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## Review Article

## Maternal directed interventions of preterm newborn on strengthening mother-newborn interaction in NICU: A systematic review

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## ABSTRACT

**Objectives:** The main factor contributing to neonatal fatalities globally is preterm birth. Maternal participation in the care of preemies in the NICU can be challenging for mothers to strengthen the bond between them. The objective of the literature review was to appraise the effectiveness of maternal-directed interventions of preterm newborns on strengthening mother-newborn interaction in NICU, identify which tools are most frequently used, and report on outcomes of strengthening mother-newborn interaction in NICU.

**Materials and Methods:** We conducted a PRISMA-compliant Meticulous search for articles indexed in the databases PubMed, Psyc INFO, Web of Science, and CINAHL using disparate combinations of keywords comprising “maternal directed interventions” AND “preterm newborn” OR “strengthening” AND “mother- newborn interaction” were used to review in the databases.

**Results:** Five empirical studies were identified, massage including Auditory, Tactile, Visual, and Vestibular was linked to a faster symptom reduction of depression, ATVV have significant implications for mom and their premature babies, especially during the initial six months of life. At day 14 ( $=45.66$ ,  $p<0.01$ ), there were noticeable differences between groups as the suction pressure rose linearly over time. The mean weight, height, and head circumference of preterm babies who received the 2-week massage intervention were higher ( $F=41.151$ ,  $6.621$ , and  $24.158$ , respectively;  $p<0.001$ ). Breastfeeding habits among mothers of preterm infants are improved by the kangaroo mother's nursing on the infant's growth, neurological development, and reduction of morbidities related to preterm infants.

**Conclusion:** Maternal interventions support infants from birth through early life to improve infant health, develop newly acquired abilities, reduce developmental issues, promote adaptive parenting and strengthen the mother-newborn bond.

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## 1. Introduction

The main factor contributing to neonatal fatalities globally is preterm birth, with the best estimates affecting 15 million infants each year.<sup>1</sup> Before 37 full weeks of pregnancy is a challenge for both the child and the family.<sup>2</sup> Preterm births make up between 5% and 18% of total births globally, and far more premature babies live at earlier

gestational periods.<sup>3</sup> Preterm infants are subjected to a lot of stress while receiving critical care in the NICU, including increased sensory output and uncomfortable procedures that can harm their developing brain despite the lack of obvious brain abnormalities and are linked to poor neurobehavioral outcomes.<sup>4</sup> Preemies requiring intensive medical care were sensory deprived of the liquor amnii and uterine wall experience. Gentle massage to newborns provides a soothing touch and promotes improved growth in premature babies.<sup>5</sup> The majority of the drawbacks of

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conventional care techniques may be solved by kangaroo mother care (KMC), which is characterized as initial, sustained, and ongoing skin-to-skin interaction between a mother and her low-birth-weight baby, both while in the hospital and after early release, until the minimum of 40th weeks of the postpartum period.<sup>6</sup> In addition to massage, the auditory, tactile, visual, and vestibular intervention (ATVV) fosters social contact, accelerates weight growth and feeding progress, and reduces hospital stay.<sup>7</sup> Although moderately and late preterm newborns and their families may not be aware of this, preterm delivery can also be linked to health concerns in both parents and children.<sup>8</sup>

## 2. Review Methods

### 2.1. Aims

To explore and summarize the following (1) effect of maternal-directed interventions of the preterm newborn on strengthening mother-newborn interaction in NICU. (2) To recognize the tools frequently used to evaluate the effect of maternal-directed interventions of preterm newborns on strengthening mother-newborn interaction and (3) report on outcomes of the effect of maternal-directed interventions of the preterm newborns on strengthening mother-newborn interaction in NICU.

### 2.2. Design

A systematic review examining outcomes of the effect of maternal-directed interventions of the preterm newborn on strengthening mother-newborn interaction in NICU.

### 2.3. Method

A Systematic review using Four English databases including PubMed, Psyc INFO, Web of Science, and CINAHL were used to look for the published studies between the year 2014 to 2020 making use of a mixture of the mentioned Free-Text Terms: “maternal directed interventions” AND “preterm newborn” OR “strengthening” AND “mother-newborn interaction”. In the early phase, identical articles were eliminated and the bibliography of pertinent articles was scrutinized to recognize further literature that satisfied the criteria. Subsequently, a research review was carried out scrutinizing the caption and abstract of studies by reviewers to determine the eligible studies.

