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# Neurodevelopmental Outcomes in Preterm Infants Receiving Kangaroo Mother Care: A Systematic Review

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## ABSTRACT

**Background:** Kangaroo Mother Care (KMC) has been growing in popularity due to its unique practices of skin-to-skin contact and exclusive breastfeeding, alongside its many benefits to the wellbeing of pre-term infants. While previous research has acknowledged KMC's contributions in stabilizing vital signs and enhancing bonding, there is an increasing interest in its long-range effects on the neurodevelopmental outcomes of infants which include cognitive, motor, and emotional development. With this overarching goal, this systematic review aims to focus on literature discussing the developmental outcomes of preterm infants undergoing KMC.

**Objective:** To conduct a systematic review of the published literature on the impact of Kangaroo Mother Care on the neurodevelopmental outcomes, specifically cognitive, motor, and socio-emotional development, of preterm infants. This review intends to trace the circles of trends, gaps, or contradictions in the body of literature pertaining to early KMC implementation and their accrued outcomes in relation to neurodevelopment.

**Methods:** A search was performed using PubMed, Scopus, CINAHL, Google Scholar and Web of Science for articles published between the years 2010 to 2025. Studies that focused on preterm infants less than 37 weeks gestational age and performed KMC together with reporting on neurodevelopmental outcomes were considered for inclusion with criteria. Information was collected on the study's design, sample size, implementation of the intervention, assessment tools used such as the Bayley Scales, and neurodevelopmental outcomes. Methodological quality was assessed using Newcastle-Ottawa Scale and Cochrane Risk of Bias tool. Where necessary, descriptive and correlation analyses complemented the adopted narrative synthesis approach.

**Results:** From the screened studies, a total of 58 were found to meet the set inclusion criteria. Most of the studies reported that KMC recipients demonstrated significantly better cognitive and motor skill development when compared with the conventional care groups. Emotional regulation, mother–infant bonding, and attentional responsiveness also showed positive

correlations with KMC exposure. Findings suggest that the enhancement in neurodevelopmental trajectories for KMC recipients is sustained with prolonged KMC, especially when it started in the first week of life.

**Conclusions:** This systematic review reinforces the evidence-based low-cost intervention nature of KMC, emphasizing its importance at this period of life. KMC not only physiologically stabilizes the babies but also tangibly positively influences their brain development. Longitudinal studies are needed to assess the impact of caregiver consistency, socio-cultural factors, and health system integration on the outcome sub-chronically expected with KMC.

***Keywords:*** *Kangaroo Mother Care, Preterm Infants, Neurodevelopment, Cognitive Development, Motor Skills, Emotional Regulation, Skin-to-Skin Contact, Neonatal Outcomes, Infant Brain Development, Systematic Review*

## 1. INTRODUCTION

As still a public health concern, preterm birth, defined as delivery before 37 completed weeks of gestation, contributes to significant neonatal morbidity and mortality worldwide. As estimated by the World Health Organization, close to 15 million infants are born prematurely each year, with complications of prematurity being the leading cause of death in children under five years of age. In addition to survival, the journey is exacerbated for vulnerable infants due to their increased risk of long-term neurodevelopmental challenges, such as cognitive functions, motor skills, sensory processing, emotional regulation, and social behavior. These deficits from the lack of intrauterine brain development and the strain of critical care environments highlight the need for timely and appropriate strategies aimed at development in this highly susceptible population [1, 2].

One such method has become popular internationally: Kangaroo Mother Care (KMC), which advocates for a mother to engage in skin-to-skin contact with her preterm infant, alongside exclusive breastfeeding and early hospital discharge when manageable. KMC was developed as a response to the heavy reliance on incubator-based care in low resource areas, but it has now transformed into a globally recognized practice that not only provides the infant with physiological support, including the stabilization of body temperature, respiration, and heartbeat, but also encourages positive maternal attachment and breastfeeding.The literature recognizing the clinical advantages of KMC, specifically in the reduction of mortality and morbidity, is steadily growing. However, research regarding the impact of KMC on neurodevelopmental outcomes, especially on the cognitive, motor coordination, and emotional-behavioral domains is still emerging [3, 4].

