICU parenting stress: Parental role alteration	34.3 (13.2)	34.7 (14.6)
Gestational age in weeks	27.0 (2.6)	27.0 (3.0)
Apgar at 1 minute	5.1 (2.3)	4.9 (2.6)
Apgar at 5 minutes	7.3 (1.4)	7.1 (1.7)
Head circumference at birth in centimeters	24.7 (2.6)	24.5 (2.8)
Length at birth in centimeters	36.0 (3.8)	35.1 (4.4)
Birth weight in grams	1020.2 (317.1)	983.4 (339.8)
Mechanical ventilation in days	16.4 (39.1)	17.9 (13.7)
Number of surgeries	0.7 (1.5)	.7 (1.2)
Neurobiological risk score	3.6 (3.8)	4.4 (3.8)

Note. Kangaroo care=KC; auditory-tactile-visual-vestibular=ATVV. Between-group differences were tested using Chi-Square, with infant size for gestational age tested using the Cochran-Mantel-Haenzel Test for proportions. The treatment group analysis controlled for first-time motherhood. Between-group mean differences were tested using t-tests, with the exception of mechanical ventilation and number of surgeries, which were tested with a nonparametric Wilcoxon Two-Sample Test due to a non-normal distribution.

* $p<.01$

** $p<.001$

Table 4

In the 62 Mothers who Breastfed after Discharge, Duration of Maternal Milk Provision by Randomized Treatment Group and Select Covariates

	Unadjusted		Adjusted	
	Hazard ratio	**(95% CI)**	**Hazard ratio**	**(95% CI)**
KC vs Information	.75	(.50–1.13)	.84	(.55–1.28)
ATTV vs Information	.98	(.66–1.45)	1.05	(.70–1.57)
Maternal race and ethnicity	.73	(.50–1.06)		
Maternal age	.98	(.95–1.01)		
Maternal education*	.90	(.83–.97)		
Marital status	.98	(.70–1.38)		
Parity	.86	(.61–1.20)		
Birth weight in grams	1.00	(.99–1.00)		
Neurobiological risk score	.99	(.95–1.04)		
KC practiced	.68	(.44–1.06)		

Note. Kangaroo care=KC; auditory-tactile-visual-vestibular=ATVV. Adjusted for the covariates of maternal race and ethnicity, parity, and maternal education. The analysis of breastfeeding duration includes three participants did not provide their milk in the hospital, but did breastfeed following discharge.

* $p<.01$

Table 5

Characteristics of Mothers Who Provided and Did Not Provide Breastmilk in the Hospital

	Provided breastmilk in the hospital *n*=171	Did not provide breastmilk in the hospital *n*=60
	% (*n*)	% (*n*)
Maternal race and ethnicity		
White, Hispanic, or Asian	22.8 (39)	13.3 (8)
Black non-Hispanic	77.2 (132)	86.7 (52)
Marital status**		
Not married	61.2 (104)	87.9 (51)
Married	38.8 (66)	12.1 (7)
Public assistance		
Not receiving public assistance	81.9 (140)	73.3 (44)
Receiving public assistance	18.1 (31)	26.7 (16)
Parity*		
First-time mother	61.2 (104)	40.7 (24)
Not a first-time mother	38.8 (66)	59.3 (35)
Study recruitment		
From North Carolina	63.7 (109)	71.7 (43)
From Illinois	36.3 (62)	28.3 (17)
Infant sex		
Female	55.9 (95)	50.0 (30)
Male	44.1 (75)	50.0 (30)
Infant size for gestational age		
Large	2.3 (4)	0.0 (0)
Appropriate	77.8 (133)	88.1 (52)
Small	19.9 (34)	11.9 (7)
Infant birth		
Was a singleton	80.7 (138)	86.7 (52)
Was a multiple	19.3 (33)	13.3 (8)
Infant infections		
None	23.4 (40)	20.3 (12)
One or more	76.6 (131)	79.7 (47)
Necrotizing enterocolitis		
Not present	86.5 (147)	83.1 (49)
Present	13.5 (23)	16.9 (10)
Intraventricular hemorrhage		
Not present	67.3 (115)	67.8 (40)
Present	32.7 (56)	32.2 (19)
KC**		

	Provided breastmilk in the hospital *n*=171	Did not provide breastmilk in the hospital *n*=60
	% (*n*)	% (*n*)
Not practiced	41.0 (48)	68.3 (41)
Practiced	59.0 (69)	31.7 (19)
	M (SD)	M (SD)
Education in years*	13.7 (2.3)	12.6 (2.1)
Age in years	27.5 (6.2)	25.9 (5.9)
Maternal psychological wellbeing at enrollment		
Depressive symptoms	15.9 (11.1)	17.6 (12.5)
State anxiety	40.6 (13.3)	41.6 (13.4)
Post-traumatic stress symptoms	4.6 (3.3)	4.6 (3.4)
Worry about child	19.9 (7.2)	20.1 (9.5)
NICU parenting stress: Infant illness	42.9 (21.6)	40.7 (21.2)
NICU parenting stress: Parental role alteration	34.6 (13.9)	34.9 (14.3)
Gestational age in weeks	27.0 (2.9)	27.8 (3.0)
Apgar at 1 minute	5.0 (2.5)	5.5 (2.5)
Apgar at 5 minutes	7.2 (1.6)	7.5 (1.7)
Head circumference at birth in centimeters	24.6 (2.7)	25.1 (2.7)
Length at birth in centimeters	35.5 (4.2)	36.5 (4.1)
Birth weight in grams	993.9 (329.0)	1067.0 (232.1)
Mechanical ventilation in days	17.1 (28.5)	13.2 (17.3)
Number of surgeries	0.7 (1.3)	0.6 (1.2)
Neurobiological risk score	4.0 (3.7)	3.9 (3.9)

Note. Between-group differences were tested using Chi-Square, with infant size for gestational age tested using the Cochran-Mantel-Haenzel Test for proportions. Between-group mean differences were tested using t-tests, with the exception of mechanical ventilation that was tested with a nonparametric Wilcoxon Two-Sample Test due to a non-normal distribution.

* $p<.01$

** $p<.001$