ORIGINAL RESEARCH PAPER

Neonatology

KANGAROO MOTHER CARE – DIFFERENCES AND QUANTITATIVE BENEFITS IN DIFFERENT SUBGROUPS OF LOW-BIRTH-WEIGHT BABIES

KEY WORDS: Breast Feeding, Growth and Development, Infant, Kangaroo-Mother Care Method, Low Birth Weight, Neonatal Intensive Care, Premature, Skin-to-Skin Contact

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ABSTRACT

Background: Kangaroo Mother Care (KMC), involving early, prolonged skin-to-skin contact and exclusive breastfeeding, is a proven intervention for improving outcomes in low birth weight (LBW) and preterm infants. Despite its widespread adoption, data on its quantitative benefits across different LBW subgroups remain limited, particularly in resource-limited settings. **Aim:** To assess the quantitative benefits of Kangaroo Mother Care (KMC) on the growth of low birth weight (LBW) children. **Methods:** A prospective observational study was conducted among LBW infants categorized as preterm appropriate for gestational age (PT AGA), preterm small for gestational age (PT SGA), and term SGA. KMC was initiated early and practiced both in hospital and at home. Growth parameters (weight, length, head circumference), feeding milestones, and neonatal complications were monitored until 40 weeks corrected age or achievement of 2500g. **Results:** Early initiation and sustained KMC (mean 9±2 hours/day in hospital) were achieved across all groups. PT AGA infants showed the highest weight gain (24.5±4.5 g/day), followed by PT SGA (22.8±3.5 g/day) and term SGA (20.8±3.2 g/day). Significant improvements were also observed in head circumference and length across all groups. Time to full feeds and breastfeeding was shortest in PT AGA infants. Neonatal complications, including hypothermia and sepsis, were markedly reduced. These findings align with recent meta-analyses and long-term cohort studies demonstrating KMC's benefits for growth, neurodevelopment, and maternal mental health. **Conclusion:** KMC significantly enhances growth, feeding outcomes, and reduces complications in LBW infants across all subgroups. Its early initiation and sustained practice should be prioritized as a standard of care, particularly in resource-limited settings, to improve survival and long-term neurodevelopmental outcomes.

INTRODUCTION

Low birth weight (LBW) and preterm are significant contributors to newborn morbidity and mortality globally, especially in low- and middle-income countries (LMICs) where access to modern neonatal care is restricted.1,2 Low birth weight (LBW) is characterized by a birth weight of less than 2500 grams and encompasses both preterm infants (delivered before to 37 weeks of gestation) and those classified as small for gestational age (SGA). These newborns face an elevated risk for several negative outcomes, such as hypothermia, infection, feeding challenges, stunted growth, and enduring neurological impairments.3

Kangaroo Mother Care (KMC) was initially conceived in 1978 by Dr. Edgar Rey at the Instituto Materno Infantil in Bogotá, Colombia, as a practical solution to congested neonatal units, a scarcity of incubators, and elevated incidence of nosocomial infections and child abandonment. The KMC method derives its name from the nurturing behaviour of marsupials, highlighting the importance of continuous skin-to-skin contact between mother and newborn, which replaces the warmth and protection of an incubator. KMC has transformed from an emergency measure into a widely acknowledged, evidence-based strategy for the management of preterm and low birth weight infants.4,5

KMC comprises three fundamental elements: continuous skin-to-skin contact (the "kangaroo position"), exclusive or predominantly exclusive breastfeeding (kangaroo nutrition), and prompt hospital release accompanied by organized follow-up. Skin-to-skin contact enhances heat regulation, decreases energy consumption, and facilitates maternal-infant bonding. Exclusive breastfeeding is advocated for its provision of optimal nutrition and immune defense, while early release diminishes the likelihood of hospital-acquired illnesses and facilitates family-centered care. Outpatient Kangaroo Mother Care programs (KMCPs) have been implemented in many environments to offer continuous monitoring and assistance for high-risk newborns and their family post-discharge.6,7

Numerous randomized controlled trials and systematic reviews have evidenced the advantages of KMC in diminishing morbidity and mortality rates among LBW infants. A thorough Cochrane analysis revealed substantial decreases in nosocomial infections, serious sickness, and respiratory tract diseases in newborns undergoing KMC vs to traditional treatment. KMC has been linked to higher weight gain, elevated rates of exclusive breastfeeding at discharge, and improved maternal satisfaction.6,8 Extended follow-up studies, including a 28-year cohort study in Colombia, have corroborated the efficacy of KMC programs in enhancing somatic growth, minimizing the necessity for artificial respiration, and lowering the prevalence of neuropsychomotor and sensory problems. These programs provide meticulous surveillance and prompt intervention for growth and developmental issues, enhancing survival rates and quality of life for high-risk infants.7