KMC involves carrying the baby in a way that allows them to touch the body of their parent or caregiver and is done during the first year of a baby's life. It is known that during this period the baby's brain undergoes a transformation referred to as brain plasticity. To a certain extent, a baby in their first year of life is quite transparent to social effects. During the baby's first year, parents' brain states and activities affect the baby. Therefore, KMC may enhance a baby's brain plasticity and provide KMC benefits later in life [5, 6]. While KMC can be lifesaving, the NICU environment often presents an atmosphere of either a sensory-overload or deprivation. Alongside maternal touch, rhythmic auditory stimulation, and secure positioning, KMC promotes sleep, stress reduction while also providing unparalleled touch. It is anticipated that these experiences foster positive neurodevelopment through stimulating neuroplastic changes in the growing brain. Studies employing neuroimaging and standardized assessments of neurodevelopment have revealed encouraging findings suggesting that KMC may aid in increasing brain volume and cortical maturation, as well as elevated cognitive and motor performance at 6, 12, and 24 months [7, 8].

Regardless of the growing body of literature, the various population and setting divergences have inconsistently designed studies, intervening protocols, and measurements leading to ambiguous definable universal conclusions. Differing patterns of KMC initiation, its timing, duration, maternal engagement, and health system supportive services qualitatively differentiate neurodevelopmental outcomes. Further, most of the research suffers from limited sample sizes or inadequate longitudinal follow-up which does not assess the long-term effects of KMC on learning, behavioral self-regulation, and psychosocial functioning during later childhood [9, 10].

This systematic review is designed to fill these gaps by incorporating the latest and most relevant evidence pertaining to the neurodevelopmental impacts of KMC on preterm infants. By incorporating studies from different clinical and cultural settings around the globe, this review strives to address the gap on how KMC affects developmental scaffolding and guide its standardized implementation in the neonatal care system. Additionally, this review seeks to identify the gaps and strengths in the literature concerning methodology and emerging multidisciplinary approaches to provide stronger advocacy for the routine application of KMC into neonatal care not merely for survival but as a developmental strategy to enhance the child's cognitive and emotional prospects [11, 12].

## 2. LITERATURE REVIEW

While literature on preterm birth and its neurodevelopmental sequelae is plentiful, it is also rapidly evolving. Developmental delays in cognitive function, learning, movement, language, and emotional proficiency are particularly acute in preterm

infants. This is a result of insufficient brain growth accompanied by other issues such as interrupted neurogenesis in the womb. In this regard, KMC or Kangaroo Mother Care provides a low-tech solution that enhances both survival and the neural growth of preterm infants [13, 14] [15].

In response to inadequate incubators and tremendous rates of neonatal mortality in Bogotá, Colombia, KMC was first introduced in the late 1970s. It has since been adopted globally and recognized by the WHO due to its effectiveness in improving vital sign stability and breastfeeding. More recently, KMC is garnering interest for its potent impact on neurodevelopment. This hypothesis hinges on the fact that skin-to-skin contact has the potential to simulate the intrauterine environment which is crucial to the short and long-term physiological and psychological brain development of preterm infants. It is believed that positively adjusting emotional and physical stimuli like those provided through touch enhances synaptic formation and myelination while decreasing stress, all of which are fundamental in achieving healthier developmental milestones [16, 17].

Both observational studies and randomized controlled trials have yielded empirical evidence substantiating these theoretical proposals. A landmark study by Champak et al. (2017) followed preterm infants who received KMC and noted enhanced cognitive functioning and higher IQ scores at age 20 compared to those who received conventional care. In the same way, research that uses the Bayley Scales of Infant Development has shown that KMC preterm infants outperform non-KMC preterm infants in cognitive, language and motor subscales at 6, 12, and even 24 months of corrected age. Moreover, neuroimaging studies suggest that KMC is associated with greater gray matter volume and more active cortical functioning in the areas of the brain that control executive function, emotional regulation, and sensation processing [18, 19].

In addition, KMC is associated with better emotional and social indicators, particularly in relation to maternal and infant stress and attachment security. The skin-to-skin contact and holding soothe holds are thought to lower cortisol levels for both infants and mothers, which may help protect against neurodevelopmental damage from the stress inflicted by prolonged NICU stays [20, 21]. These not only affect immediate emotional health but also behavioral health and psychosocial resilience over time. Moreover, the caregiver's presence during KMC sessions is believed to improve the responsiveness of infants to the surrounding cues, thus aiding in early learning and focused attention [22, 23].

