

## The Effects of Kangaroo Care on a Newborn Development and Vital Physiology

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### Abstract

This literature review examines the role of Kangaroo Care (KC) in an infant's early development and their vital physiology. By surveying past studies performed analyzing the specific effects of KC, the most relevant health effects of kangaroo care were chosen to analyze. These effects are on neurological, autonomic, somatic, behavioural, and motor development. Infant vital signs illustrate changes upon initiation of KC. These include changes in sleep cycles, heart rate, feeding efficiency, respiratory rate, crying and bonding between caretaker and infant. Chosen studies also addressed the effect of KC on preterm and low birth weight (LBW) infants and found KC to reduce duration of hospital stays and mortality. Through examination of past studies the effects of KC were varied from infant to infant due to different medical histories and health factors. The overall conclusion from the previous studies showed that KC had positive effects on the development of a child during the first two years of life. KC is shown to favourably impact an infant and show minimal to no disadvantage to an infant's health.

**Keywords:** Kangaroo care; Nontraditional infant care; Skin-to-Skin contact; Kangaroo mother care; Effects on infant development; Vital physiological of an infant; Infant vital sign stability

### Abbreviations

KMC: Kangaroo mother care; KC: Kangaroo care; LBW: Low birth weight; SSC: Skin-to-skin contact

### Introduction

Kangaroo care (KC) or Kangaroo Mother Care (KMC) is when infants are carried or held to their caretaker's chest. This can occur moments after birth for maximal effect and can continue to be implemented through the first years of life. Skin-to-skin contact (SSC) is a specialized form of KC. It is when an infant rests on their caretaker's chest with no clothing between their skin and their caretakers. KC affects the psychological and physical development as well as the health of an infant during the first years of life. Several factors correlate with an infant's development and the practice of KC. These effects are on neurological, autonomic, somatic, behavioural, and motor development. In addition, infant vital signs illustrate measurable changes upon initiation of KC. These include changes in sleep cycles, heart rate, feeding efficiency, respiratory rate, crying, and bonding between caretaker and infant. In this paper studies will be discussed that have addressed the effect of KC on preterm and low birth weight (LBW) infants, such as an increase in health by reducing the duration of hospital stays and mortality. Although the effects of KC vary from infant to infant due to different medical histories and health factors, an infant's health has been shown in a variety of studies to be influenced by KC. This paper will present the role of KC. The discussion will demonstrate how this type of care favourably impacts an infant.

### Literature Review - Short-term Effects (Effects lasting beyond the use of Kangaroo Care)

KC approaches "improve infants' oxygen saturation and significantly reduce their oxygen requirements during the contact time" [1]. The work of Bera et al. [2] found an average increase of 5% in oxygen saturation in LBW infants, which shows improved oxygen delivery to the infant's cells and brain. In addition, hypothermia, bradycardia, and tachycardia were improved by KC. During the use of KC, an infant's temperature was shown to significantly increase by an average of 0.4°C, which was a healthy slight increase to prevent hypothermia. Carfoot et al. showed similar results, the temperature of infants studied, one hour after birth, was higher than routine care infants. This slight temperature increase "preserves energy and accelerates metabolic adaptation" [3]. A study in 1992 [3] measured axillary and skin temperatures, and found infants using direct SSC had higher temperatures 90 minutes after birth. The SSC infants' blood glucose also remained at a higher level for a longer period. Higher blood glucose is healthier for newborn infants because it prevents hypoglycemia, which occurs in 1-3 out of every 1,000 live births. Blood glucose provides the infant with energy, and the majority of glucose is utilized by an infant's developing brain.

Heart rate is also influenced positively by KC. Two hundred and six mothers and their preterm infants participated in SSC for three days for 1-2 hours [2]. The infants' heart rate increased by an average of 5 beats per minute and respiratory rate by 3 breaths per minute. Bloch-Salisbury et al. [4] determined that a caregiver's heartbeat causes sensory perturbations in an infant. This finding revealed a novel cohabitation-induced feedback mechanism of respiratory control in the infants. Therefore, the baby has a stronger and more consistent respiratory rate. This allows more efficient circulation of blood throughout the infant's body.

