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Effect of Early Skin-to-Skin Contact on Mother-Preterm Infant Interaction Through 18 Months: Randomized Controlled Trial

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High quality mother-infant interaction, particularly during the formative first year, is positively associated with intelligence quotient and school performance in the child's later life (Kelly et al., 1996). However, premature birth exposes both infants and their mothers to an array of different interactions and to a range of developmental risks. Preterm infants look less at their caregivers and respond poorly to sounds, smiles, and levels of play activity (Beckwith & Cohen, 1990; Gerner, 1999); and are less adaptable and more intense (Medoff-Cooper, 1986). Mothers of preterm infants are also stressed by preterm birth (Miles et al., 1992) and perceive a loss and feel guilty about the early abrupt termination of their pregnancies (Affonso et al., 1992).

Skin-to-skin contact (SSC), also known as kangaroo care (KC) or kangaroo mother care (KMC), was originally developed in Bogotá, Colombia in 1978 in response to the shortage of incubators needed to care for low-birth-weight infants (Charpak et al., 2005; Rey & Martinez, 1983). The term KMC is reserved for care given almost continuously and mostly by the mother to facilitate lactation and successful breastfeeding. Until recently, the focus of SSC studies was on physiological measurements of adaptation in preterm infants. These include, such as, temperature, respiration, heart rate, oxygen saturation, weight gain, breastfeeding status, mortality, and morbidity (Bergman & Jurisoo, 1994; Bergman et al., 2004; Cattaneo et al., 1998; Ludington-Hoe et al., 2004; Suman et al., 2008) and on sleep organization (Ludington-Hoe et al., 2006). Results of these studies have shown that SSC promotes beneficial physiological conditions such as increased quiet sleep state and more stable thermoregulation, heart rate, respiratory rate, and higher oxygen saturation.

Effects of SSC on mothers of preterm infants

When mothers of preterm infants were studied, the focus was on the psychological response of the mother to her SSC experience. With a sample of Swedish mothers, Affonso et al. (1989) were the first to report the effect of SSC on maternal feelings toward their infants during and after SSC. In a subsequent study, Affonso et al. (1993) examined the effect of SSC on the

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reaction of American mothers to stable, very-low- and low-birth-weight preterm infants in a tertiary level intensive care nursery. These researchers found that SSC provided a way for mothers to know their infants, to develop strong positive feelings towards them, and to reconcile their feelings about having a premature birth, so that emotional healing could take place. In another qualitative study, Roller (2005) interviewed 10 mothers who experienced SSC with their preterm infants. Interviews occurred after the infants were discharged from the hospital. Two essential themes that emerged from the SSC experience were “kept from knowing” her infant and “getting to know” her preterm infant. In short, mothers felt that SSC (termed KC in this study) provided an opportunity for them to get to know more about their infants during a stressful time.

Similar positive psychological responses were also found in mothers of intubated preterm infants. Gale et al. (1993) and Neu (1999) both found that after experiencing SSC, parents (mostly mothers) reported stronger identification with and knowledge of their preterm infants. Most recently, Johnson (2007) interviewed a group of 18 primiparous mothers who experienced 60 minutes of SSC with their preterm infants three times in the first two weeks post-birth. These infants were either receiving ventilator support or oxygen therapy. After SSC, mothers expressed their feelings as “heart-warming,” “being needed,” and “having confidence in knowing” how to care for her infant.

Long-term effects of SSC on mother-preterm infant interaction

In a Cochrane review, Moore, Anderson, and Bergman (2007) reported more maternal affectionate touching and attachment behaviors at follow-up in randomized controlled trials (RCTs) with mothers of fullterm infants who experienced SSC. However, only one RCT has been conducted (Charpak, Ruis-Pelaez, Figueroa, & Charpak, 1997) in which long-term effects of SSC on mother-preterm infant interaction (MPI) have been reported (Tessier et al., 1998). In this RCT ($N = 488$) which was conducted in Bogota, Colombia, 488 mothers were encouraged to provide KMC for their infants 24 hours a day. An objective instrument, Nursing Child Assessment Feeding Scale, was used to measure maternal perception and the state of each mother’s readiness to respond to her infant’s needs at 41 weeks post-conception. KMC dyads had higher scores on maternal sensitivity (a subscale of the feeding scale) than controls ($p = .05$).

Positive effects of SSC on MPI and infant and family health were also reported in three publications from a matched-control study conducted with 146 preterm infants in two hospitals in Jerusalem, Israel. Feldman, Eidelman et al. (2002) reported that at 37 weeks’ gestation, SSC mothers were less depressed and had more positive affect, touch, adaptation to infant cues, and perception of their infants. At three months SSC parents were more sensitive and provided a better home environment and SSC infants scored higher on the Bayley Mental and Motor Developmental Indices. Feldman, Weller et al. (2002) found that at hospital discharge SSC infants had more mature state distribution and organized sleep-wake cycle and at three months SSC infants were more tolerant to negative maternal emotion, displayed less negative affect, and their parents were more sensitive and less intrusive. SSC parents also demonstrated more affectionate touching of their infants and of each other, and more often held their infants in a position conducive to mutual gaze and touch. At six months, SSC mother-infant dyads shared attention, and infants’ sustained exploration of their environment began sooner and lasted longer. Feldman, Weller et al. (2003) found that SSC had a positive impact on mother-infant interaction, father-infant interaction, and the spousal relationship. Feldman and Eidelman (2003) then conducted a prospective case-control study in one hospital with 70 very-low- and low-birth-weight preterm infants. The 35 infants who experienced SSC for at least one hour a day for 14 days had significantly more rapid maturation of vagal tone between 32 and 37 weeks'

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gestation and better behavioral organization (e.g., longer periods of quiet sleep and alert wakefulness, and shorter periods of active sleep).