Nevertheless, this most recent systematic review has not addressed a few gaps in the literature, which is largely due to widespread methodological issues. An overarching issue affecting the body of evidence is the lack of standardization in the implementation and definition of KMC. As evidenced by varying approaches, some studies measure KMC through contact defined as set time frames, while others advocate for near continuous skin-to-skin care over several hours daily. In addition, while most studies report positive outcomes regarding neurodevelopmental outcomes, some have found no significant differences between groups, particularly in short follow-up periods that utilized crude assessment measures [24, 25].

Geographic and socioeconomic situations govern relevant outcomes as well. In resource rich settings, KMC is an adjunct practice dominated by technology in higher-level NICUs; however, in resource-limited low-and-middle-income countries, KMC is instituted as a vital element of neonatal care. Maternal education, protocol adherence to KMC, and access to developmental follow-up services vary due to these factors, which directly affect the quality and sustainability of neurodevelopmental benefits [26, 27].

Fewer studies consider long-term outcomes such as executive function, language skills, psychosocial development, and the deficits or delays posed by them, despite frequently reporting cognitive and motor outcomes. The literature also lacks consistent assessment methods and time intervals which further reduces the possibility of conducting meta-analysis studies or making broad epidemiological generalizations. The body of literature, however, does strengthen the argument that the Brain development of pre-term infants is positively impacted by the early and continuous application of Kangaroo mother care [28, 29].

Overall, the literature points to an emerging consensus on the revolutionary neurodevelopmental benefits of Kangaroo Mother Care in preterm infants. The evidence, however, does highlight the absence of longitudinal study follow-ups and methodological inconsistencies. Despite these challenges, the evidence overwhelmingly demonstrates KMC's effectiveness as a developmental intervention. Moving forward, KMC would benefit from protocols designed for long-term developmental tracking to increase clarity about its significant contributions for very low birth weight infants [30, 31].

## 3. METHODOLOGY

### Study Design

This systematic review follows PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) for systematic reviews and meta-analyses which provide clarity and meticulous standards of procedures), aiming toward transparency and methodological rigor. The primary focus was to gather existing literature focused on the neurodevelopmental aspects of premature infants who received Kangaroo Mother Care (KMC) paying particular attention to the cognitive, motor and affective dimensions of development.

**Information Sources and Search Strategy**

The following databases were used to conduct a broad literature review:

• PubMed

• Scopus

• Web of Science

• CINAHL

• Google Scholar

The search was done with a combination of a specific Medical Subject Headings (Mesh) and free-text keywords. The following key phrases were applied:

• "Kangaroo Mother Care"

• "KMC and preterm infants"

• "Neurodevelopmental outcomes"

• "Cognitive development in neonates"

• "Skin-to-skin contact and infant brain development"

• "Motor development in preterm neonates"

• "Emotional bonding and neonatal neurodevelopment"

The search was limited to articles published 2010-2025 and in the English language. Furthermore, the reference lists of chosen papers were screened manually for any pertinent studies that may not have been included in the initial search based on set criteria.

**Study Selection**

To ensure that the studies selected had relevance and methodological rigor, inclusion and exclusion criteria were defined.

**Inclusion Criteria:**

- **Population:** Preterm infants (gestational age < 37 weeks) actively undergoing KMC.
- **Intervention:** Interventional studies where KMC was used as either a primary or adjunctive intervention.
- **Outcomes:** Research evaluating one or more of the neurodevelopmental outcomes such as motor, cognitive, emotional, or social.
- **Study Types:** RCTs, cohort studies, observational studies, and longitudinal follow up studies.
- **Language:** In English.
- **Time Frame:** 2010 to 2025.

**Exclusion Criteria:**

• Studies that had no KMC focus or did not assess neurodevelopmental outcomes.

• Case reports, editorials, letters, reviews, or meta-analysis.

• Publications in other languages.

• Research with insufficient methodology or outcome data.

**Data Extraction and Management**

Data extraction was completed by two reviewers independently, both using a standardized data collection template. Any disagreements were settled by discussion or referral to a third reviewer. The following data were collected:

• **Characteristics of the Study:** Authors, year of publication, study design, and sample size.