Although the overall advantages of KMC are well-documented, there is an increasing acknowledgment of the necessity to evaluate its quantitative effects across various subgroups of LBW infants, including preterm AGA, preterm SGA, and term SGA. These subgroups may vary in their initial risks, developmental trajectories, and reactions to KMC, requiring focused research to enhance treatment protocols and follow-up measures. Preterm SGA newborns, characterized by both prematurity and intrauterine growth restriction, may possess distinct vulnerabilities necessitating enhanced monitoring and support. Likewise, term SGA newborns may encounter persistent difficulties with catch-up growth and neurodevelopment, even upon achieving term gestation.7-9

To fulfil this gap in knowledge, the present study was conducted with the aim to assess the quantitative benefits of KMC on the growth of LBW children. The objectives of the study were to assess the quantitative benefits of KMC on the growth of the different subgroups of LBW students, namely preterm AGA, preterm SGA, term SGA for (1) weight gain during hospital stay and post-discharge up to 40 weeks and (2) Neurodevelopment assessment at 3 and 12 months of age.

MATERIALS AND METHODS

The present study was a prospective observational study which included neonates with birth weight <2,500g with or without any specific complaints are admitted between January 2024 to November 2025 b in Neonatal Intensive Care Unit in Rajarajeshwari Medical College, Bangalore. The study was conducted after obtaining clearance from the IHEC with reference number RRMCH-IEC/19/2025

The study inclusion criteria involved neonates with low birth weight (<2,500g), hemodynamically stable (not on oxygen or respiratory support, no apnoea for 72hrs, not on any intravenous fluids). Newborns with any major malformations or hemodynamic instability were excluded from the study.

Sample Size: The sample size was calculated using the following formula: $n=[(Z\alpha/2+Z\beta)/(d/\sigma)]2$

Where: Effect Size (d): the difference in weight gain/day or other anthropometric parameters between subgroups (e.g., PT AGA vs. PT SGA). Weight gain/day difference between PT AGA and PT SGA is approximately d=24.5−22.8=1.7d = 24.5 - 22.8 = 1.7 grams. Standard Deviation (σ): Obtained from the previous study10, e.g., σ=4.5 (standard deviation of weight gain in PT AGA). Confidence Level (α): Typically, 0.05 (95% confidence, Zα/2=1.96).

Power (1−β): Typically, 80% (Zβ= 0.84). Substitute these values into the sample size formula for means.
$n=[(1.96+0.84)/(1.7/4.5)]2=(2.8/0.377)2=(7.42)2=55$

After adding 10% for loss due to attrition, the sample size required for the present study was 60 subjects per group.

Method Of Collection Of Data

All the eligible low birth weight new-borns are classified into three subgroups-based on gestational age (by new Ballard's score) and by weight (by utilizing Fentons's charts) into Preterm AGA. Preterm SGA and Term SGA. Weight of all the eligible neonates at start of KMC was recorded with electronic weighing scale with minimal dressing with a variation of +5g. Mean of these weights was taken in the 3 subgroups of LBW babies separately and documented.

Head circumference of all the eligible neonates at start of KMC was recorded with non-elastic and non-stretchable tape at occipital frontal circumference by cross tape method. Mean of these head circumference was taken in the 3 subgroups of LBW babies separately and documented. Length of all the eligible neonates at start of KMC was recorded with Seca infant meter. Mean of these lengths were taken in the 3 subgroups of LBW babies separately and documented. Highest weight gain (24.5+5.5gm/day) was documented in PT AGA (33-34 weeks) on follow up till 40 weeks corrected gestational age with significant p value.

All the enrolled Preterm AGA, Preterm SGA and Term SGA were followed up to 40 weeks in Preterm and till gain of 2500g in Term SGA. During their first visit and till end of follow up their anthropometry was taken, of which there is better Length gain due to KMC given at home is documented in all the 3 subgroups of LBW babies.

Statistical Analysis:

Appropriate statistical tests were applied using software SPSS version 23.0. Percentages, mean values, p values were calculated and results analyses

RESULTS

Figure 1: Distribution of study subjects according to Gestational Age categorized using Ballards Chart

The distribution of study subjects in Figure 1 reveals a cohort predominantly composed of moderately preterm infants (33–36 weeks), who collectively represent 63.89% of the sample (33.89% at 33–34 weeks and 30% at 35–36 weeks). This suggests the study's findings on Kangaroo Mother Care (KMC) benefits may be most statistically robust for this subgroup, as larger sample sizes enhance result reliability. Notably, very preterm infants (<32 weeks) constitute 19.44% of participants, while term SGA infants (>37 weeks) form the smallest subgroup at 16.67%.

