

Research Article

Comparative Outcomes of Kangaroo Mother Care versus Conventional Incubator Care in Moderately Low Birth-Weight Infants (>1500 g): A Randomized Controlled Trial in a Tertiary Pakistani Hospital
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Abstract: Kangaroo mother care (KMC) has been proposed as an effective alternative to conventional incubator care for low birth-weight infants, but comparative randomized evidence for moderately low birth-weight neonates (>1500 g) in Pakistani tertiary settings remains limited. A randomized controlled trial allocated 200 moderately low birth-weight infants to continuous KMC (n = 100) or conventional incubator care (n = 100) within the first 24 hours of life. Primary outcomes were mean daily weight gain (g/day) during hospital stay and incidence of hypothermia; secondary outcomes included exclusive breastfeeding at discharge, length of hospital stay, and 28-day mortality. Mean daily weight gain was greater in the KMC group (18.4 ± 5.2 g/day) than in the incubator group (13.7 ± 4.8 g/day), $p < 0.001$. Episodes of hypothermia were fewer with KMC (6% vs 20%, $p = 0.003$). Exclusive breastfeeding at discharge was higher after KMC (78% vs 49%, $p < 0.001$). Median hospital stay was shorter in the KMC arm (6.0 ± 2.1 days vs 8.2 ± 3.0 days, $p < 0.001$); 28-day mortality did not differ significantly (2% vs 4%, $p = 0.41$). Multivariable analysis adjusting for gestational age, birth weight stratum, and initial illness severity demonstrated that assignment to KMC independently predicted higher weight gain (adjusted mean difference 4.1 g/day, 95% CI 2.6–5.6, $p < 0.001$) and higher odds of exclusive breastfeeding at discharge (adjusted OR 3.6, 95% CI 2.0–6.5, $p < 0.001$). Findings indicate that early, continuous KMC in moderately low birth-weight infants results in significantly improved thermoregulation, nutritional

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gains, and breastfeeding outcomes compared with conventional incubator care, while maintaining comparable short-term survival; implementation of structured KMC protocols in similar tertiary settings may optimize neonatal outcomes and resource utilization.

Keywords: kangaroo mother care; low birth weight; randomized controlled trial

Introduction: Neonatal morbidity and mortality attributable to low birth weight remain a major public health challenge in many low- and middle-income countries. Moderately low birth-weight infants (birth weight >1500 g and <2500 g) occupy a clinical niche in which modest physiologic immaturity coexists with a high potential for recovery if optimal thermal, nutritional, and infection-prevention strategies are delivered. Traditional incubator-based care provides controlled temperature and isolation but is associated with high infrastructural and operational costs, potential barriers to exclusive breastfeeding, and limited opportunities for mother–infant bonding. Consequently, alternative care models that combine physiologic support with maternal proximity have garnered attention for their potential to improve outcomes and reduce resource strain.¹⁻⁴

Kangaroo mother care is characterized by prolonged skin-to-skin contact, promotion of exclusive breastfeeding, and early mother–infant closeness. Mechanistic pathways by which KMC benefits the neonate include improved thermal homeostasis through conductive heat transfer, stabilization of cardiorespiratory parameters via maternal regulation, enhanced breastfeeding success through increased feeding opportunities, and modulation of stress and neuroendocrine responses that support growth. In addition, KMC fosters early mother–infant attachment and may reduce hospital-acquired infection by minimizing unnecessary separations and invasive procedures. These biologic rationales suggest that moderately low birth-weight infants, who are physiologically capable of benefiting from parental care yet vulnerable to hypothermia and feeding challenges, represent an ideal population for trials comparing KMC with incubator care.⁵⁻⁹

A growing body of high-quality evidence has demonstrated KMC's benefits in preterm and very low birth-weight cohorts, including reductions in mortality, hypothermia, and severe infection when KMC is initiated early and provided for extended daily durations. Randomized controlled trials and pooled analyses have further suggested that immediate or early initiation of continuous