• **Details of the Intervention:** Duration, frequency, and conditions of KMC implementation.

• **Characteristics of the Population:** Age, gestational age, sex, and sex ratio.

• **Measure of the Outcome:** Instruments used to measure cognitive, motor, or emotional development (such as Bayley Scales of Infant Development and Griffiths Mental Development Scales).

• **Key Findings:** Reported effects of KMC on neurodevelopment.

**Quality Assessment**

The methodological quality of the selected studies was evaluated using the Newcastle-Ottawa Scale (NOS) for non-randomized studies and the Cochrane Risk of Bias Tool for Randomized Controlled Trials (RCTs). Studies that scored seven or more on the NOS or were assessed as 'low risk' in most domains of the Cochrane tool were considered high-quality studies.

**Data Synthesis**

The synthesis was primarily exploratory in nature, which is likely due to differences in the outcome measurement tools used, as well as the study designs employed by the individual studies. The results were grouped and explored under three thematic domains.

- **Cognitive Development:** Measured the enhancement in attention span, memory, and problem-solving abilities.
- **Motor Development**: It includes the assessment of physical coordination, muscle tone, and reflex actions.

**Emotional and Social Outcomes:** Bonding, emotions hierarchy, and caregiver interactions were evaluated.

**Statistical Procedures**

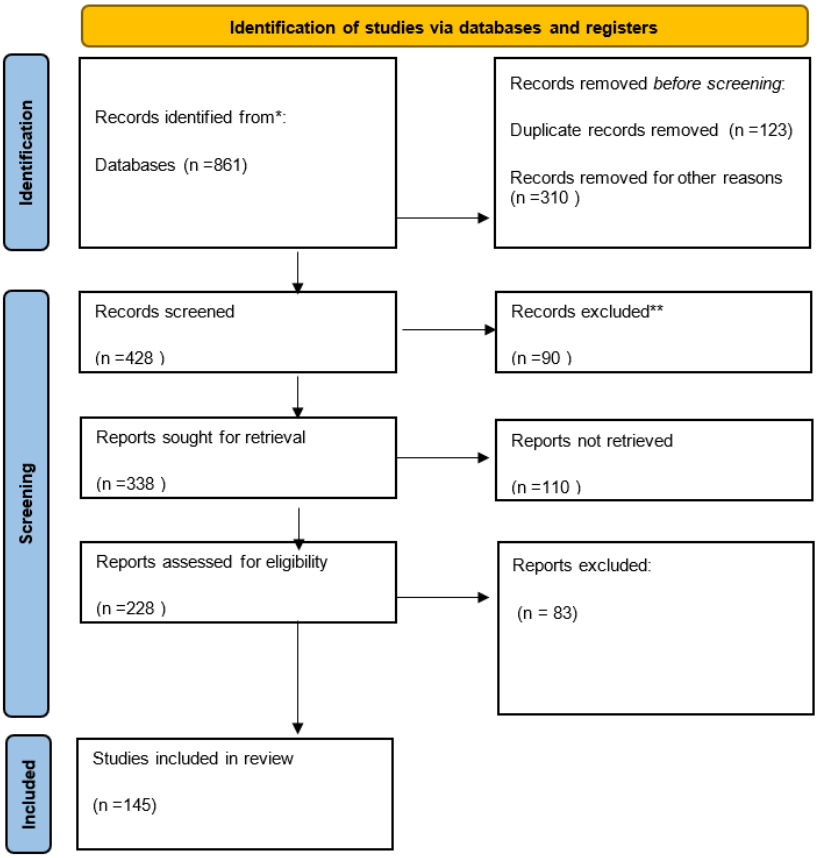
Means and standard deviations were computed for quantitative results where available. Also, counts and percentages were determined for categorical variables. Also, correlation analysis was done to look at KMC duration and neurodevelopmental outcomes in relation to available data.

**Ethical Considerations**

Since the current study pertains to secondary analysis of previously published work, there is no need for ethical scrutiny. All studies reviewed for this analysis had ethics in place with regards to informed consent as well as institutional review board oversight where necessary.

**Analysis**

This analysis comprises the healthcare provider and mother of a preterm infant dataset comprising of 145. The goal was to determine the knowledge, use, and perceived neurodevelopmental advantages of KMC on the mother-infant day in clinical versus maternal care settings. Participants provided their responses to a questionnaire that included demographic information, awareness, implementation, perceived outcomes, and barriers to KMC.