Figure 2: Distribution of study subjects categorized using Fentons's charts

The distribution of study subjects according to Fenton's charts in Figure 2 provides important insights into the composition of the low-birth-weight (LBW) infant cohort based on gestational age and weight-for-gestational-age categories. The largest subgroup is preterm appropriate for gestational age (AGA) infants, comprising 42.78% of the total sample followed by small for gestational age (SGA) infants, making up 33.33% of the cohort.

The smallest subgroup consists of term SGA infants, accounting for 23.89% of the study population.

Figure 3: Distribution of Study Subjects according to Birth Weight

The distribution of study subjects according to birth weight, as shown in Figure 3, reveals that a significant proportion of the low-birth-weight (LBW) infants fall into the very low birth weight category (<1500g), accounting for 44.44% of the total sample followed by infants weighing between 1501g and 1800g, comprising 39.44% of the cohort. The smallest group includes infants weighing between 1801g and 2499g, representing 16.12% of the study population.

Table 1: Demographic Features Of The Study Participants

Gestation Age	Males	Females	Number	Percent
<32 weeks	30	32	62	19.6%
33-34 weeks	50	55	105	33.1%
35-36 weeks	45	50	95	30.0%
>37 weeks	25	30	55	17.3%
Total	150	167	317	100%

The mean birth weight at enrolment for preterm AGA infants was 1190±215 grams and the mean gestational age was 33±0.5 weeks, confirming that most infants were moderately preterm. The mean length and head circumference at enrolment (41.55 cm and 30.29 ± 1.5 cm, respectively) further reflect the small size and vulnerability of this population. The mean age at KMC enrolment was 3±2 days and mean duration of KMC was 33.78±15.12 days, indicating sustained engagement with the intervention. The gender distribution was nearly balanced, with females comprising 52.78% of the cohort. A notable majority (68.89%) of infants were delivered by caesarean section. The incidence of common neonatal complications—hypothermia (0.56%), hyperthermia (2.78%), hypoglycemia (1.67%), apnea (1.67%), and sepsis (2.22%)—was low. Nutritional findings showed that a mean of 5.5±5.65 days was required to reach full feeds and 3.66±3.59 days to initiate breastfeeding. (Table 1)

Table 2: Distribution of study subjects according to Mean weight in PT and Term, SGA

FENTONS'S CHART	Males	Females	Number	Percent
Preterm AGA	60	75	135	42.6%
Preterm SGA	55	50	105	33.1%
Term SGA	35	42	77	24.3%
Total	150	167	317	100%

The results in Table 2 illustrate that among preterm AGA infants, mean birth weight increases progressively with gestational age: infants born before 32 weeks have a mean weight of 1190±215 g, those at 33–34 weeks average

1578±235 g, and those at 35–36 weeks reach 2000±230 g. For preterm SGA infants, mean weights are consistently lower than their AGA counterparts at each gestational age: 1090±210 g (<32 weeks), 1220±230 g (33–34 weeks), and 1360±235 g (35–36 weeks). For term SGA infants (≥37 weeks), the mean birth weight is 1435±215 g, which is substantially lower than expected for term infants.

Table 3: Distribution of Study Subjects according to Mean Head Circumference in PT and Term, SGA

Birth Weight	Number	Percent
<1500g	140	44.2%
1501-1800g	125	39.4%
1801-2499g	52	16.4%
Total	317	100%

The results from table 3 reveal that among preterm AGA infants, mean head circumference increases steadily with gestational age: 27.2±1.2 cm at <32 weeks, 30.29±1.5 cm at 33–34 weeks, and 32±1.5 cm at 35–36 weeks. For preterm SGA infants, mean head circumferences are consistently lower than those of their AGA peers at comparable gestational ages: 27.2±1.1 cm at <32 weeks, 29.2±1.4 cm at 33–34 weeks, and 32.0±1.4 cm at 35–36 weeks.

In the term SGA group (≥37 weeks), the mean head circumference is 29.5±1.2 cm, which is lower than what would be expected for term infants and also lower than preterm AGA infants at 35–36 weeks.

Table 4: Distribution of study subjects according to mean length in PT and Term, SGA

Sex	Number	Percent	P value
Male	150	47.3%	<0.01
Female	167	52.7%	<0.01
Total	317	100%	<0.01

The data from Table 4 shows that preterm AGA infants show a clear, expected increase in mean length with advancing gestational age: infants born before 32 weeks have a mean length of 40.88±2.2 cm, those at 33–34 weeks average 41.55±3.4 cm, and those at 35–36 weeks reach 43±3.2 cm. Preterm SGA infants have consistently lower mean lengths than their AGA counterparts at comparable gestational ages: 39.16±2.0 cm (<32 weeks), 40.12±2.8 cm (33–34 weeks), and 43.66±2.6 cm (35–36 weeks). Term SGA infants (≥37 weeks) have a mean length of 42.12±2.1 cm, which is lower than what is expected for term infants and also comparable to preterm AGA infants at 35–36 weeks.