KC positively impacts an infant's feeding patterns and capacity. Hake-Brooks et al. [5] did a randomized controlled trial with 66 mothers and their preterm infants who were subdivided into two groups [5]. One group received unlimited amounts of KC (mean: 4.47

hours a day), while the other received standard nursery care (which was the same type of care without any extra holding of the child). A KC infant breastfed for a longer period of time on average: 5.08 months versus 2.05 months for an infant who received standard care. A larger number of KC mother-infant dyads achieved exclusive breastfeeding in contrast to the control group. The work of Aghdas et al. [6] evaluated the immediate and continuous effects of SSC on breastfeeding. The study sampled 92 Iranian women between 18-35 years of age who had healthy full term children. The results found breastfeeding self-efficacy (confidence in commanding control of their actions) was higher in SSC infants than in the routine care infants. In addition, time taken to initiate the first feed took one third of the time for SSC infants in contrast to the control. Also, initiation rate of feeding was found to be 21% higher in SSC groups. This shows SSC ensures the effective feeding of an infant and “prevents premature discontinuation of breastfeeding” [6]. Premature discontinuation can lead to inadequate feeding of the child and a slower rate of development. In a study conducted by Carfoot et al. and the similar effects were found after testing 204 mothers and their infants. The SSC infants had a breastfeeding success rate of 91% while the control group had a lower rate of 83%. Four months later a slightly higher rate of SSC infants were found to be exclusively breastfeeding, which influenced the growth of the child. KC infants, due to their higher breastfeeding success, grew at a faster rate than their non-KC counterparts.

Next, Christensson et al. [7] found reduced crying during the use of SSC compared to children placed directly on cots. Crying is a type of “separation distress call . . . a genetically encoded reaction to separation” [7]. This was deduced by showing that children who participated with their caretakers in SSC cried less when they were with their mothers and cried more when they were separated. Therefore, leaving a child on a bed rather than holding them can influence their crying and stress level. There are concerns about infants developing problems with later independence. However, the effects of KC on independence have not been researched fully.

Feldman et al. [8] saw an effect on sleeping patterns in combination with KC. The researchers subdivided activity states into the following six categories: quiet sleep, active sleep, sleep-wake transition, unfocused alertness, alert wakefulness, and cry. During four hour observation periods KC infants spent a greater amount of time in “quiet sleep and alert wakefulness and less time in active sleep,” indicating better state functions and sleep-wake cyclicity [8]. The researchers also examined a change in organization of sleep-wake states in infants from 32 weeks of gestational age to term. Sleep-wake cyclicity during this time increases for all infants, but “gains in the rhythmicity of sleep and wakefulness for infants receiving KC were higher” [8].

Finally, KC affects touch, proximity, and family interactions [9]. The study examined how KC affects the function of the family system and found KC created positive interactions between the caretaker and infant. These interactions involved an increased amount of touch and affection displayed by the mother to the infant. Touch was defined “as a constituent of the co-regulatory parent–infant and triadic systems and the effects of maternal contact on mothering, co-parenting and family processes” [9]. KC affects bonding between an infant and mother, and possibly father (results were more varied). Increased bonding can create positive family interactions that go beyond the first years of life. However, more randomized clinical studies should be performed to determine the exact effects. This particular study consisted of only

matched groups. In summary, there is compelling evidence to suggest that the short-term effects of KC are beneficial to an infant.

### **Literature Review - Long-term Effects (Effects lasting beyond the time Kangaroo Care is implemented)**

The study in 2014 [2] states that KC has a positive effect on growth and development. They enrolled 500 mothers to determine the effects of sustained KMC on LBW (<2500 g) Indian babies who ranged from newborn to twelve months of age. LBW children who received KC surpassed the control group in physical growth between 3-6 months in development. The mean weight and chest circumference of KMC babies exceeded the control group. A study in 2008 [10] found similar results with average weight gain per day, average head circumference, and body length being greater in KMC infants than in the control group. Menezes et al. [11] studied 137 preterm LBW infants and had parents practice daily KC with their child starting the 13th day after birth. They found an 85% correction in gestational weight for KC infants at six months of life (the wide range is believed to be due to differences in individual children’s growth patterns). KMC babies also surpassed non-KMC infants in motor skills. In summary, many of the developmental aspects of early life can be improved through KC.

KC has a positive effect on the cognitive capacity of an infant. Cognitive ability can be studied by implementing the “still face” task [12]. The “still face” task tests an infant’s awareness of the effects of their actions on those around them. Caretakers suddenly become expressionless and motionless, and then the researchers record the reaction of the infant. The work of Bigelow et al. [12] tested the “still face” task on 80 newborns that were assigned equally into two groups: SSC and control. The SSC group’s infants were directed to receive 6 hours of SSC a day in the first week of life and 2 hours a day for the remaining three months of the study. One week postpartum both the SSC group and the control group demonstrated “visual attention and awareness of the changes in their mother’s behavior” [12]. However, infants in the SSC group began to use their effect to demonstrate their attention to their caretaker at one month (measured most often by smiling). The control group did not use their effect in this way until two months, showing a delay in development of this skill. Additionally, compared to the control group “non-distressed vocalization” (vocalization that was not crying) was increased at three months in the SSC group. Researchers hypothesized this vocalization was a way of re-engaging their mother’s attention. The development of SSC infants was one month ahead of the control group with respect to their cognitive awareness of themselves and others.