### 2.4. Data extraction

The data was retrieved systematically from the eligible studies by using the data extraction tool: (1) Attributes of the Study, name of the author, research design, Place and year of data collection, (2) Attributes of preterm newborn mother: a total of preterm newborn mother, (3) Tools used to measure the effect of maternal directed interventions of the preterm newborn on strengthening mother- newborn interaction in

NICU and (4) Findings.

### 2.5. Quality appraisal

The tools used to assess the exceptional evidence within the systematic review were: (1) the checklist of items recommended for Observational Studies by STROBE and (2) Guidelines for Critical Review Form - Quantitative Studies. Every question can be answered either fully (2 points), partially (1 point), or imprecisely (0 points). The aggregate points were computed for each study. The studies were then evaluated independently by external experts based on the grades achieved as excellent (aggregate points between 30 and 36) good (aggregate points between 25 and 30) fair (aggregate points between 13 and 24) and poor (aggregate points below 12 points). A methodological flaw could introduce bias as well. The random selection and allocation concealment had a high risk of 10% across all studies, according to the risk of bias table. More than 45% of the bias risks were unknown for performance and detection bias. The likelihood of bias in attrition, reporting, and other factors was minimal which is depicted in (Figure 1).

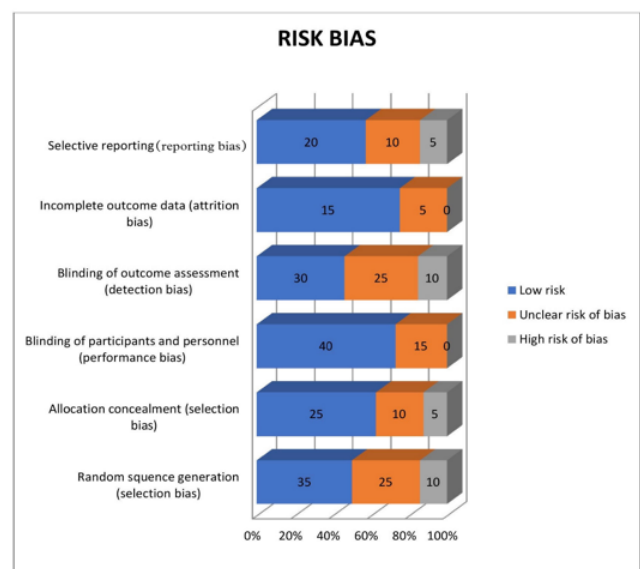


Figure 1: Representation of risk in the study

## 3. Results

302 studies were found using our search method (PubMed: 146, PsycINFO: 83, Web of Science: 61, and CINAHL: 12). Following the elimination of duplicate publications, we found 168 potential articles. All selected studies' titles and abstracts were reviewed during the screening step. As a result, 134 papers were excluded since they weren't deemed appropriate for the current study. 36 studies were ultimately chosen for the eligibility phase. 31 of these studies were dropped because they failed to meet the requirements for

inclusion. In the end, 5 empirical studies were found to be pertinent to our research (Table 1). More information on the research selection process is available in the reporting items for the systematic flow chart (Figure 2).

### 3.1. Study quality

Two studies received a "fair" quality rating<sup>9,10</sup> and "good" for the remaining three<sup>5,6,11</sup>

### 3.2. Characteristics of the study

Table 1 provides a summary of the key methodological and general characteristics of all the research examined. Three studies are randomized clinical trials<sup>5,9,10</sup> One study is a three-group longitudinal design study<sup>11</sup> and another study is a hospital-based observational study.<sup>6</sup> Every study was released between 2014 and 2020. These included studies were carried out in North Carolina, Chicago, China, and India.