In a historical-control study with healthy low-birth-weight infants, Ohgi et al. (2002) found that SSC infants scored higher than controls on behavioral organization during the neonatal period and on the Bayley Developmental Indices at 12 months. In a comparison study in Italy, Tallandini and Scalembra (2006) examined the effects of KMC on very-low-birth-weight preterm infants and their mothers. Control dyads (n = 21) received routine care and KMC dyads (n = 19), who experienced SSC for at least one hour per day for a mean of 24.37 days (SD = 11.06). KMC mothers wee were less emotionally stressed while in the hospital, and mother-infant interaction was better 38 gestational weeks.

The above review supports the beneficial effects of SSC on mother-preterm infant interaction. However, the focus of most of these was on subjective self-report of maternal feelings during or shortly after SSC. When an objective measure was used, follow-up data were collected only once at 41 weeks' gestation (Tessier et al., 1998) or once right after hospital discharge (Tallandini & Scalembra, 2006), or the study was not an RCT (Feldman & Eidelman, 2003; Feldman, Eidelman et al., 2002; Feldman, Weller et al., 2002, 2003; Ohgi et al., 2002; Tallandini & Scalembra).

Inspired by the early work of Ourth and Brown (1961), Kennell et al. (1974), and Klaus et al. (1972), the Mutual Caregiving Model was developed by the second author (1972, 1977, 1989). Briefly stated, beginning with birth, the ideal habitat (ecological niche) for each newborn infant is the specific and relatively familiar milieu provided by its mother. Although human infants are born with the skills needed to survive and be nourished in a self-regulatory fashion, this can only happen optimally if infants remain with their mothers in this habitat and in skin-to-skin contact. This experience promotes a broad parasympathetic (vagal) response (e.g., glandular secretion), which is physiologically beneficial and comforting for both mother and infant and would logically promote bonding and attachment. Similar conceptualizations have been set forth by others (e.g., Bergman et al., 2004; Labbok & Krasovec, 1990; Uvnäs-Moberg, 1998; Widström et al., 1987; Winberg, 2005). Thus, an RCT was conducted to further examine the effects of early SSC on the health of preterm infants and their mothers during their hospital stay and through 18 months. Two publications have resulted from this RCT to date. Anderson et al. (2003) reported mother-infant contact information during the first two days' postbirth, and Hake-Brooks & Anderson (2008) focused on breastfeeding duration and exclusivity of mother-infant dyads in the hospital and through 18 months. The purpose of the report presented here was to examine the effect of SSC on mother-preterm infant interaction at 6, 12, and 18 months.

Methods

Design and Sample

This two-group RCT was conducted at University Hospitals of Cleveland, Cleveland, Ohio, a large urban teaching and research hospital and Kadlec Medical Center, Richland, Washington, a regional hospital in a somewhat rural setting. Approval from the Institutional Review Board was obtained at each site. Eligibility was established and informed consent was obtained during early labor. Inclusion and exclusion criteria are delineated elsewhere (Anderson et al., 2003). After birth, mothers and their preterm infants who remained eligible were randomized using minimization to either SSC or control group.

Results of a pilot RCT by Syfrett (1993) were used for sample size estimation. With a power of .8, alpha of .01 (two tailed), and a medium-sized effect, a sample of 33 dyads per group were needed. To protect possible attrition during the follow-up phase, 50 dyads per group were

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recruited. Between 1997 and 2000, 75 dyads were randomized at the midwestern hospital and 25 at the northwestern hospital.

Instrumentation

The computerized minimization program contains an algorithm for minimizing between-group imbalance of potential confounding factors (Conlon & Anderson, 1990; Zeller et al., 1997). This program was developed using principles introduced by Pocock and Simon (1975). Researchers can choose only factors already known (e.g., delivery method) because this information must be entered into the computer before the minimization program can be run. Thirteen prognostic factors were chosen for randomization: maternal factors (socioeconomic status, race, parity, smoking, feeding intent, MgSO4 use, epidural use, delivery method, dexamethosone use) and infant factors (gender, NICU or not, gestational age, and birth time).

To avoid potential selection bias for the first 10 dyads, one investigator (GCA) created an abbreviated permuted block sequence with randomly selected blocks of six and then four. First 10 envelopes were labeled 1 to 10. Then 6 papers (3 labeled SSC and 3 Control), were tightly folded, placed into a bag, and vigorously stirred. Next one paper was randomly selected and placed, still folded, in Envelope 1 which was then sealed. Envelopes 2 to 6 were filled in the same manner. This procedure was repeated with 4 additional papers (2 SSC; 2 Control) and Envelopes 7 to 10. This process also minimized the history threat to internal validity because group size increased at a relatively balanced yet unpredictable rate until the minimization program could begin.

The Nursing Child Assessment Satellite Training Program (NCAST) Feeding and Teaching scales (Sumner & Spietz, 1994a, b) were used to measure MPI. The feeding scale has a possible 76 points and the teaching scale has 73. The feeding scale can be used with infants from birth to one year, the teaching scale with infants from birth to 3 years. Both scales consist of six subscales to assess mother-infant interaction: sensitivity to cues, response to infant distress, social-emotional growth fostering, cognitive growth fostering, clarity of cues, and responsiveness of the child to the caregiver. Each subscale lists a series of caregiver and infant behaviors that the evaluator observes during a routine feeding session and a teaching session. In the teaching session, the mother teaches her infant a task she thinks the infant will not know how to do. The scales consist of binary (yes/no) items. All items rated *yes* are summed. A higher score indicates an interaction that is richer in positive affect, sensitivity, synchronicity, vocalization, and reciprocity. The feeding and teaching scales have established validity and reliability (Sumner & Spietz, 1994a, b).