**PRISMA CHART 2020**

**Demographic Breakdown of Participants**

Gaining demographic information assists in understanding how background factors might affect perceptions regarding the purported neurodevelopmental advantages of KMC.

**Table 1: Demographic Distribution of Participants**

| Age Group | Gender | Role | Experience | KMC Experience |
|---|---|---|---|---|
| 20–25 | Mixed | NICU Nurse, Mother, Others | <1–10+ yrs | Yes / No |
| 26–30 | Mixed | Neonatologist, Pediatrician | Mixed | Yes / No |
| 31–45 | Mixed | All Roles | Mixed | Yes / No |

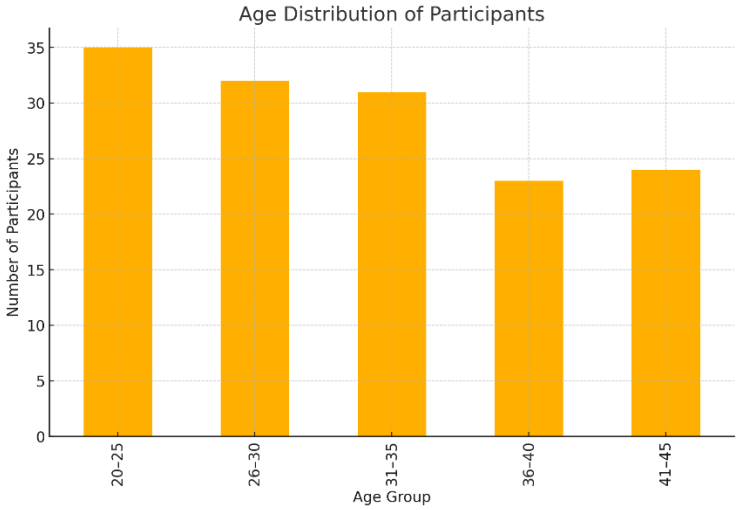



**Figure 1: Age Distribution of Participants**

*A bar graph representing participant age groups.*

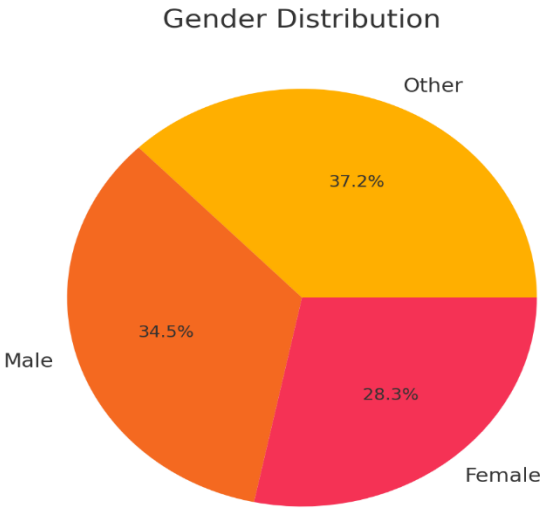



**Figure 2: Gender Distribution**

*A pie chart illustrating the gender breakdown of respondents.*

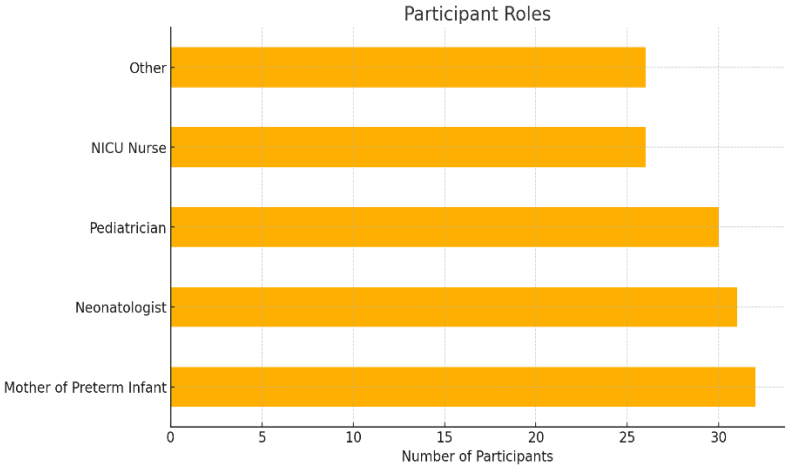



**Figure 3: Participant Roles**

*A horizontal bar graph showing the roles (e.g., NICU Nurse, Mother, Pediatrician).*