### 3.3. Characteristics of preterm newborn mother

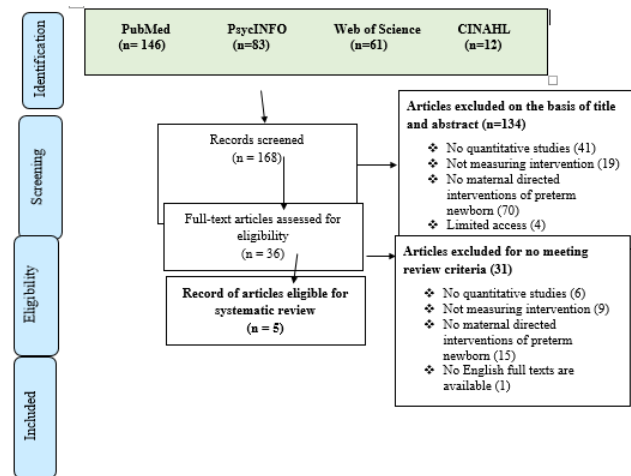
In these 5 studies, the total number of the preterm newborn mother was 808.

### 3.4. Measuring intervention used in preterm newborn and mother

This review of measuring intervention used in preterm newborn mothers showed that Holditch-Davis et al.,<sup>11</sup> used the Auditory-Tactile-Visual-Vestibular intervention (ATVV), kangaroo care (KC) intervention; Medoff-Cooper et al.,<sup>9</sup> investigated Infant nutritive sucking indices and Auditory-Tactile-Visual-Vestibular intervention; Nadar et al.,<sup>10</sup> adopted Anderson Behavior State scale, Specific Physiotherapy Intervention and Auditory-Tactile-Visual-Vestibular intervention; Zhang and Wang,<sup>5</sup> administered massage intervention and E et al.,<sup>6</sup> administered kangaroo mother care intervention.

### 3.5. Outcomes of the effect of maternal-directed interventions of the preterm newborn on strengthening mother-newborn interaction in NICU

Among selected studies reported the effect of maternal-directed interventions of the preterm newborn on strengthening mother-newborn interaction in NICU. Holditch-Davis et al.,<sup>11</sup> found that Massage with ATVV was linked to a quicker symptom reduction of depression. ATVV, especially in the first half of the first year of life, has a significant impact on postpartum mothers and their premature babies. In a randomized clinical trials study, Medoff-Cooper et al.,<sup>9</sup> showed that the number of suckers, suckers per burst, and maturity index all demonstrated a quadratic trend with the intervention group showing



**Figure 2:** PRISMA flow diagram – presentation of literature search and selection of articles.

noticeably faster growth up to day 7. Model estimates for the group day are respectively = 13.69,  $p<0.01$ ; = 1.16,  $p<0.01$ ; and = 0.12,  $p<0.05$ , respectively. There were noticeable variations between groups as the suction pressure increased linearly over time on day 14 ( $=45.66$ ,  $p<0.01$ ). Nadar et al., 2018<sup>10</sup> reported that both groups had better sucking coordination and improved scores on the neurobehavioral measure following the treatment about the before interventional states ( $P<0.0001$ ). When comparing the two groups, the SPI group had better sucking coordination than the ATVV group, and both groups' improvements on the neurobehavioral scale were comparable. Zhang and Jun Wang, 2019,<sup>5</sup> observed that premature babies who received the 2-week stimulation strategy had greater average weights, heights, and head circumferences ( $F=41.151$ ,  $6.621$ , and  $24.158$ , respectively;  $p<0.001$ ). E et al., 2020<sup>6</sup> demonstrated that kangaroo mother grooming had favorable impacts on child growth, neurological development, a decrease in morbidities related to preterm newborns, and nursing behaviors in mothers of preterm infants.