Before starting the MPI assessment, several research team members, including the first author, received training from an NCAST certified instructor to reach at least 85% accuracy in scoring standardized reliability videotapes of feeding and teaching sessions. After each follow-up, interactions were scored by the first author and other members of the research team who were masked to group assignment. Then, 10% of randomly selected tapes were scored for interrater reliability, which was maintained at 90% throughout the scoring period.

In-Hospital Procedure and Intervention

Informed consent was obtained during early labor. On the day of delivery, after the infants were born and as soon as continuing eligibility was established, mother-infant dyads were randomly assigned to either the SSC or control group. Dyads in both groups received routine care from hospital staff. Control dyads were cared for in incubators, warmer beds, or bassinettes and were held wrapped in blankets. In addition, SSC dyads were encouraged to begin experiencing SSC as early, as often, and for as long each time as possible.

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For those dyads who were able to begin SSC immediately following birth, infants were placed prone between their mother's breasts and covered across the back with a large warming blanket folded in half and tucked slightly under the mother on both sides. Infants wore a cap that often became damp and was then replaced with a dry one. If SSC began later mothers held their infants between their breasts with either their hospital gown or their own clothing and a blanket folded across the infant's back for warmth. Infants wore a small diaper and often, a cap.

Mothers in both groups were contacted frequently for data collection by the researchers, who also provided brief support if needed or requested at these times. The presence of the nurse researchers was approximately equal in both groups because of the identical and numerous data collection points in the protocol. Details of recruitment, randomization, intervention, and in-hospital data collection are in Anderson et al. (2003) and Hake-Brooks & Anderson (2008).

Follow-up Procedure

Follow-up assessment of MPI occurred when infants reached 6, 12 and 18 months corrected age. Before each follow-up, a member of the research team arranged the visit at a meeting time convenient for mother and infant. Many follow-up visits were done on weekends. Transportation was provided by taxi as needed. At the Ohio site, when mothers returned for follow-up visits, a research member greeted each mother and her infant at the entrance to the hospital lobby and escorted them to a private room in a clinic. The clinic, used primarily for research studies, was well lighted and quiet. Similar procedures were carried out at the Washington site, except that mothers and infants returned for follow-up to an outpatient clinic. During these visits each dyad was videotaped during a feeding session at 6 and 12 months and during a teaching session at 6, 12, and 18 months. Mothers also completed several sets of questionnaires, and infants were assessed for growth and development using the Bayley Scale of Infant Development II (Bayley, 1993) by trained research staff. Although the members who contacted mothers to make follow-up arrangements were aware of the group assignment of each mother-infant dyad, the research staff involved in follow-up assessments were not aware of group assignment. At the completion of each visit, remuneration was provided. All follow-up assessments were completed by the end of 2001.

Results

In-Hospital Sample

Of the 491 women approached during a period of four years, 229 (47%) declined to participate. Reasons provided fell into two main categories: study too complicated and not interested in research. Of the 262 women (53%) who consented, 100 (38%) were studied; 52 were randomized to the SSC group and 48 to the control group (Figure 1). During the in-hospital phase, five dyads (2 SSC; 3 controls) withdrew. Reasons were: three mothers (2 SSC; 1 control) did not want their infant connected to a monitor; one control mother did not provide a reason; and one control mother wanted to have SSC with her infant.

Five dyads (3 SSC; 2 controls) discontinued their in-hospital participation but agreed to participate during follow-up. Reasons for discontinuation included infant on ventilator support (1 SSC; 1 control), hospital transfer (1 control), not wanting infant connected to the monitor (1 SSC), and maternal illness (1 SSC). At hospital discharge, 95 dyads were eligible for follow-up. No demographic between-group differences were found (Table 1). Two of the 50 SSC dyads did not experience SSC because the infants required ventilator support. The remaining 48 dyads first experienced SSC at a mean of 9.9 hours (SD: 11.3, range: 0.5 to 42.1), for an average 11.6 times (SD: 5.2, range: 1 to 25), and for an average 1.3 hours each time (SD: 0.5, range: 0.5 to 2.5). Seven dyads (14.6%) experienced SSC during the first hour postbirth and

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41 (85.4%) within the first 24 hours. During the study duration (ranging from 2 to 5 days), these dyads spent 17.7% (SD: 13.3, range: 3 to 63%) in SSC holding.

Follow-Up Sample

Before the six-month follow-up, two female infants (1 SSC; 1 control) died due to Sudden Infant Death Syndrome. The SSC infant was born at 32 weeks gestation to a 20-year-old Hispanic mother and died at 5 months of age. The control infant was born at 34 weeks gestation to a 25-year-old African American mother and died before 3 months of age. Demographics for these two infants were included in the lost to follow-up columns for analysis purposes (Table 2).

Although 95 dyads were eligible for the 6-month follow-up at hospital discharge, assessment measures for MPI were not in place until Dyad 7. Therefore, only 69 of the 72 dyads who returned for the 6-month follow-up could be assessed. At the 12-month follow-up, 71 dyads returned. One SSC dyad did not complete the feeding session because the infant was hungry and was fed just before arriving for follow-up. The other SSC infant was brought to follow-up by her foster mother, not her biological mother, so feeding and teaching assessments were not done and the infant was considered lost to follow-up. Therefore, 69 dyads were assessed for feeding interactions and 70 for teaching interactions. At 18 months, 76 dyads returned for follow-up and all had teaching sessions.