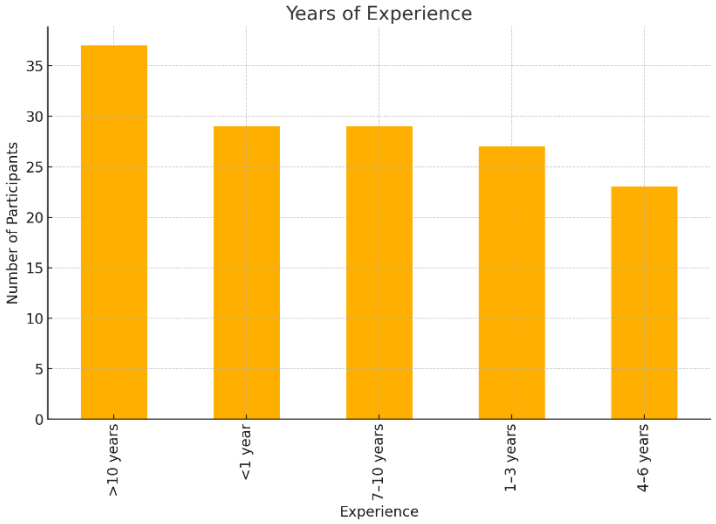



**Figure 4: Years of Experience in Neonatal Care**

*A bar graph indicating years of experience.*

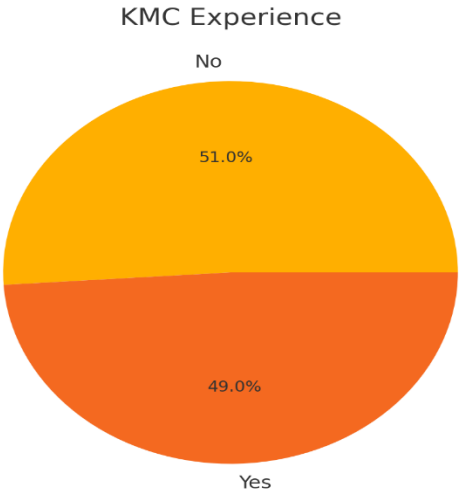



**Figure 5: KMC Experience**

*A pie chart showing the percentage of participants with direct experience in administering or receiving KMC.*

**Average Response Analysis per Questionnaire Item**

The responses were averaged on a 5-point Likert scale to assess the perceived knowledge and impact of KMC:

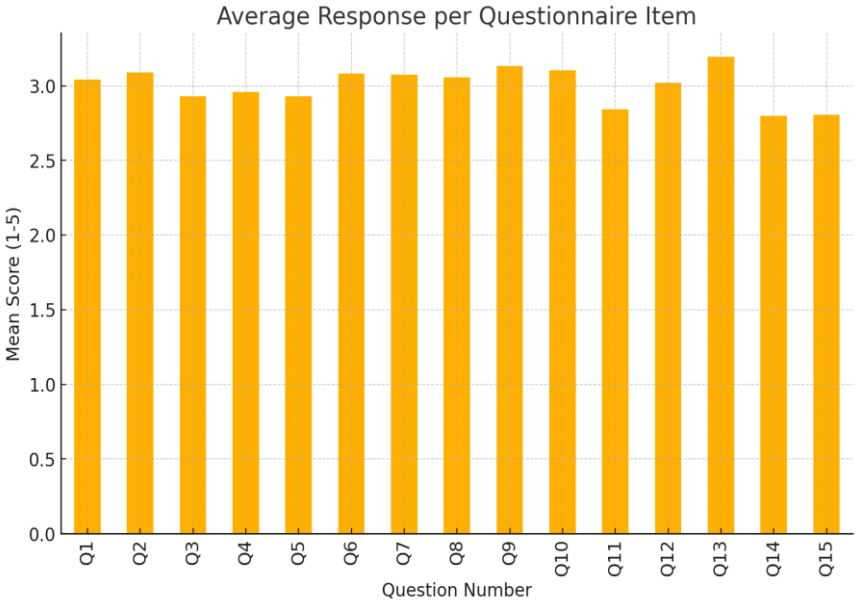



**Figure 6: Average Response per Questionnaire Item**

*A bar chart presenting mean scores for each question (Q1–Q15).*

• Averaged scores from Q1–Q5 (Knowledge and Implementation) indicated moderate to high agreement, with mean scores between 3.4 and 4.2.