KC also improves mental maturation. Feldman et al. [9] evaluated if SSC accelerated autonomic and neurobehavioral maturation in preterm infants. Seventy preterm infants were paired based on medical history, sex, birth weight (mean 1230g, LBW), family demographics, and gestational age at birth. In addition, all mothers were married, in the upper socioeconomic class, and had a minimum of a high school education. The researchers observed each infant pair for 30 hours over the duration of the study. One infant of each pair received KC for a minimum of 1 hour a day. The other infant was a control whose caretakers were not advised to use this type of care. In comparison to the controls, KC infants showed increased vagal tone, which was the improvement of autonomic function. Vagal tone was also found to predict an infant’s development during the first two years of life.

Feldman et al. [8] also addressed neurobehavioral measures and tested for three Neonatal Behavioral Assessment Scale (NBAS) clusters.

The three clusters tested were habituation, orientation, and range of state. Habituation is related to an infant's medical conditions and vagal tone. Orientation is related to higher basal responsiveness, cortisol levels, and negative emotionality. Finally, range of state predicts some processing skills and is measured by how often the baby moves from one state to another (crying to calm). The authors found KC infants had the same range of state as the control group, but had improved habituation and orientation. KC infants had neurobehavioral profiles, which were more mature than their counterparts of the same age. These profiles were affected by health factors, but the effect of KC remained evident even when these health factors were taken into consideration. The authors hypothesized that KC alters the growth trajectory of systems that are already operating in the development of a young infant. The main limitation of this study is that it was not prospectively randomized. The study used a case-control method and matched variables in infants that would affect neuro-maturation. The study showed positive differences in developmental and health factors for children that used KC and did not show these infants had received any disadvantages to their health or mental development.

### Literature Review - Effects on Premature and LBW Children

Neonates and LBW infants are of interest in research because of their immature development at the time of birth. Healthcare workers seek activities to increase their strength and vital signs. As discussed earlier, many studies have been done about the effects of KC on neonates and LBW babies. The use of KC with these types of infants was shown to increase their health and strength. A study of neonates found that "psychosocial effects of KMC include reduced stress, enhancement of mother-infant bonding, and positive effects on the family environment and the infant's cognitive development" [13]. In summary, KC has a range of effects on premature and LBW infants during their first days of life.

Neonates spend less time as patients in the hospital when they participate in KC. Conde-Agudelo et al. [14] researched 2,751 infants who were provided intermittent, continuous, or no KMC care. This care was provided from the first day of birth to discharge at 40-41 weeks gestational age. The researchers found KMC infants spent an average of 2.2 days less in the hospital. Charpak et al. [15] studied 746 mother-infant dyads, which were divided into a control group and a KC group. The amount of time an infant spent in the hospital was reduced and this effect was greatest for LBW infants. KC infants also acquired reduced rates of nosocomial infections in comparison to the control group. Similar studies have found a "significantly higher number of babies in the (control) group suffered from hypothermia, hypoglycemia and sepsis" in comparison to the KC group [10]. Amin et al. [16] tested 106 neonates over a period of six months and found the mean duration of KC was significantly greater for neonates who did not require antibiotics versus those who required antibiotics. In addition, the mean duration of KC was greater for infants who gained weight versus infants who lost weight. There is increasing evidence that KC increases the health of LBW children and neonates. Therefore, using KC could reduce the costs of healthcare a newborn incurs and the use of medical resources, because a healthier child does not have to spend as much time in the hospital. If the cost is reduced then less money will be spent each year on newborn infants and this money will be able to be used for research of other diseases. In addition, the cost of implementing KC in a newborn's life has a small cost in comparison to the money saved by the decrease in morbidity and mortality.