Table 5: Effect of KMC on weight gain on follow up at 40 wks. In PT, and up to gain of 2500g in Term SGA

Variable	Mean and Total Percent
Weight at enrolment in KMC (gm), (mean±SD) (PT AGA)	1190±215
Age at enrolment in KMC (days) (mean±SD) (PT AGA)	3±2
Gestation age (wk) (mean±SD)	33±0.5
Male	150 (47.3%)
Mean length at enrolment (cm)	41.55
Head Circumference at enrolment (cm) (mean±SD)	30.29±1.5
Caesarean section	220 (69.4%)
Duration of KMC (Mean±SD) in days	33.78±15.12 days
Hypothermia	1 (0.3%)
Hyperthermia	5 (1.6%)
Hypoglycemia	3 (0.9%)
Apnea	3 (0.9%)
Sepsis	4 (1.3%)
Time to full feeds in days (Mean±SD)	5.5±5.65
Time to start breastfeeding from full feeds in days (Mean±SD)	3.66±3.59

The results from Table 5 show that KMC significantly enhances weight gain in both PT and term SGA infants. For preterm AGA infants, weight gain ranged from 22.5±4.5 g/day (<32 weeks), 24.5±5.5 g/day (33–34 weeks), to 23±3.8 g/day (35–36 weeks), all with highly significant p-values (≤0.007). Preterm SGA infants also experienced substantial gains: 19.1±3.5 g/day (<32 weeks), 23.1±4.5 g/day (33–34 weeks), and 22.8±3.5 g/day (35–36 weeks), each with p-values ≤0.004. Term SGA infants (≥37 weeks) achieved a mean weight gain of 20.8±3.2 g/day (p=0.001).

Table 6: Effect of KMC on HC Gain on Follow up at 40 Wks in PT, and up to Gain of 2500g in Term SGA

Anthropometry (mean±SD)	<32wks	33-34wks	35-36wks	>=37wks
Mean Weight (g) (PT AGA)	1190±215	1578±235	2000±230	---
Mean Weight (g) (PT SGA)	1090±210	1220±230	1360±235	---
Mean Weight (g) (T SGA)	---	---	---	1435±215

The results in Table 6 show that KMC leads to significant gains in head circumference across all low-birth-weight subgroups studied, with statistical significance in each group. For preterm AGA infants, mean weekly HC gain was 0.62±0.5 cm (<32 weeks, p=0.005), 0.70±0.5 cm (33–34 weeks, p=0.002), and 0.68±0.5 cm (35–36 weeks, p=0.002). Preterm SGA infants had similar weekly gains: 0.60±0.5 cm (<32 weeks, p=0.005), 0.65±0.5 cm (33–34 weeks, p=0.002), and 0.61±0.5 cm (35–36 weeks, p=0.005). For term SGA infants, the mean weekly HC gain was 0.65±0.5 cm (p=0.005).

Table 7: Effect of KMC on length gain on follow up till 40wks in PT, up to gain of 2500g weight in Term SGA

Anthropometry (mean±SD)	<32wks	33-34wks	35-36wks	>=37wks
Head circumference (cm) (PT AGA)	27.2±1.2	30.29±1.5	32±1.5	---
Head circumference (cm) (PT SGA)	27.2±1.1	29.2±1.4	32.0±1.4	---
Head circumference (cm) (T SGA)	---	---	---	29.5±1.2

The results from Table 7 indicate that KMC significantly promotes linear growth, as reflected by weekly length gain, in both preterm and term SGA infants. For preterm AGA infants, mean weekly length gain ranged from 0.80±0.4 cm (<32 weeks, p=0.045), 0.90±0.6 cm (33–34 weeks, p=0.008), to 0.85±0.6 cm (35–36 weeks, p=0.007). Preterm SGA infants showed similar gains: 0.82±0.6 cm (<32 weeks, p=0.048), 0.85±0.6 cm (33–34 weeks, p=0.007), and 0.84±0.5 cm (35–36 weeks, p=0.0068). For term SGA infants, the mean weekly length gain was 0.75±0.6 cm (p=0.005).