## 4. Discussion

The outcome of the systematic review will aim to determine maternal-directed interventions for preterm newborns to strengthen mother-newborn interaction in the NICU. The quality assessment of the articles under examination revealed that they satisfied the majority of the necessary criteria, including the topic's relevancy; the quality of the methodology; the analysis of the results; and the impact that resulted in an agreement. The reviewed articles showed the effect of maternal-directed interventions of the preterm newborn on strengthening mother-newborn interaction in the NICU. The kangaroo mother's nursing positively impacts an infant's growth, neurological development,

**Table 1:** Summary of the key participant characteristics studies examined.

Author(year)	Type of study design (Nation)	Number of preterm newborns & mother (n)	Measuring intervention	Findings
Holditch-Davis et al., 2014	Three-group longitudinal design study (North Carolina)	240	Kangaroo care (KC) intervention, and auditory-tactile-visual-vestibular (ATVV) intervention	The ATVV-infused massage was linked to a quicker symptom reduction of depression. For moms and their preterm children, particularly during the first half of the first year, KC and ATVV have significant effects.
Medoff-Cooper et al., 2015	Two-group randomized trial design study (Chicago)	230	Infant nutritive sucking indices and Auditory-Tactile-Visual-Vestibular intervention	There were significant differences between groups in the steadily increasing sucking pressure on day 14 ( $=45.66$ , $p<0.01$ ).
Nadar et al., 2018	Randomized Clinical Trials (India)	126	Anderson Behavior State Scale, Specific Physiotherapy Intervention, and Auditory-Tactile-Visual-Vestibular intervention	Compared to the situation before the intervention, both groups showed improved coordination when sucking and an improvement on the neurobehavioral scale ( $P<0.0001$ ). When comparing the two groups, the SPI group had better sucking coordination than the ATVV group, and both groups' improvements on the neurobehavioral scale were comparable.
Zhang and Jun Wang, 2019	Randomized Clinical Trials (China)	112	Massage intervention	The mean weight, height, and head circumference of preterm infants who received the 2-week massage intervention were greater ( $F=41.151$ , $6.621$ , and $24.158$ , respectively; $p<0.001$ ).
E et al., 2020	Hospital-based observational study (India)	100	Kangaroo mother care intervention	The kangaroo mother's nursing positively impacts an infant's growth, neurological development, the reduction of morbidities related to premature births, and breastfeeding practices among moms of preterm infants.

the reduction of morbidities related to premature births, and breastfeeding practices among moms of preterm infants. Analysis of variance with repeated measures demonstrated that the intervention group's weight, height, and head circumference all significantly improved, the mean weight, height, and head circumference of preterm infants who received the 2-week massage intervention were greater ( $F=41.151$ ,  $6.621$ , and  $24.158$ , respectively;  $p<0.001$ ). General linear mixed models with consideration for recruiting location and parity were used to examine the effects of the treatment. Foster mothers of kangaroos showed a quicker drop in worry than the other mothers. Infant social behavior and developmental maturity, both of which were higher in kangaroo infants, were the only interacting aspects that were different between groups. The interventions had an impact on how several distinct newborn behaviors changed over time. Regardless

of group assignment, massage was linked to quicker improvements in depression symptoms and higher HOME scores when mothers reported on the interventions they had carried out. Both interventions were associated with less parenting stress. As a short-term intervention, KC has important implications for mothers and their preterm infants, particularly in the first half of the first year.<sup>5,6,11</sup> Supportively, most moms discovered beneficial effects on maternal compassion in love or touch, breastfeeding, and maternal trust in caring for the newborn. For these three groups of newborns, sucking was seen during the test. With more sucking when listening to recordings with highly modulated speech, analysis of variance revealed a significant difference between the infants by voice grouping,  $F(2,21) = 4.077$ ,  $p = 0.03$ . The moms who received the intervention did better on the maternal sensitivity/responsiveness scale ( $p=0.05$ ). Being a first-