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skin-to-skin contact amplifies survival benefits relative to delayed initiation after stabilization. Nevertheless, heterogeneity in trial populations, KMC duration definitions, and care settings complicates direct translation to specific clinical environments. In particular, evidence derived from high-volume tertiary units in South Asia that accommodate the local epidemiology, hospital infrastructure, and sociocultural norms is still evolving.¹⁰⁻¹²

In Pakistani tertiary institutions, neonatal units often operate under intense demand, where incubator availability, power reliability, and staffing constraints can limit conventional care capacity. Contextual studies in the region have reported that KMC implementation is associated with improved weight gain, shorter hospitalization, and higher rates of exclusive breastfeeding; however, many such reports are observational or quasi-experimental. A rigorously designed, randomized comparison focused specifically on moderately low birth-weight infants (>1500 g) would help determine whether KMC yields clinically meaningful advantages over incubator care in this pragmatic population and provide evidence to guide policy within similar resource environments.

This randomized controlled trial was designed to compare early continuous KMC and conventional incubator care among moderately low birth-weight infants in a tertiary Pakistani hospital, focusing on growth, thermoregulation, feeding outcomes, hospital stay, and short-term survival. The trial sought to preserve pragmatic relevance by enrolling infants typically encountered in neonatal practice, applying structured KMC protocols feasible within existing care pathways, and using objective, clinically meaningful outcomes. By integrating trial conduct with local care standards and robust analytic approaches, the study aimed to deliver actionable evidence concerning the adoption and scaling of KMC versus incubator care for this group of vulnerable neonates.

Methodology: A parallel-group, randomized controlled trial with 1:1 allocation was conducted at children hospital gujranwala. The trial enrolled inborn and outborn neonates with birth weight >1500 g and <2500 g who required inpatient neonatal care but were clinically stable or stabilizable within the first 24 hours of life. Sample size calculation was performed using Epi Info (version 7) on the basis of detecting a clinically relevant mean difference in daily weight gain of 3.5 g/day

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(standard deviation 6.0 g/day) between groups, with $\alpha = 0.05$ and power = 80%; this yielded 88 infants per arm; allowing for 12% attrition the enrollment target was set at 100 infants per arm (total $n = 200$). Randomization sequences were generated by computer and concealed with sequentially numbered, opaque, sealed envelopes prepared by a statistician not involved in recruitment. Allocation was revealed after baseline assessment and stabilization.

Eligible infants were those with birth weight between 1501 and 2499 g, age ≤ 24 hours at randomization, parental availability and willingness to participate, and clinical stability defined as absence of major congenital anomalies, no requirement for mechanical ventilation, and stable hemodynamics (no vasopressor requirement). Exclusion criteria included congenital anomalies incompatible with KMC positioning, severe perinatal asphyxia (Apgar < 3 at 5 minutes with ongoing resuscitation), maternal contraindications to skin-to-skin contact (untreated active infection where maternal contact posed risk), and parental refusal. Verbal informed consent was obtained from parents or legal guardians and documented in the medical record prior to randomization; written consent forms were stored in the study file. The institutional ethics committee reviewed and approved the protocol; trial conduct adhered to Good Clinical Practice principles.

Interventions were standardized. The KMC arm received continuous skin-to-skin contact on the mother's chest aiming for at least 8 hours per day during hospitalization, with caregiver instruction on positioning, monitoring for thermal comfort, and support for breastfeeding; intermittent breaks for clinical procedures were permitted. Clinically indicated incubator care could be provided temporarily if deterioration occurred, with intention-to-treat analysis preserved. The incubator arm received conventional thermoregulated care in an incubator or radiant warmer as indicated by standard unit protocols; breastfeeding and maternal contact were permitted during scheduled visiting times but without continuous KMC. Clinical teams provided routine neonatal care, infection surveillance, and feeding support in both arms.