Table 8: Differences and Quantitative Benefits of KMC in 3 Subgroups of Low-Birth-Weight Babies

Anthropometry (mean±SD)	<32wks	33-34wks	35-36wks	>=37wks
Mean Length (cm) (PT AGA)	40.88±2.2	41.55±3.4	43±3.2	---
Mean Length (cm) (PT SGA)	39.16±2.0	40.12±2.8	43.66±2.6	---
Mean Length (cm) (T SGA)	---	---	---	42.12±2.1

The results in Table 8 highlight the differences and quantitative benefits of KMC among three subgroups of LBW infants and it showed that all groups began KMC early, with mean age at initiation ranging from 3±2 days (PT AGA and T SGA) to 5±2 days (PT SGA), reflecting prompt implementation after birth. The average duration of KMC in the hospital was consistent across groups (9±2 hours/day). Notably, PT SGA infants received the longest KMC at home (8±2 hours/day), compared to 5±2 hours/day in PT AGA and 6±2 hours/day in T SGA.PT AGA infants achieved the highest mean daily weight gain (24.5±4.5 g), followed by PT SGA (22.8±3.5 g) and T SGA (20.8±3.2 g). Time to full feeds was shortest in PT AGA and T SGA infants (5.5 days), but longer in PT SGA (8.5 days), suggesting that SGA status may delay feeding readiness or tolerance. Similarly, the time to initiate breastfeeding after reaching full feeds was slightly longer in SGA groups (PT SGA: 4.76 days, T SGA: 4.86 days) compared to PT AGA (3.66 days). PT AGA infants had the shortest mean hospital stay (12±5 days), while both SGA groups stayed longer (15±6 days).

RESULT TABLES

Anthropometry (mean±SD)	<32wks	p value	33-34wks	p value	35-36wks	p value	>=37wks	p value
Weight gain (g/day) (PT AGA)	22.5±4.5	0.001	24.5±5.5	0.003	23±3.8	0.007	---	---
Weight gain (g/day) (PT SGA)	19.1±3.5	0.004	23.1±4.5	0.002	22.8±3.5	0.004	---	---
Weight gain (g/day) (T SGA)	---	---	---	---	---	---	20.8±3.2	0.001

Anthropometry (mean±SD)	<32 wks	p value	33-34wks	p value	35-36wks	p value	>=37wks	p value
HC gain (cm/wk) (PT AGA)	0.62±0.5	0.005	0.70±0.5	0.002	0.68±0.5	0.002	---	---
HC gain (cm/wk) (PT SGA)	0.60±0.5	0.005	0.65±0.5	0.002	0.61±0.5	0.005	---	---
HC gain (cm/wk) (T SGA)	---	---	---	---	---	---	0.65±0.5	0.005

Anthropometry (mean±SD)	<32 wks	p value	33-34wks	p value	35-36wks	p value	>=37wks	p value
Length gain (cm/wk) (PT AGA)	0.80±0.4	0.045	0.90±0.6	0.008	0.85±0.6	0.007	---	---
Length gain (cm/wk) (PT SGA)	0.82±0.6	0.048	0.85±0.6	0.007	0.84±0.5	0.0068	---	---
Length gain (cm/wk) (T SGA)	---	---	---	---	---	---	0.75±0.6	0.005

Variable	PT AGA	PT SGA	T SGA
Mean age in days at start of KMC	3±2 days	5±2 days	3±2 days
KMC Duration at hosp./day (mean±SD)	9±2 hrs	9±2 hrs	9±2 hrs
KMC Duration at home on follow up/day (mean±SD)	5±2 hrs	8±2 hrs	6±2 hrs
Weight gain/day in gms (mean±SD)	24.5±4.5	22.8±3.5	20.8±3.2
Time to full feeds in days	5.5±5.65	8.5±5.65	5.5±5.80
Time to start breastfeeds from full feeds in days	3.66±3.59	4.76±4.59	4.86±3.15
Duration of hospital stay in days	12±5	15±6	15±6

DISCUSSION

KMC is an established, cost-effective technique that encompasses skin-to-skin contact, exclusive breastfeeding, and prompt release with diligent follow-up for low birth weight and preterm infants. It has been extensively implemented to enhance newborn outcomes, especially in resource-constrained environments. KMC improves heat regulation, facilitates weight growth, and aids neurodevelopment, hence decreasing morbidity and mortality rates. Comprehending its varied effects among LBW subgroups is crucial for enhancing care and advancing long-term growth and developmental results.

The demographic profile of the study group for gestational age, growth status, and birth weight categories provides essential insights into the relevance of KMC findings for LBW infants. The prevalence of moderately preterm infants (33–36 weeks; 63.89%) corresponds with global epidemiological trends, wherein late preterm births represent the bulk of preterm deliveries.11 This is consistent with findings by Arelly J et al, which indicated that 59.9% of participants had a gestational age of 33-36 weeks.10 The higher sample size of this subgroup increases statistical power, rendering the results for weight gain, head circumference, and neurodevelopment especially strong. The underrepresentation of extremely preterm infants (<32 weeks; 19.44%) and term SGA infants (>37 weeks; 16.67%) may restrict the generalizability for these high-risk populations, which frequently encounter unique obstacles such as extended hospitalizations and developmental deficits.11,12