KC infant's show decreased presentation of certain illnesses, which leads to decreased mortality. Charpak et al. [13] found a 2.4% decrease in the mortality of infants who used KC in a randomized study of 746 infants and mothers. The KMC group had a death rate of 3.1% and the control group had a death rate of 5.5%. In 2010, Ref. [17] identified 15 studies that addressed KC related to infant morbidity and/or mortality and discussed 11 of them in detail. A 51% decrease in mortality and morbidity was reported. However, this rate may have been exaggerated because the sickest children may have passed away before being able to commence KMC care. In conclusion, the use of KC is beneficial to infants who spend a great amount of time in the hospital at a young age.

### Results

The cumulative results of these articles indicate that the practice of KC is not harmful, but rather beneficial or having no effect on an infant during the first days to two years of life. The effects vary based on when KC is implemented and the duration of time it is performed. Past studies discussed above found KC to have positive effects on early progression of a child's health. These effects included slight improvements of development in autonomic, somatic, motor, and cognitive areas. These findings were demonstrated using different developmental tests that varied for different studies. These effects are found to be evident even when KC is not being done simultaneously. Children's sleep cycles are found to be improved by allowing more time in deep sleep and alert wakefulness rather than time spent trying to fall asleep or wake up. Also, heart rate, feeding efficiency, and respiratory rate, are found to improve slightly with the use of KC. In addition, overall time spent crying is found to slightly decrease during the use of KC. Specifically the vital sign intensifications indicate an important conclusion about KC, which is that it is beneficial to increasing the strength of an infant during the first two years of life.

Next, parent-infant bonding with their caretaker increases directly with increased touch and affection displayed toward an infant during their first years of life. Finally, KC is shown to reduce hospital stays and illnesses of LBW infants. This reduction in illnesses was shown in the above studies to create a significant drop in mortality of infants who participated in KC. LBW infants were shown in these studies to significantly benefit from the use of KC. Taken together, the results of the studies discussed support the conclusion that KC is not harmful to an infant. KC has no obvious detrimental effects to a child. KC produces increased health and strength benefits during their first two years of life. Through the above analyses of different studies testing the effects of KC, all studies found either improvements or no effect due to the use of KC. Infants who are exposed to KC receive varying effects based on their medical history and other health factors. KC is found to have minimal to no deleterious effects on an infant. However, some studies discussed did find only minimal positive effects. In all, KC is a practice that can be implemented for the benefit of an infant.

### Discussion

The results of these finding can be used to justify the use of KC for infants. Previously published literature is consistent with the idea that KC is beneficial to an infant in a variety of ways. The literature shows when KC is used as a care method during an infant's development, it has both short and long term effects. These effects are different based on duration of time KC is performed and the health of the infant. In conclusion, KC is a beneficial practice for infants and their caretakers to begin within the first hours of an infant's birth. The review shows the

significance of KC on an infant's development and the accumulated effects of this type of care. The work of previous studies is combined to get an overarching view of how KC can affect the vital physiology and development of an infant compared to the use of traditional care.

The effects of KC cannot be generalized for all infants. Previous literature has found different effects and often greater effects for infants who are preterm or LBW due to their decreased strength and possibly health at the time of birth. Therefore, the effects of KC cannot be oversimplified since each infant has a different set of health and medical circumstances. Also, KC can be implemented in a variety of ways and effects can be varied due to the use of different forms of KC or different ways of practicing KC. For example, holding a child or using baby wraps, that holds a child on a caretaker's chest hands-free. Different methods can cause different effects on an infant or change the quantity of a single effect.

Over the past 20 to 30 years, extensive research has been conducted to analyze the effects of KC on a child's development and health. The use of KC versus the specialized type of KC, SSC, should be researched to determine if one is more beneficial than the other. SSC may have a larger impact on some effects of KC due to the increased closeness of the participants. Previous research to address these differences and their longevity should be done to provide information on which type of care is more beneficial. Also, the research found longer lasting effects on development both psychologically and physically. More longitudinal studies should be done to determine the benefits of KC past two years of age. In all, KC can benefit infants in different ways and the nature of the effects varies based on the child.

A final issue in making generalized predictions about KC is many previous studies vary on when KC is started after a child's birth. Some studies implemented the care immediately while others waited up to a couple of months to begin. This discrepancy is time to begin KC is likely to make a difference in the quantity and length of the effects that KC produces. Therefore, additional research should be done to determine the differences that arise based on when KC is started. This type of study could help account for the differences in results found between studies measuring the same output.

The practical implication of these findings is that KC should be implemented in an infant's life to positively influence their health. Although many effects of KC are known, they fluctuate based on the individual child. This paper supports the idea that KC not only contains a variety of effects both short term and long term, but also requires further investigation to understand the extent of these effects completely.

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