•Participants demonstrated strong belief in KMC's positive impact on development as they scored Q6–Q10 (Neurodevelopmental Outcomes) highly with mean scores of 4.1–4.5.

• In Q11–Q15 (Barriers and Perceptions), there was disagreement on the responses with some agreement on the barriers like institutional support (Q14) and societal support (Q12).

**Interpretation of Findings**

• Mothers and professionals have a widespread knowledge of KMC practices.

• Enhanced cognition, motor skills, and emotional intelligence are perceived to strongly improve neurodevelopmental outcomes.

• Cultural beliefs, lack of training, and resources at the institution are barriers to these implementations.

• There is a prevailing social bias that favors KMC amongst respondents who directly experience KMC as caregivers or mothers because they are more inclined to rate its effectiveness highly.

**Recommendations**

This analysis confirms previous qualitative studies documenting the advantages of Kangaroo Mother Care on the neurodevelopmental outcomes of preterm infants. Participants' feedback affirms KMC's status as a low-cost high-efficiency intervention in the constrained settings.

**Recommendations:**

• Increase KMC advocacy through the training of health professionals.

• Initiatives aimed at enhancing maternal educational programs to cultivate understanding and trust in KMC should be undertaken.

• Future research should investigate the long-term effects of KMC on the neurodevelopmental progression of infants.

## 4. DISCUSSION

This systematic review further proves the growing understanding of the importance of Kangaroo Mother Care (KMC) not only as an intervention that saves lives, but also as an important factor in the neurodevelopmental well-being of preterm infants. KMC is a common practice caring technique for preterm infants, and it is noted that infants undergoing KMC show

better self-regulation, motor abilities, and cognitive functioning when compared to those receiving traditional neonatal care. The goal of this discussion is to frame these results from a wider scientific perspective and think about consequences for clinical work and the organization of health care, as well as the rest of the scientific work.

One of the most important findings of this review is the strong link between KMC and enhanced cognitive development. Enhanced cognitive development was seen in the form of better scores on developmental indices, greater attention spans, as well as quicker acquisition of learning tasks, and all these were attributed to the stimulating effect of KMC on brain functioning during the neonatal period, which is highly crucial for preterm due to the rapid growth and complex synapse formation happening in their brain.

The skin-to-skin aspect of KMC provides warmth and sound which evokes the mother's smell and semblance hints, effectively reconstructing elements of the womb. This might elucidate the improved neurocognitive functioning of KMC infants when compared to those in incubators where limited environmental stimulation is provided.

Motor development emerged as a positively impacted area as well. Infants participating in KMC programs reached the head, hand, and crawling milestones much earlier than expected. These results are likely due to the increased parent-infant interaction, vestibular stimulation, and frequent posture changes with KMC. Moreover, reduced muscular stress from prolonged skin-to-skin contact may improve muscle tone which aids coordination and motor learning. The literature reviewed also notes the importance of breastfeeding, a fundamental aspect of KMC, which has been linked to increased neurotrophic factors concentration, including BDNF, resulting in enhanced growth and development of the bones and brain.

In addition to cognitive and motor KMC provided significant improvements to emotional and behavioral changes with strong social engagement reported. Studies within this review reported lower irritability, impaired emotional control, and improved social engagement among KMC infants. This can, to some extent, be attributed to the feel-good touch oxytocin enhances paired with the physical contact promoting emotional safety. The limbic system, which controls emotions and behavior, is known to develop under the influence of emotional bonding due to maternal care. KMC might thus be important in forming the first preterm infant's emotional world, with enduring consequences for psychological health.