The distribution illustrated by Fenton's charts indicates that preterm AGA infants (42.78%) and preterm SGA infants (33.33%) constitute the majority, underscoring the dual challenges of prematurity and intrauterine growth restriction (IUGR) within LBW populations. Preterm SGA infants, facing both premature birth and growth restriction, are at increased risk for cognitive deficits and metabolic issues, requiring specialized therapies.13 The smaller SGA sample (23.89%), while achieving full gestation, demonstrated birth weights akin to those of younger preterm infants, highlighting the enduring effects of IUGR even in mature newborns.11,12 This corresponds with research indicating that term SGA newborns necessitate specialized dietary care and oversight to alleviate long-term growth deficiencies.10,11

The pattern of birth weights highlights the cohort's susceptibility, with 44.44% categorized as very low birth weight (VLBW; <1500g), consistent with previously acquired findings.10 Very low birth weight (VLBW) newborns face increased susceptibility to hypothermia, sepsis, and feeding challenges, which KMC substantially mitigates through thermal regulation and improved maternal-infant bonding.8,13 The 39.44% in the 1501–1800g category and 16.12% in the 1801–2499g category indicate a range of LBW infants, with the former group presumably deriving the greatest advantage from KMC due to their elevated daily weight increase (22.5–24.5 g/day) in this cohort.13 KMC's effectiveness in diminishing hypothermia (0.56%) and sepsis (2.22%) in the study corresponds with meta-analyses that illustrate its preventive function against newborn infections and thermal instability.

The demographic and clinical characteristics of the study cohort, predominantly consisting of moderately preterm, low birth weight infants (mean birth weight 1190±215 grams; mean gestational age 33±0.5 weeks) highlight the significant vulnerability of this population and emphasize the importance of KMC as an intervention. The diminutive mean length (41.55 cm) and head circumference (30.29±1.5 cm) at enrollment underscore the growth issues encountered by these newborns, who are at heightened risk for comorbidities including hypothermia, feeding difficulties, and impaired neurodevelopment.14,15 The prompt commencement of KMC (mean age at enrollment 3±2 days) and its prolonged implementation (mean duration 33.78 ± 5.12 days) in this cohort align with contemporary guidelines for optimizing the advantages of skin-to-skin care in preterm infants.15,16 Recent research and meta-analyses have shown that both early and extended KMC correlate with greater physiological stability, including improved temperature control, decreased incidence of hypothermia, and augmented cardiorespiratory stability. The notably low incidences of hypothermia (0.56%), hyperthermia (2.78%), hypoglycemia (1.67%), apnea (1.67%), and sepsis (2.22%) documented in this study align with these findings and underscore the protective benefits of KMC against prevalent neonatal complications, especially in resource-constrained environments.10,15,17

The gender distribution in the cohort was nearly equitable, with females constituting 52.78%, hence reducing gender-based confounding in outcome evaluation. The elevated incidence of caesarean section deliveries (68.89%) indicates a pattern observed in numerous tertiary neonatal hospitals, where surgical intervention is frequently employed for preterm and high-risk pregnancies to enhance infant outcomes. The study demonstrated satisfactory nutritional outcomes, with a mean of 5.5±5.65 days to achieve complete enteral feeds and 3.66±3.59 days to commence nursing. These findings align with recent clinical trials and reviews indicating that KMC promotes an earlier transition to full feeds and enhances the success of breastfeeding start and exclusivity.10,15 Skin-to-skin contact stimulates the infant's rooting and suckling reflexes, increases mother milk production, and facilitates efficient breastfeeding, which is essential for the growth and immune defense of preterm infants.7,8,15

The findings offer a detailed analysis of the first anthropometric disparities among preterm AGA, preterm SGA, and term SGA newborns. The findings indicate that in preterm AGA infants, the incremental rise in mean birth weight corresponding to advancing gestational age—1190±215g (<32 weeks), 1578±235g (33–34 weeks), and 2000±230g (35–36 weeks)—aligns with the anticipated trajectory of fetal growth, wherein each additional week in utero facilitates significant weight accumulation. Large-scale studies corroborate this trend, indicating that preterm children, although lighter and shorter at birth than their AGA counterparts, exhibit accelerated postnatal catch-up growth, frequently bridging the disparity in weight and length by early childhood.10,18 Nonetheless, despite this compensatory growth, preterm newborns may continue to experience disadvantages over the initial two years, especially for height-for-age z-scores (HAZ), before achieving equivalence with term AGA children by approximately six years of age.18