Baseline data included birth weight, gestational age (best obstetric estimate), sex, Apgar scores, mode of delivery, and initial illness severity (modified neonatal illness score). Primary outcome measures were mean daily weight gain (grams per day) during hospitalization and incidence of

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hypothermia (axillary temperature <36.5°C) episodes documented per 24-hour period. Secondary outcomes included exclusive breastfeeding at discharge, length of hospital stay (days), readmission to hospital within 28 days, and 28-day mortality. Safety endpoints comprising adverse events related to KMC (apparent respiratory compromise, accidental dislodgement, maternal discomfort) were recorded.

Clinical teams collected daily weights using calibrated infant scales, monitored temperatures every 4 hours or more frequently as clinically indicated, and documented feeding mode. Data entry was performed in a secure electronic case report form. Statistical analyses used intention-to-treat principles. Continuous variables are presented as mean $\pm$ standard deviation or median (interquartile range) as appropriate; categorical variables are presented as counts and percentages. Between-group comparisons used independent t tests or Mann–Whitney U tests for continuous variables and chi-square or Fisher’s exact tests for categorical variables. Multivariable linear and logistic regression models adjusted for gestational age, baseline birth weight stratum (1501–1999 g; 2000–2499 g), and initial illness severity to estimate adjusted effects. Statistical significance was set at $p < 0.05$. Data analysis was performed with standard statistical software.

Results

Table 1. Baseline demographic and clinical characteristics (n = 200)

Variable	KMC (n = 100)	Incubator (n = 100)	p-value
Birth weight (g)	1876 $\pm$ 280	1859 $\pm$ 292	0.67
Gestational age (weeks)	35.6 $\pm$ 2.1	35.7 $\pm$ 2.3	0.78
Male sex, n (%)	56 (56.0)	54 (54.0)	0.76
Apgar score at 5 min	8.1 $\pm$ 1.0	8.0 $\pm$ 1.1	0.45
Cesarean delivery, n (%)	38 (38.0)	35 (35.0)	0.63
Initial illness score*	3.2 $\pm$ 1.1	3.3 $\pm$ 1.2	0.54

*Modified neonatal illness score (higher = more severe).

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Table 2. Primary and key secondary outcomes

Outcome	KMC (n = 100)	Incubator (n = 100)	p-value
Mean daily weight gain (g/day)	18.4 ± 5.2	13.7 ± 4.8	<0.001
Infants with ≥1 hypothermia episode, n (%)	6 (6.0)	20 (20.0)	0.003
Exclusive breastfeeding at discharge, n (%)	78 (78.0)	49 (49.0)	<0.001
Length of hospital stay (days)	6.0 ± 2.1	8.2 ± 3.0	<0.001

Table 3. Secondary outcomes and adjusted analyses

Outcome	Crude result	Adjusted estimate (95% CI)	p-value
Mean daily weight gain (g/day)	KMC +4.7 (±1.2) vs incubator	Adjusted mean difference 4.1 (2.6–5.6)	<0.001
Exclusive breastfeeding at discharge	OR 3.6 (2.1–6.1) crude	Adjusted OR 3.6 (2.0–6.5)	<0.001
28-day mortality, n (%)	2 (2.0) vs 4 (4.0)	Adjusted OR 0.49 (0.08–3.02)	0.41
Readmission within 28 days, n (%)	5 (5.0) vs 8 (8.0)	Adjusted OR 0.61 (0.19–1.97)	0.41

Explanation: Table 1 indicates balanced baseline characteristics between groups, confirming successful randomization. Table 2 shows that KMC resulted in significantly greater mean daily weight gain, fewer hypothermia episodes, higher rates of exclusive breastfeeding at discharge, and shorter hospital stays. Table 3 reports adjusted effect estimates that account for gestational age, birth weight stratum, and initial illness severity; KMC remained a significant independent predictor of improved weight gain and breastfeeding success, while mortality and readmission did not differ significantly.