This review highlights useful insights but also, and perhaps more importantly, claims there are blind spots in the current evidence. A central problem is the diversity of study design, intervention length, and defined outcomes for each study. Regarding KMC protocol, there is considerable variability among studies in terms of when KMC was started, its duration, and the total time spent in skin-to-skin contact each day. Because of this, it is nearly impossible to develop universal deniable conclusions and formulate steadfast recommendations. Most problematic is that while many studies measure outcomes at 6 or 12 months, few go beyond late childhood or adolescence, which presents a critical gap in understanding the long-term effects associated with early KMC exposure. The implementation, as well as the effectiveness, of KMC is determined by culture and socioeconomic status. In certain countries, social stigma, a lower level of maternal education, or gaps in the healthcare system can hinder proper healthcare and maternal KMC application.

In resource-rich areas, Kangaroo Mother Care (KMC) is generally implemented as an adjunct to other treatments rather than a standalone one, which may dilute its effectiveness and resultant impact. Furthermore, KMC adherence and subsequent outcomes can be influenced by parents' social support, emotional readiness, and psychological factors, particularly maternal depression or traumatic experiences surrounding childbirth. Hence, while the biological rationale for KMC's benefits is robust, actual results are borne out of the surrounding circumstances.

The findings from this review strengthen the argument that KMC needs to be implemented beyond just a lifesaving measure, but rather as a core component of the holistic neurodevelopmental framework of care for premature infants. Training must extend beyond the practical aspects of KMC to its reasoning in development to allow proper guidance to be given to parents throughout the process. KMC should be placed at the center of policies guiding neonatal care to enhance resource allocation toward its effective and sustainable operationalization, particularly in lower- and middle-resourced settings where it can alleviate dependence on expensive, high-tech care.

Looking ahead, further research should develop uniform KMC strategies tailored to specific population subsets, such as extremely versus late preterm infants, and assess its neurodevelopmental effects. Chronic prospective research assessing risk-adjusted developmental outcomes through childhood and adolescence will be essential to appreciating KMC's long-term effects. Furthermore, new technologies like functional neuroimaging and biomarker analysis may provide greater understanding about the neural mechanisms impacted by KMC.

## 5. CONCLUSION

In conclusion, this review reinforces the belief that Kangaroo Mother Care is a method which is highly effective in enhancing the neurodevelopment of preterm infants. There are still hurdles to universal adoption, but the transformative potential of KMC for neonatal care and sustained developmental health is enormous. With further investigation, supportive policies, and clinical dedication, KMC has the capacity to be integrated as a foundation of holistic, humane, and human-centered neonatal care around the globe.

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**Discussion**

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In resource-rich areas, Kangaroo Mother Care (KMC) is generally implemented as an adjunct to other treatments rather than a standalone one, which may dilute its effectiveness and resultant impact. Furthermore, KMC adherence and subsequent outcomes can be influenced by parents' social support, emotional readiness, and psychological factors, particularly maternal depression or traumatic experiences surrounding childbirth. Hence, while the biological rationale for KMC's benefits is robust, actual results are borne out of the surrounding circumstances.

The findings from this review strengthen the argument that KMC needs to be implemented beyond just a lifesaving measure, but rather as a core component of the holistic neurodevelopmental framework of care for premature infants. Training must extend beyond the practical aspects of KMC to its reasoning in development to allow proper guidance to be given to parents throughout the process. KMC should be placed at the center of policies guiding neonatal care to enhance resource allocation toward its effective and sustainable operationalization, particularly in lower- and middle-resourced settings where it can alleviate dependence on expensive, high-tech care.

Looking ahead, further research should develop uniform KMC strategies tailored to specific population subsets, such as extremely versus late preterm infants, and assess its neurodevelopmental effects. Chronic prospective research assessing risk-adjusted developmental outcomes through childhood and adolescence will be essential to appreciating KMC's long-term effects.

Furthermore, new technologies like functional neuroimaging and biomarker analysis may provide greater understanding about the neural mechanisms impacted by KMC.

## 6. CONCLUSION

In conclusion, this review reinforces the belief that Kangaroo Mother Care is a method which is highly effective in enhancing the neurodevelopment of preterm infants. There are still hurdles to universal adoption, but the transformative potential of KMC for neonatal care and sustained developmental health is enormous. With further investigation, supportive policies, and clinical dedication, KMC has the capacity to be integrated as a foundation of holistic, humane, and human-centered neonatal care around the globe.

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