time mother facilitated an increase in the intervention's effectiveness. Compared to more seasoned moms, first-time mothers were more receptive to their infant's cues ( $p=0.01$ ), and the dyads displayed higher degrees of synchronization ( $p=0.02$ ). Their infants showed a more upbeat attitude ( $p=0.04$ ). Modest and late preterm infants of primipara benefit from improved mother-child interaction as a result of the intervention.<sup>8,12–16</sup> Our review study,<sup>10</sup> indicated that the intervention group gained considerably faster gains through day 7 (model estimates for group\*day: = 13.69,  $p<0.01$ ; = 1.16,  $p<0.01$  (or = 0.12,  $p<0.05$ )). A quadratic trend was seen for the number of suckers, suckers per burst, and maturity index. On day 14 (=45.66,  $p<0.01$ ), there were noticeable variations between the groups as the suction pressure increased linearly over time. Infants who received the ATVV intervention demonstrated enhanced sucking organization while in the hospital, indicating that the ATVV intervention enhances oral feeding. Compared to the situation before the intervention, both groups showed improved coordination when sucking and an improvement on the neurobehavioral scale ( $P< 0.0001$ ). The SPI group had greater sucking coordination than the ATVV group, and both groups' improvements in the neurobehavioral measure were comparable. In comparison to multimodal stimulation, certain physiotherapeutic therapies in preterm infants are more effective in enhancing sucking coordination, have greater weight gain, and are equally beneficial in enhancing neurological behavior. Similarly, 10 (83%) of the very preterm children identified by Perra et al.<sup>17</sup> Neel et al.,<sup>18</sup> Krueger et al.,<sup>19</sup> Lavalley et al.,<sup>20</sup> Price et al.,<sup>21</sup> Filippa et al.,<sup>22</sup> Endendijk et al.,<sup>23</sup> were recruited for the research. The individuals' parents were well educated. The baseline and endpoint measurements were completed at the ideal rate. The multisensory group also experiences simultaneous handling and gentle pressure for sensory stimuli, the sound of the mother's voice played in response to the infant sucking a pacifier for sound stimuli, exposure to a cloth saturated with the scent of the parent for olfactory stimulation, and exposure to carefully regulated therapist breathing is mindful and responsive on the condition of the child for vestibular stimulation. The main finding is a time-locked EEG measurement of multisensory processing in the brain. Secondary outcomes include motor and linguistic function assessed at one- and two-year gestational ages corrected, sensory adaptation, tactile processing, speech sound discrimination, and so on. However, in low and high-frequency performance, singing was significantly different from the pre-and post-conditions before and after the singing intervention ( $p=0.037$ ). Preterm newborn vagal activity is temporarily increased by maternal singing but not speech, which enhances ANS stability. The fact that preterm children triggered higher activity in certain brain regions (dmPFC, right insula, left caudate, hippocampi, parahippocampi, and PAG) previously linked to negative

emotion processing may explain why parents and preterm infants have trouble getting along.

Finally, our study reveals the scarcity of published studies on the effect of maternal-directed interventions of preterm newborns on strengthening mother- newborn interaction in NICU. Further research in this area would be beneficial to determine whether efforts to enhance maternal-directed interventions of preterm newborns on strengthening mother-newborn interaction in NICU are effective. There is also a scarcity of data on follow-up assessments, as well as the transfer and generalization outcomes of the effect of maternal-directed interventions of the preterm newborn on strengthening mother-newborn interaction in the NICU. We specifically eliminated qualitative research because its results cannot be applied to large groups of individuals with the same level of reliability as quantitative analysis, despite their significant contributions to the literature on this subject.

## 5. Conclusion

Our analysis reveals that The ATVV intervention helped achieve organizational suction skills earlier on the seventh day. We would make significant progress in our understanding of preterm baby development if we investigated the strength of the association between earlier nutritional skill maturation and better developmental outcomes. Interventions using massage therapy are as beneficial in improving neurological behavior, better in enhancing weight growth, and more successfully at enhancing sucking coordination. The kangaroo mother's nursing positively impacts an infant's growth, neurological development, the reduction of morbidities related to premature births, and breastfeeding practices among mothers of premature infants. Thus, maternal interventions nurture infants from birth through early childhood to promote infant health, improve emerging skills, reduce developmental delays, treat existing disabilities, prevent functional decline, promote adaptive parenting, and promote maternal-newborn strengthening interaction.

## 6. Authors Contribution

RSL conceptualized and designed the study including the development of the search strategy, data extraction forms, and quality assessment criteria. Participated in analysis and interpretation, and writing and revision of the manuscript. TLM designed the development of the search strategy, data extraction forms, and quality assessment criteria. Participated in the interpretation of the data and revision of the manuscript. SSC participated in the collection of data, such as conducting searches, screening studies for inclusion, and extracting data from studies, and contributed to the analysis and interpretation of the data.

All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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## 8. Conflict of Interest

About this manuscript, none of the authors have disclosed any conflicts of interest.

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