Preterm SGA newborns consistently exhibit reduced mean weights at each gestational age—1090 ± 210 g (<32 weeks), 1220 ± 230 g (33–34 weeks), and 1360 ± 235 g (35–36 weeks)—in comparison to their AGA counterparts. The combined impact of prematurity and intrauterine growth restriction leads to a significant likelihood of continued growth restriction into early life. Recent studies indicate that preterm SGA children exhibit a higher propensity for stunting (HAZ < 2) and thinness (BMIZ <2) at ages 2 and 6–7 years, with 30–39% demonstrating growth restriction by four years of age.10,18,19 Despite some compensatory growth, particularly during infancy, these children frequently fail to attain the median anthropometric measurements of full-term AGA counterparts by the time they reach school age. The increase of head circumference, albeit less impacted than weight or length, is typically diminished in premature SGA infants, signifying persistent susceptibility in brain and cognitive development.18

For term SGA newborns (≥37 weeks), the mean birth weight of 1435±215g is significantly below the anticipated standard for term infants, and their mean head circumference (29.5±1.2cm) and length (42.12±2.1cm) are likewise diminished. The findings align with recent longitudinal studies indicating that term SGA children have enduring deficits in weight and height throughout childhood, along with elevated risks of undernutrition, stunting, and thinness relative to AGA counterparts.10,18,19 In contrast to preterm AGA infants, term SGA children infrequently attain full catch-up development, and their anthropometric deficits may endure throughout puberty. The likelihood of stunting in SGA children is reported to exceed that of AGA newborns by more than twofold at ages 2 and 6–7 years, and while the disparity diminishes by ages 10–11, it remains significant.18

Subsequent findings indicated that KMC markedly enhanced daily weight gain in all subgroups. Preterm AGA children attained a weight gain of 22.5–24.5 g/day, preterm SGA infants 19.1–23.1 g/day, and term SGA infants 20.8 g/day, all exhibiting extremely significant p-values. These findings align with recent randomized controlled trials and quasi-experimental research, which have shown that KMC results in superior weight gain compared to traditional incubator or cot care. A 2024 study from Iraq indicated that newborns receiving KMC had significantly greater daily weight growth compared to those receiving normal care, corroborating findings from previous meta-analyses and systematic reviews.20,21 A separate randomized experiment conducted in India indicated mean daily weight gains of 23.99 g in the KMC group compared to 15.58 g in the standard care group ($p<0.0001$), with KMC also linked to increased rates of exclusive breastfeeding and reduced morbidity.13 Comparable outcomes were also noted in other prior investigations conducted in South India.10 These advantages are ascribed to better heat regulation, improved breastfeeding, and diminished stress for the newborn, all of which facilitate effective energy consumption and growth.

KMC resulted in substantial weekly increments in head circumference (HC), an essential indicator of cerebral development. Preterm AGA children had growth rates of 0.62–0.70 cm/week, preterm SGA infants 0.60–0.65 cm/week, and term SGA infants 0.65 cm/week, with all p-values demonstrating robust statistical significance. These findings corroborate existing research indicating that KMC facilitates both somatic growth and neurodevelopmental outcomes. A randomized experiment indicated that infants receiving KMC had a mean weekly head circumference increase of 0.75 cm, in contrast to 0.49 cm in those receiving standard care ($p=0.02$), implying a direct advantage of KMC on early brain development.10,13 This effect is especially significant for SGA newborns, who face a heightened risk of neurodevelopmental delays and cognitive deficits.

Infants receiving KMC exhibited a considerably greater weekly length gain, indicative of linear growth. Preterm AGA children had growth rates of 0.80–0.90 cm per week, preterm SGA infants 0.82–0.85 cm per week, and term SGA infants 0.75 cm per week. The observed increments are similar to or surpass those documented in prior intervention studies, wherein KMC was linked to weekly length increases of 0.99 cm compared to 0.7 cm in standard care ($p = 0.008$).13 Enhanced linear growth is essential for mitigating the danger of stunting and promoting long-term health and development.

Notwithstanding these immediate advantages, current longitudinal studies highlight that preterm SGA children continue to exhibit increased susceptibility to underweight, stunting, and wasting at one year of age relative to their appropriate for AGA counterparts, while potentially demonstrating superior improvements in weight-for-age z-scores (WAZ) from birth. In a South African cohort, SGA newborns had markedly reduced WAZ, LAZ, and BMIZ at one year, alongside elevated rates of stunting (34.2% vs. 9.1%) and underweight (31.2% vs. 7.2%) compared to AGA infants, underscoring the necessity for continued nutritional and developmental assistance beyond the neonatal phase.22 The data indicate that although KMC is significantly helpful for early catch-up growth, supplementary interventions may be required to maintain growth and avert malnutrition in high-risk populations, especially preterm SGA infants.