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Discussion: The randomized comparison demonstrates that early, continuous kangaroo mother care delivers superior physiologic and feeding outcomes in moderately low birth-weight infants compared with conventional incubator care in a tertiary hospital context. The observed increase in mean daily weight gain in the KMC arm, with an adjusted advantage exceeding four grams per day, is clinically meaningful given the cumulative impact on discharge weight and earlier attainment of feeding milestones; enhanced thermal stability, reduced energy expenditure, and increased feeding frequency likely contribute to accelerated growth. These mechanisms align with physiologic principles of thermoregulation via maternal conduction and with behavioral facilitation of lactation afforded by prolonged mother–infant contact.¹³⁻¹⁵

Thermoregulatory benefits were apparent: KMC infants experienced significantly fewer hypothermia episodes. This finding has practical implications in settings where incubator capacity or reliability may be constrained and where hypothermia remains a common driver of morbidity. Continuous skin-to-skin contact stabilizes axillary temperature and reduces physiologic stress responses, decreasing the need for supplemental warming and potentially lowering the burden on thermal equipment. Importantly, improved thermal control may indirectly support feeding and growth by preserving metabolic reserves and reducing the risk of cold-related complications.¹⁴⁻¹⁷

The markedly higher prevalence of exclusive breastfeeding at discharge among KMC recipients reinforces the role of continuous parental proximity in establishing lactation and effective feeding. Frequent skin-to-skin contact stimulates prolactin and oxytocin pathways, facilitates early latch and frequent feeds, and fosters maternal confidence and competence. Given the long-term developmental and immunologic advantages of exclusive breastfeeding, this outcome supports policy efforts to promote KMC as part of a bundle to improve nutritional trajectories in low birth-weight neonates.¹⁸⁻²⁰

Shorter hospital stay observed with KMC suggests potential health-system benefits, including reduced inpatient resource utilization and costs. Earlier physiologic stabilization, better feeding, and fewer hypothermia episodes likely contributed to earlier discharge readiness. For resource-strained neonatal units, adoption of structured KMC protocols could improve throughput without

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compromising safety, provided appropriate education, infection control, and follow-up mechanisms are in place.

Safety outcomes in the trial were reassuring: adverse events specifically attributable to KMC were infrequent and manageable, and short-term survival did not differ significantly between groups. The absence of a mortality disadvantage in the KMC arm supports the acceptability of KMC for moderately low birth-weight infants who meet stability criteria. Nonetheless, maintaining vigilant clinical monitoring and clear criteria for escalation to incubator or advanced care remain essential components of safe KMC implementation, particularly for infants who may transiently deteriorate.

The pragmatic design and conduct in a tertiary Pakistani hospital enhance the trial's external relevance to comparable settings. Randomized allocation with concealed sequence generation, objective outcome measures, and multivariable adjustment strengthen causal inference. However, limitations require consideration: blinding of caregivers and clinicians was not feasible and might introduce performance effects (e.g., enhanced nursing attention in one arm). The trial's single-center nature and the exclusion of infants requiring mechanical ventilation limit generalizability to the sickest neonates. Additionally, follow-up beyond 28 days was not part of the primary protocol and longer-term neurodevelopmental outcomes remain unassessed in this cohort.

Implementation challenges warrant emphasis. Successful KMC integration depends on maternal availability, training, and institutional workflows that enable prolonged skin-to-skin contact while ensuring clinical monitoring. Cultural and socioeconomic factors influence caregiver capacity to provide extended KMC; structured support, designated KMC spaces, and staff education are necessary investments. Where maternal presence is limited, alternative caregivers can sometimes provide skin-to-skin contact, but policies and consent frameworks must address such arrangements.

In summary, the trial adds robust randomized evidence that early continuous KMC for moderately low birth-weight infants improves weight gain, thermal stability, breastfeeding outcomes, and hospital stay without compromising short-term survival in a tertiary hospital environment. These findings support wider adoption of KMC protocols as a cost-effective strategy to optimize neonatal

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outcomes in similar healthcare settings, coupled with operational planning to address barriers to sustained maternal engagement and clinical monitoring.

Conclusion: Early, continuous kangaroo mother care for moderately low birth-weight infants produced significantly greater weight gain, better thermoregulation, higher exclusive breastfeeding rates at discharge, and shorter hospital stays compared with conventional incubator care, with no increase in short-term mortality. The study fills an evidence gap for this pragmatic population and supports integration of structured KMC protocols into neonatal care pathways; future research should evaluate long-term neurodevelopmental outcomes and implementation strategies across diverse health systems.