Among the five dyads that discontinued in-hospital participation, two SSC dyads returned for all follow-up visits. The other three dyads (1 SSC; 2 controls) returned at 12 and 18-months. Reasons for attrition included having one's phone disconnected, not responding to request for follow-up, moving without leaving a forwarding address, moving out of the state, not coming to a scheduled follow-up, and no longer having custody of the infant. A CONSORT diagram of the number of all possible dyads for all follow-ups is presented in Figure 1.

Analyses for demographic variables were conducted between dyads who returned for follow-up and completed MPI assessment and those who did not at 6, 12, and 18 months (Table 2). At 6-months, married mothers were significantly more likely to return compared to single mothers ($p = .002$). At 12-months, married, White mothers, or infants born vaginally were more likely to return compared to single ($p = .004$), non-white ($p = .02$) mothers, or infants born by cesarean ($p = .04$). Infants who returned had higher 5-minute APGAR scores ($p = .03$). At 18-months, infants who returned had a slightly longer gestation ($p = .04$). All comparisons are presented in Table 2. No differences were found when demographics were further examined based on group assignment (Table 3, Table 4, & Table 5).

Mother-Infant Interaction

Descriptive statistics (mean and standard deviation) and intention-to-treat analysis were used to describe and analyze data related to mother-infant interaction. Between-group differences in feeding and teaching scores were examined using student t-tests. To avoid inflating a Type 1 error, total teaching and feeding scores were first compared at each follow-up, followed by comparisons of the Mother Total and Child Total scores. SSC mothers and infants had higher total feeding scores at 6 and 12 months. When examining mothers and infants separately, SSC mothers had slightly higher Mother Total feeding scores at 6 and 12-months. SSC and control infants had comparable Infant Total feeding scores (Table 6). Total Teaching scores were similar between groups throughout follow-up. SSC mothers had consistently higher Mother Total scores at all three follow-ups. In contrast, SSC infants had lower Infant Total scores at 6 months ($p = .001$) but not at 12- and 18-months. Upon further analysis, at 6-month follow-up, control infants had higher scores on the Child's Response to Caregiver sub-scale ($p = .001$) (Table 7).

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Discussion

Mother-infant interaction is a complex phenomenon. Positive impact of SSC on feelings of mothers of preterm infants has been reported in several studies (e.g., Affonso et al., 1989, 1993; Dombrowski et al., 2000; Moran et al., 1999; Neu, 1999; Roller, 2005; Roller et al., 1999; Swinth et al., 2000). In most recent publications, SSC mothers were more sensitive and less intrusive, and their infants showed less negative emotion and more dyadic reciprocity (Feldman & Eidelman, 2003; Feldman, Eidelman et al., 2002; Feldman, Weller et al., 2002; Feldman, Weller et al., 2003; Tallandini & Scalembra, 2006).

Although other SSC study findings appeared similar at first, more careful examination revealed dissimilarities between studies to allow valid comparisons, such as study design (Feldman, Weller et al., 2003) and infant populations (Sloan et al., 1994; Rojas et al., 2003). Other examples include Tallandini and Scalembra (2006) who used the same instrument but their study was not a randomized trial and follow-up was done shortly after discharge. Findings most similar to our study are by Tessier et al. (1998) in terms of study design (RCT) and one instrument (NCAST feeding scale) used to measure MPI. Reporting on follow-up outcomes from the RCT conducted by Charpak et al. (1997) in which only the NCAST feeding scale was used, these researchers found that the SSC experience was not directly related to MPI in 488 preterm infants at 41 weeks' post-conception age. Although they found that SSC mothers were more sensitive than controls to needs of their infants during a feeding session, the difference was very small. Results of our study were similar. SSC and control mother-preterm infant dyads had similar mother-infant interactions. In addition, SSC mothers, compared to controls, demonstrated consistently slightly higher scores in both feeding and teaching interactions throughout follow-ups. The strength of our study compared to Tessier's study is that we, in addition to the NCAST feeding scale, used the NCAST *teaching* scale to assess MPI.

In our study SSC infants often scored lower than control infants, especially at the 6-month teaching session, in which SSC infants were significantly less likely to respond to their caregiver's cues. The fact that this difference was not apparent at 12 and 18 months suggests that SSC infants might have been at a qualitatively different developmental stage than the controls at 6 months (cf. Lewis & Ramsey, 1995). However we have no data to support this suggestion and can only recommend that such data be collected in future studies.

Several other possible explanations merit consideration effects of SSC on MPI. First, attrition may have contributed to results. In our study, the SSC group had a higher return rate than the control group at all three follow-up visits. In addition, dyads who did not return were more likely to be mothers who were single or non-white. Attrition raises the possibility that the returning dyads had more positive interaction than dyads who did not return. Although some demographic differences were found between returning and non-returning dyads, whatever possible influences these differences, and the directions thereof, might have had on the measurement of mother-infant interaction is unclear.

Second, heterogeneity of the study infants is another possible reason. During the in-hospital phase of this study, subject recruitment was much slower because, by the time the study was funded, the primary study hospital was competing with secondary level hospitals that had established small NICUs to increase market share. Most of the pregnant women admitted into the primary study hospital were at higher risk than expected, as were their preterm infants after birth. As a result, many preterm infants did not meet the inclusion criteria and expansion of inclusion criteria to permit recruitment of higher-risk dyads was needed. Thus, about 70% of the preterm infants in the study were admitted into the NICU and several of these infants also required ventilator support. Dyads admitted to the NICU and/or needing ventilator support could not begin SSC as early or for as long due to infant care needs. The heterogeneity of this

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sample may have increased individual differences in terms of the dependent variable, thereby inflating the error variance and decreasing the chance of detecting a significant intervention effect (Stewart & Archbold, 1992). In addition, possible intervention diffusion cannot be ignored. Although our study only studied one dyad at a time, some SSC infants stayed in the NICU after the study ended. Parents of the control infants could have observed other parents experiencing SSC and initiated SSC themselves. This information, however, was not obtained at the time of follow-up visits.