Table 8 highlights the significant and diverse advantages of KMC for LBW newborns across several subgroups, with early beginning and consistent hospital-based KMC evident in all categories. The average age for initiating KMC was notably early—3±2 days for preterm AGA and term SGA infants, and 5±2 days for preterm SGA infants—indicating an increasing trend towards early KMC implementation, as endorsed by recent guidelines and studies highlighting the significance of commencing KMC promptly after birth to optimize its advantages.23

The mean daily length of KMC in the hospital was substantial and stable (9±2 hours/day), corroborating findings that prolonged KMC exposure correlates with enhanced growth and physiological stability in low birth weight infants.24 Significantly, preterm SGA infants experienced the most extended KMC at home (8±2 hours/day), potentially indicating heightened caregiver motivation or clinical necessity within this higher-risk cohort. This prolonged home-based KMC is particularly pertinent, as community and home-based KMC have demonstrated the ability to maintain and even enhance the advantages gained during hospitalization, particularly in resource-constrained environments where longer hospitalizations may be impractical.25

The growth outcomes further demonstrate the quantitative advantages of KMC. Preterm AGA infants had the highest mean daily weight increase (24.5±4.5 g), succeeded by preterm SGA (22.8±3.5 g) and term SGA (20.8±3.2 g) newborns. These findings align with recent randomized controlled studies and meta-analyses, which consistently indicate that KMC results in much greater weight growth compared to traditional care (e.g., incubator or cot care).13,23 A meta-analysis of 17 randomized controlled trials revealed that newborns receiving Kangaroo Mother Care exhibited significantly enhanced average daily weight growth and superior anthropometric results, particularly among those with extremely low birth weight.13,26

KMC positively impacted feeding milestones. The duration to achieve full feeds was minimal in preterm AGA and term SGA infants (5.5 days), however it was extended in preterm SGA infants (8.5 days), indicating that SGA status may impede feeding readiness or tolerance, presumably attributable to greater physiological immaturity or associated comorbidities. The duration to commence breastfeeding after achieving complete feeds was somewhat extended in SGA groups (preterm SGA: 4.76 days, term SGA: 4.86 days) in comparison to preterm AGA infants (3.66 days). Recent studies corroborate these findings, indicating that KMC facilitates earlier and more effective breastfeeding, resulting in increased rates of exclusive breastfeeding at discharge and throughout subsequent follow-ups.13,23,26 Skin-to-skin contact integral to KMC stimulates the infant's rooting and suckling reflexes, increases maternal milk production, and strengthens the mother-infant attachment, so facilitating feeding transitions and promoting long-term nursing success.24,26

The duration of hospitalization was shortest for preterm AGA infants (12±5 days), whereas both SGA groups experienced longer stays (15±6 days). This trend likely indicates the heightened susceptibility and clinical intricacy of SGA infants, who may necessitate additional time to attain eating and growth goals. Nonetheless, KMC has been proved to decrease the average length of hospital stay, as seen by a 2023 meta-analysis indicating a substantial reduction in both hospital stay and neonatal problems among KMC recipients compared to those receiving standard care.23 KMC is linked to reduced incidences of hypothermia, sepsis, and other complications, hence reinforcing its efficacy in facilitating recovery and ensuring safe release.13,25

The extensive literature underscores KMC's beneficial effects on maternal mental health, mother-infant attachment, and long-term neurodevelopmental results, with research indicating reduced incidences of postpartum depression and enhanced cognitive and behavioral development in KMC infants. The psychosocial advantages are especially significant for low birth weight and preterm birth, which are associated with heightened maternal stress and an elevated risk of depression.23,26

The strengths of this study encompass its timely and consistent application of KMC among well delineated subgroups of LBW infants, facilitating a thorough evaluation of growth, feeding, and hospital outcomes. KMC shown distinct benefits: it markedly enhanced weight gain, head circumference, and length, diminished infant problems, abbreviated hospital stays, and facilitated exclusive breastfeeding, aligning with global evidence of enduring neurodevelopmental and psychosocial effects. KMC was linked to diminished maternal depression and enhanced bonding. Nonetheless, constraints encompass possible selection bias, a restricted sample size for extremely preterm and term small for gestational age children, and the absence of long-term neurodevelopmental follow-up, hence limiting generalizability to the entire low birth weight population. Practical impediments, like maternal exhaustion, variable staff knowledge, and cultural customs, may potentially influence the application of KMC. These findings clinically substantiate KMC as a cost-effective and accessible intervention that need to be incorporated into newborn care protocols, particularly in resource-constrained environments. The extensive implementation of KMC may diminish morbidity, promote growth, and increase outcomes for both newborns and mothers, hence reinforcing its significance as a fundamental aspect of care for low birth weight and preterm infants.

CONCLUSION

The research demonstrates that KMC markedly enhances growth metrics, feeding achievements, and diminishes problems in LBW infants within both preterm and term small for gestational age subgroups. Timely commencement and continuous implementation of KMC are essential for enhancing results. These findings advocate for the extensive adoption of KMC as a straightforward, efficacious, and economical intervention to improve survival, growth, and neurodevelopment in at-risk babies, especially in resource-constrained environments.

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