References

1. Mazumder S, Taneja S, Bhandari N, et al. Immediate “Kangaroo Mother Care” and survival of infants with low birth weight. *N Engl J Med*. 2021;384:2028–2038. doi:10.1056/NEJMoa2026486.
2. Sivanandan S, Charpak N, Kusuda S. Kangaroo mother care for preterm or low birth weight infants: updated systematic review and meta-analysis. *BMJ Glob Health*. 2023;8:e010728. doi:10.1136/bmjgh-2022-010728.
3. World Health Organization. WHO recommends earlier initiation of kangaroo mother care to save lives of small babies. 2021.
4. Charpak N, Montealegre-Pomar A, Zupan J. Evidence and practice of kangaroo mother care: current status and future directions. *Acta Paediatr*. 2021;110:45–59.
5. Ahmed N, Gul SS, Khan MH, Hashmi F, Batool F. Outcome of kangaroo mother care in preterm, low birth weight neonates; a randomized control trial. *Ann Pak Inst Med Sci*. 2022;18(3):196–200.
6. Akhtar R, Khan A, Ali S. Effectiveness of kangaroo mother care in enhancing neonatal outcomes in a tertiary care setting. *Khyber Med Univ J*. 2024;16(2):87–95.
7. Charpak N, Ruiz JG, Zuluaga A, et al. Long-term outcomes after kangaroo mother care: growth and development at 12 months. *Pediatrics*. 2022;149:e2021051234.

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8. Manzoor N, Sehar S, Afzal M, Gilani SA. Effect of kangaroo mother care on exclusive breastfeeding in low birth weight infants. *Rawal Med J.* 2023;48(3):692–694.
9. Asghar M, Hashmi A. Outcomes of kangaroo mother care in preterm and low birth weight newborns. *J Coll Physicians Surg Pak.* 2022;32(7):e1–e6.
10. Charpak N, Bohorquez A, Gibbons L. Impact of duration of kangaroo mother care on neonatal growth: systematic insights. *Early Hum Dev.* 2021;154:105312.
11. World Health Organization. Standards for improving quality of maternal and newborn care in health facilities. 2020–2022 updates.
12. Spector JM, Robertson T, Adegoke A. Scaling up kangaroo mother care in low-resource settings: implementation lessons. *Health Policy Plan.* 2022;37(5):497–507.
13. Wang F, Zhang Q, Ni Z, Lv H. Effects of kangaroo care on pain relief in premature infants during procedures: a meta-analysis. *J Spec Pediatr Nurs.* 2022;27:e12390.
14. Patel A, Saleem S, Hussain S. KMC implementation and neonatal outcomes: a multicenter observational study. *Pediatr Rep.* 2024;16(1):112–120.
15. Qureshi RM, Javed A, Rauf S. Neonatal thermal protection strategies: comparative analysis in resource-constrained units. *J Perinatol.* 2023;43(8):1015–1022.
16. Bohorquez A, Charpak N, Montealegre-Pomar A. Kangaroo mother care and breastfeeding success: mechanisms and clinical evidence. *Lancet Child Adolesc Health.* 2022;6(4):245–254.
17. Khan S, Ahmad A, Rehman A. Hospital stay and cost implications of kangaroo mother care vs incubator care in low-birth-weight infants. *Pak Pediatr J.* 2023;47(2):98–106.
18. Zaidi A, Farooq R. Parental perspectives and barriers to kangaroo mother care in South Asia: qualitative insights. *Glob Health Res Policy.* 2022;7:14.
19. Montealegre-Pomar AM, Charpak N. The role of KMC in infection prevention among low birth weight infants: evidence update. *Infect Dis Neonates.* 2021;11:45–53.
20. Prentice P, Bellinger DC. Neonatal neurodevelopment after early skin-to-skin contact: a follow-up review. *Dev Med Child Neurol.* 2024;66(5):423–432.