Finally, the instruments chosen for this study may not reflect the essence of mother-infant interaction after experiencing SSC. Gross et al. (1993) reported that the NCAST Teaching Scale measures the cognitive experience, rather than affective feeling, of the mother. In addition, each item on the feeding and teaching scales was rated as a dichotomous response (presence or absence). As soon as ae behavior occurred the item was scored “yes” regardless of how often the behavior occurred thereafter. Then all items scored yes were added to obtain a sum score. Thus, the *quantity* of each behavior (e.g. kissing, caressing, and touching) was not measured. For these reasons, these two scales might not be sensitive enough to capture any between-group difference in changes resulting from the intervention.

Recommendations for Future Studies

Based on the experience of conducting this study, we recommend that researchers of future studies consider the following factors when assessing mother-infant interaction in dyads who experience SSC. Internal validity can be strengthened by consistent and more homogenous inclusion criteria, a higher return rate, and documentation of SSC experience throughout follow-ups. The feasibility of achieving these suggestions will also require careful evaluation.

Methodological triangulation with multiple measurement tools should be considered to better understand the effect of SSC on mother-infant interaction. One such tool is the Parent Child Early Relational Assessment (PC-ERA) in which observations of interactions are made during a play session. Based on our experience of conducting follow-ups, we learned that by the time the mother-infant dyads arrived, some infants and their mothers had already become tired from preparing for and making the trip. Thus, a play session that would be more comfortable for the dyads might help elicit a more familiar interaction pattern between infants and mothers. In addition, a subjective (qualitative) measure needs to be collected regarding mothers’ perceptions of connectedness to their infants.

Confounding variables should also be identified and measured concurrently or in advance. For example, shorter maternal leaves are associated with an increase in infants’ internalized behaviors (Berger et al., 2005) and more negative affect/behaviors in maternal-infant interactions (Clark et al., 1997). Other examples are parenting stress (Holditch-Davis & Miles, 2000; Jarvis & Creasey, 1991) and lack of a support system (Kotch et al., 1997).

Although definitive conclusions regarding the long-term effects of SSC on mother-infant interaction cannot be made at this time, it is important to note that no adverse effects were found. Based on positive findings from current literature about mother-infant interaction during and after SSC, all new mothers, if they are able and whether or not they ask to do SSC, should be encouraged to experience SSC and assured that they will have additional support from hospital staff. The longer term effects of SSC on mother-infant interaction, however, merit further testing

What is already known about this topic?

1. Mother-infant interaction is positively associated with child development.

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2. Skin-to-skin contact elicits positive subjective responses from mothers of preterm infants.
3. Skin-to-skin contact promotes beneficial physiological conditions in preterm infants such as increased quiet sleep state, and more stable thermoregulation, heart rate, respiratory rate, and oxygen saturation.
4. Skin-to-skin contact also promotes longer breastfeeding duration and exclusivity.

What this paper adds:

1. This is the first study to assess mother-preterm infant interaction throughout 18 months in a randomized controlled trial of very early skin-to-skin contact. In addition the infant participants were predominantly (68%) late-preterm infants.
2. Mother-preterm infant dyads in both groups had similar interactions during feeding and teaching sessions, except that skin-skin contact infants were less likely to respond to their mothers' teaching cues at 6 months.

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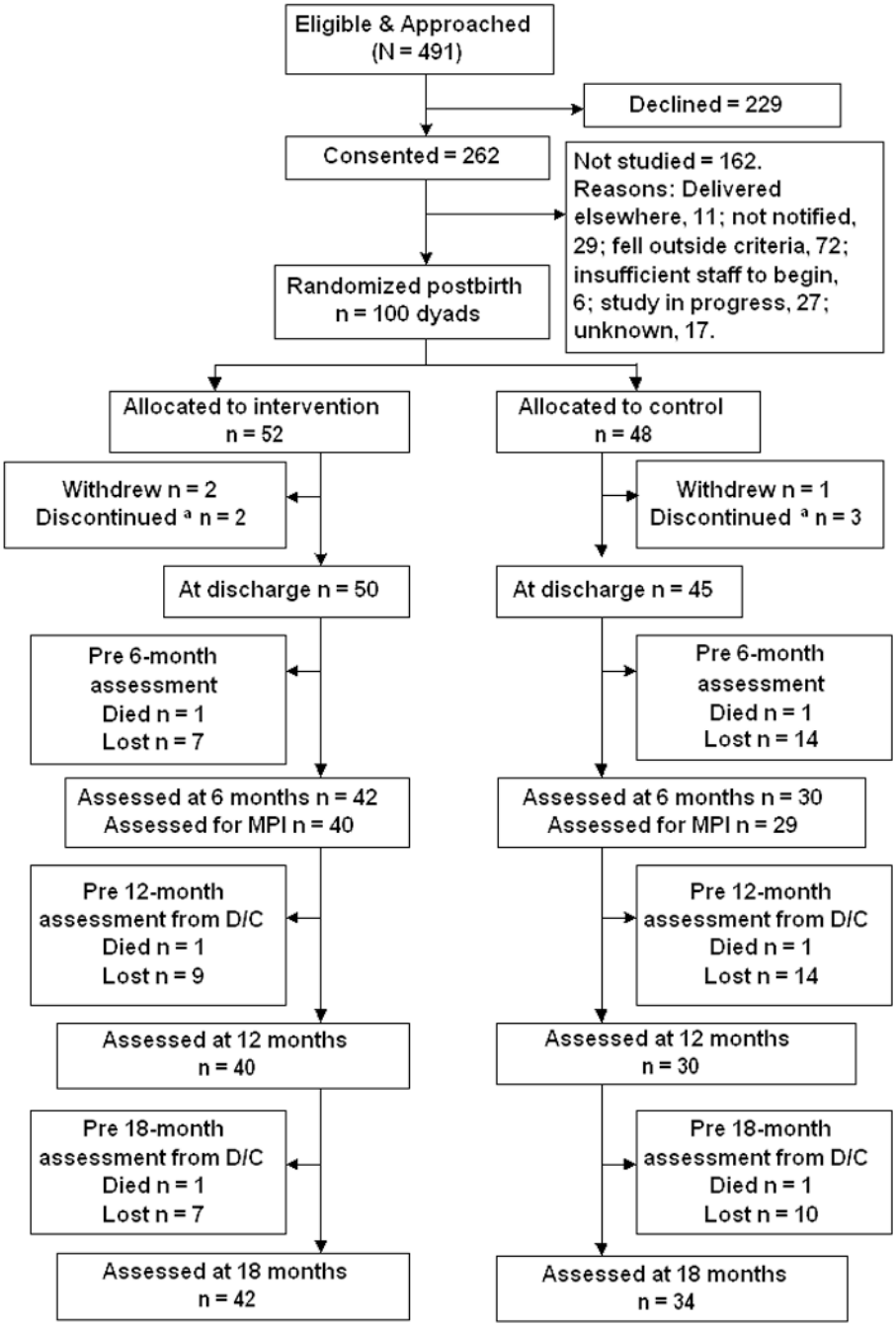

Figure 1.
CONSORT diagram of all possible and actual dyads returned for mother-preterm infant interaction (MPI) assessment at follow-up.
[a]Dyads who discontinued their in-hospital participation agreed to participate during follow-up. D/C = discharge.

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Table 1

Selected Demographics of All Possible Dyads by Group at Discharge (N = 95)

	SSC (n = 50)		Control (n = 45)		
Variables	**M**	**SD**	**M**	**SD**	**p**
Maternal age at delivery (year)	25.0	6.3	24.4	5.8	.63
1-minute APGAR	7.4	1.4	7.6	1.4	.59
5-minute APGAR	8.6	0.8	8.6	0.6	.90
Birth weight (g)	2257	426	2211	394	.59
Gestational age (wk)	34.4	1.6	34.6	1.4	.54
	n	%	n	%	
Gestational age					
Moderately preterm (32–33)	17	34	13	30	.59
Late preterm (34 -< 37)	33	66	32	71	
Delivery method					
Vaginal	39	78	34	76	.78
Cesarean section	11	22	11	24	
Marital status					
Single	29	58	28	62	.68
Married	21	42	17	38	
Maternal race					
Non-White	30	60	28	62	.82
White	20	40	17	38	
Parity					
Primipara	25	50	19	42	.45
Multipara	25	50	26	58	
Insurance status					
Public	21	42	20	44	.81
Private	29	58	25	56	

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Variables	SSC (n = 50) M	SSC (n = 50) SD	Control (n = 45) M	Control (n = 45) SD	p
Feeding Intent					
Bottle	14	32	16	36	.43
Breast	36	68	29	64	
Child's sex					
Female	23	46	26	58	.25
Male	27	54	19	42	
NICU admission					
Yes	34	68	30	67	.89
No	16	32	15	33	
Ventilator support[a]					
Yes	9	18	5	11	.34
No	41	82	40	89	

[a]SSC did not begin until infants were no longer receiving ventilator support.

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Table 2

Comparison of Maternal/Infant Demographics of Returned to Lost Dyads at 6, 12, and 18-Month Follow-ups

	6 Months					12 Months					18 Months				
	Returned (n = 72)		Lost (n = 23)			Returned (n = 70)		Lost (n = 25)			Returned (n = 76)		Lost (n = 19)		
Variable	**M**	**SD**	**M**	**SD**	***p***	**M**	**SD**	**M**	**SD**	***p***	**M**	**SD**	**M**	**SD**	***p***
Maternal age (yr)	25.3	6.1	23.0	5.7	.11	25.1	6.3	23.5	5.0	.24	25.0	6.2	23.5	5.3	.33
1 minute APGAR	7.5	1.3	7.4	1.7	.57	7.6	1.3	7.2	1.6	.30	7.6	1.3	7.1	1.7	.26†
5 minute APGAR	8.6	0.7	8.4	0.8	.16	8.7	0.6	8.3	0.8	.03†	8.6	.63	8.3	.89	.16†
Birth weight (g)	2277	405	2104	402	.08	2262	416	2162	389	.30	2266	415	2115	373	.15
Gestation (wk)	34.6	1.5	34.0	1.4	.10	34.6	1.5	34.1	1.4	.21	34.6	1.5	33.8	1.4	.04
	n	%	n	%		n	%	n	%		n	%	n	%	
Group assignment															
SSC	42	58	8	35	.05	40	57	10	40	.14	42	55	8	42	.30
Control	30	42	15	65		30	43	15	60		34	45	11	58	
Delivery method															
Vaginal	53	74	20	87	.19	20	29	2	8	.04	56	74	17	90	.14
Cesarean section	19	26	3	13		50	71	23	92		20	26	2	11	
Marital status															
Single	37	51	20	87	.002	36	51	21	84	.004	43	57	14	74	.17
Married	35	49	3	13		34	49	4	16		33	43	5	26	
Maternal race															
Non-White	40	56	18	78	.05	38	54	20	80	.02	44	58	14	74	.21
White	32	44	5	22		32	46	5	20		32	42	5	26	
Parity															
Primipara	35	49	9	39	.43	36	51	8	32	.09	37	49	7	37	.35
Multipara	37	51	14	61		34	49	17	68		39	51	12	63	

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	6 Months					12 Months					18 Months				
	Returned (n = 72)		Lost (n = 23)			Returned (n = 70)		Lost (n = 25)			Returned (n = 76)		Lost (n = 19)		
Variable	**M**	**SD**	**M**	**SD**	***p***	**M**	**SD**	**M**	**SD**	***p***	**M**	**SD**	**M**	**SD**	***p***
Insurance status															
Public	27	38	14	61	.05	28	40	13	52	.30	31	41	10	53	.35
Private	45	63	9	39		42	60	12	48		45	59	9	47	
Feeding Intent															
Bottle	24	33	6	26	.52	20	29	10	40	.29	25	33	5	26	.58
Breast	48	67	17	74		50	71	15	60		51	67	14	74	
Child's sex															
Female	36	50	13	57	.59	37	53	12	48	.68	41	54	8	42	.36
Male	36	50	10	44		33	47	13	52		35	46	11	58	
NICU admission															
Yes	46	64	18	78	.20	25	36	6	24	.28	51	67	13	68	.91
No	26	36	5	22		45	64	19	76		25	33	6	32	
Ventilator support															
Yes	11	15	3	13	.79	12	83	2	92	.27	12	84	2	11	.56
No	61	85	20	87		58	17	23	8		64	16	17	90	

Note. Percents are column percents. Percents do not always add to 100 because of rounding.

† indicates the result of separate variance t-tests

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Table 3

Maternal and Infant Characteristics of Returned Dyads by Group at 6-month Follow-up (*N* = 69)

Variables	SSC (n = 40) M ± SD	Control (n = 29) M ± SD	p
Maternal age at delivery (yr)	26.1 ± 6.3	24.2 ± 5.9	.22
1-minute APGAR	7.5 ± 1.4	7.6 ± 1.3	.88
5-minute APGAR	8.6 ± 0.7	8.7 ± 0.6	.85
Birthweight (g)	2288 ± 385	2262 ± 438	.62
Gestational age (wk)	34.6 ± 1.5	34.7 ± 1.4	.70
	n (%)	n (%)	
Gestational age			
Moderately preterm (32–33)	12 (30)	9 (31)	.93
Late preterm (34 -< 37)	28 (70)	20 (69)	
Delivery method			
Vaginal	31 (78)	19 (66)	.27
Cesarean section	9 (23)	10 (35)	
Martial status			
Single	20 (50)	15 (52)	.89
Married	20 (50)	14 (48)	
Maternal race			
Non-white	23 (58)	15 (52)	.63
White	17 (43)	14 (48)	
Parity			
Primipara	18 (45)	15 (52)	.58
Multipara	22 (55)	14 (48)	
Insurance			
Public	15 (38)	10 (35)	.80
Private	25 (63)	19 (66)	
Feeding Intent			
Bottle	11 (28)	11 (38)	.36
Breast	29 (73)	18 (62)	
Child’s sex			
Female	18 (45)	18 (62)	.16
Male	22 (55)	11 (38)	
NICU admission			
Yes	27 (68)	17 (59)	.45
No	13 (33)	12 (41)	
Ventilator support			
Yes	7 (17)	4 (13)	.70
No	35 (83)	26 (87)	

Note. Percents are column percents. Percents do not always add to 100 because of rounding.

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Table 4

Maternal and Infant Characteristics of Returned Dyads by Group at 12-month Follow-up (N = 70)

Variables	SSC (n = 40) M ± SD	Control (n = 30) M ± SD	*p*
Maternal age at delivery (yr)	25.3 ± 6.4	24.9 ± 6.3	.80
1-minute APGAR	7.5 ± 1.3	7.7 ± 1.3	.54
5-minute APGAR	8.7 ± 0.7	8.7 ± 0.6	.96
Birthweight (g)	2247 ± 429	2281 ± 404	.73
Gestational age (wk)	34.4 ± 1.6	34.8 ± 1.3	.35
	n (%)	n (%)	
Gestational age			
Moderately preterm (32–33)	14 (35)	7(23)	.29
Late preterm (34 -< 37)	26 (65)	23 (77)	
Delivery method			
Vaginal	30 (75)	20 (67)	.45
Cesarean section	10 (25)	10 (33)	
Martial status			
Single	20 (50)	16 (53)	.78
Married	20 (50)	14 (47)	
Maternal race			
Non-white	22 (55)	16 (53)	.89
White	18 (45)	14 (47)	
Parity			
Primipara	21 (53)	15 (50)	.84
Multipara	19 (48)	15 (50)	
Insurance			
Public	16 (40)	12 (40)	1.0
Private	24 (60)	18 (60)	
Feeding Intent			
Bottle	9 (23)	11 (37)	.19
Breast	31 (78)	19 (63)	
Child’s sex			
Female	19 (48)	18 (60)	.30
Male	21 (53)	12 (40)	
NICU admission			
Yes	27 (68)	18 (60)	.52
No	13 (33)	12 (40)	
Ventilator support			
Yes	8 (21)	4 (13)	.46
No	32 (80)	26 (87)	

Note. Percents are column percents. Percents do not always add to 100 because of rounding.

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Table 5

Maternal and Infant Characteristics of Returned Dyads by Group at 18-month Follow-up (N = 76)

Variables	SSC (n = 42) M ± SD	Control (n = 34) M ± SD	*p*
Maternal age at delivery (yr)	25.1 ± 6.2	24.9 ± 6.2	.91
1-minute APGAR	7.5 ± 1.3	7.7 ± 1.3	.62
5-minute APGAR	8.6 ± 0.7	8.6 ± 0.6	.86
Birthweight (g)	2260 ± 427	2273 ± 406	.90
Gestational age (wk)	34.5 ± 1.6	34.8 ± 1.3	.33
	n (%)	n (%)	
Gestational age			
Moderately preterm (32–33)	14 (33)	8 (24)	.35
Late preterm (34 -< 37)	28 (67)	26 (77)	
Delivery method			
Vaginal	32 (76)	24 (71)	.58
Cesarean section	10 (24)	10 (29)	
Martial status			
Single	23 (55)	20 (59)	.72
Married	19 (45)	14 (41)	
Maternal race			
Non-white	25 (60)	19 (56)	.75
White	17 (41)	15 (44)	
Parity			
Primipara	22 (52)	15 (44)	.47
Multipara	20 (48)	19 (56)	
Insurance			
Public	18 (43)	13 (38)	.68
Private	24 (57)	21 (62)	
Feeding Intent			
Bottle	12 (29)	13 (38)	.37
Breast	30 (71)	21 (62)	
Child’s sex			
Female	19 (45)	22 (65)	.09
Male	23 (55)	12 (35)	
NICU admission			
Yes	30 (71)	21 (62)	.37
No	12 (29)	13 (39)	
Ventilator support			
Yes	8 (19)	4 (12)	.39
No	34 (81)	30 (88)	

Note. Percents are column percents. Percents do not always add to 100 because of rounding.

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Table 6

Six and 12-Month Feeding Scores by Group

	6-Month			12-Month		
	SSC n = 40	Control n = 29		SSC n = 39	Control n = 30	
Feeding Scales[a]	**M (SD)**	**M (SD)**	**p**	**M (SD)**	**M (SD)**	**p**
Mother						
Sensitivity to cues (16)	13.1 (1.8)	12.9 (2.0)	.74	12.5 (1.6)	12.1 (2.1)	.40
Responses to distress (11)	9.7 (1.2)	9.6 (1.5)	.73	9.6 (1.5)	9.7 (1.5)	.72
Social-emotional growth fostering (14)	11.6 (1.6)	11.4 (1.6)	.66	11.7 (1.6)	11.1 (1.9)	.16
Cognitive fostering (9)	6.8 (1.6)	6.6 (1.7)	.49	7.6 (1.4)	7.3 (1.5)	.38
Mother total score (50)	41.2 (3.9)	40.4 (4.9)	.46	41.2 (3.9)	40 (5.2)	.29
Infant						
Clarity of cues (15)	12.8 (1.5)	13.0 (1.7)	.63	12.9 (1.7)	13 (1.9)	.78
Response to mother (11)	7.4 (1.5)	7.6 (1.8)	.66	7.6 (1.3)	7.5 (2)	.85[b]
Infant total score (26)	20.2 (2.8)	20.5 (3.1)	.61	20.5 (2.4)	20.5 (3.4)	.96
Total feeding score (76)	61.4 (6.0)	60.9 (6.9)	.79	61.5 (5.2)	60.5 (7.7)	.57[b]

[a] Numbers in parentheses in this column indicate maximum scores for each scale.

[b] Indicates the result of separate variance t-tests.

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Table 7

Six, 12-, and 18-Month Teaching Scores by Group

	6-Month			12-Month			18-Month		
	SSC n = 40	Control n = 29		SSC n = 40	Control n = 30		SSC n = 42	Control n = 34	
	M (SD)	M (SD)	p	M (SD)	M (SD)	p	M ± SD	M ± SD	p
Teaching Scales[a]									
Mother									
Sensitivity to cues (11)	8.9 (1.1)	8.5 (1.2)	.16	8.9 (1.2)	8.3 (1.2)	.05	8.6 (1.6)	8.2 (1.4)	.36
Responses to distress (11)	10.0 (1.1)	9.6 (1.3)	.17	9.4 (1.7)	9.3 (1.5)	.72	9.4 (1.9)	9.2 (1.7)	.57
Social-emotional growth fostering (11)	8.1 (1.4)	8.1 (1.0)	.97	8.3 (1.4)	8 (1.5)	.39	8.3 (1.4)	8.6 (1.2)	.35
Cognitive fostering (17)	11.4 (2.5)	11.1 (2.9)	.68	11.9 (2.3)	11.5 (2.4)	.49	12.5 (2.6)	12.4 (2.5)	.90
Mother total (50)	38.3 (4.4)	37.3 (4.5)	.34	38.3 (4.8)	37.1 (4.7)	.29	35.5 (13.3)	34.2 (14.4)	.68
Infant									
Clarity of cues (10)	8.3 (1.2)	8.7 (0.7)	.07	9.0 (0.9)	9.2 (1.0)	.37	9.1 (.8)	9.3 (.7)	.29
Response to mother (13)	8.4 (2.3)	10.0 (1.6)	.001	9.0 (2.0)	9.6 (2.5)	.29	8.7 (1.8)	9.4 (2.5)	.20
Infant total (23)	16.7 (3.2)	18.8 (1.8)	.001	18.0 (2.4)	18.8 (3.3)	.26	17.8 (2.2)	18.7 (2.9)	.17
Total teaching score (73)	55.1 (6.6)	56.0 (5.0)	.51	56.5 (5.1)	55.2 (5.7)	.32	56.7 (5.4)	56.7 (4.9)	.97

[a]Numbers in parentheses in this column indicate maximum scores for each scale.