



Research Article

A Hybrid Implementation-Effectiveness Review on Community Strategies, Digital Health Innovations, and Post-Discharge Continuation

Ritika Rupal^{1,*} , Gajendra Singh² ¹Maternal and Child Health Department, Translational Health Science and Technology Institute, Faridabad, India²Department of Public Health, IIHMR University, Jaipur, India

Abstract

Background: Low birth weight (LBW, <2500 g) and preterm births (<37 weeks) drive most neonatal deaths across India. Kangaroo Mother Care (KMC)—continuous skin-to-skin contact (SSC), exclusive breastfeeding, and early discharge—decreases neonatal mortality by 30–40% in stable neonates and by 25% when initiated immediately after birth (Immediate KMC / iKMC). Despite strong trial efficacy, implementation gaps in achieving universal KMC coverage persist across Indian health systems, with effective population coverage remaining below 20%. **Methods & Focus:** Using JBI scoping review principles and CFIR 2.0 framing, this review synthesizes evidence across micro- (infant, mother, family), meso- (clinical teams, SNCU/MNCU units, frontline workers), and macro-levels (policy, HMIS, equity). It maps barriers across six care settings, appraises quality improvement (QI) initiatives, clarifies community Home-Based Newborn Care (HBNC) vs Home-Based Care for Young Child (HBYC) visit schedules, evaluates digital health tools, and incorporates growth milestones (proportion reaching ≥ 2.5 kg by 40 weeks postmenstrual age [PMA]). **Conclusion:** Achieving sustainable scale-up requires zero-separation Mother-Newborn Care Units (MNCUs), hospital QI routines, family redistribution of KMC to surrogate caregivers, empowered ASHA networks, and duration-sensitive HMIS metrics.

Keywords

Kangaroo Mother Care, Low Birth Weight, Preterm, Mother-Newborn Care Unit

1. Introduction & Global Imperative

Preterm births and low birth weight (LBW) remain the leading causes of under-five child mortality globally, accounting for nearly 1 million deaths per year [1, 3, 20]. India contributes nearly 40% of the world's LBW burden (3). Kangaroo Mother Care (KMC) is a proven, evidence-based intervention comprising continuous/prolonged skin-to-skin contact (SSC), exclusive breastmilk feeding, early facility discharge, and post-

discharge continuity [4, 5].

Cochrane reviews confirm that KMC reduces neonatal mortality by 32–40% in stable LBW infants, while reducing sepsis by 15–47% and hypothermia by 78% [6, 7]. Furthermore, the landmark WHO Immediate KMC (iKMC) trial established a 25% mortality reduction when continuous KMC is initiated immediately after birth prior to stabilization in dedicated

*Correspondence: Ritika Rupal (ritikarupal24@gmail.com)



Mother-Newborn Care Units (MNCUs) [8].

Despite this clinical evidence, implementation gaps in achieving universal KMC coverage persist across Indian facilities, where population coverage remains under 20% [10]. Moreover, while KMC is often termed a low-cost tool, effective health-system scale-up is resource-intensive, requiring investments in MNCU spatial remodeling, nurse staffing, beds/recliners, structured discharge counseling, and frontline tracking systems [11-13].

2. Methodology & Multilevel Implementation Framework

This synthesis follows JBI scoping review methods and PRISMA-ScR guidance [14, 15]. Electronic databases (PubMed/MEDLINE, Scopus, Web of Science, CINAHL, Cochrane CENTRAL, IndMED, and MoHFW/NHM repositories) were searched from inception through December 2024 using terms: ('KMC' OR 'Kangaroo Mother Care' OR 'skin-to-skin contact') AND ('implementation' OR 'quality improvement' OR 'ciKMC' OR 'mHealth' OR 'post-discharge') AND ('India' OR 'LMIC').

Evidence was mapped using CFIR 2.0 [16] across a nested ecological model: (1) Micro-level: infant clinical needs, maternal physical/mental recovery, and family dynamics; (2) Meso-level: healthcare providers, QI routines, hospital wards (SNCU/MNCU), and frontline workers (ASHAs/ANMs); and (3) Macro-level: national policy, HMIS reporting, financing, and equity.

3. Setting-Specific Bottlenecks & Enablers Across the Continuum

- 1) *Delivery Room & Labor Ward*: Routine immediate swaddling, early cord clamping, and rapid transfer to radiant warmers impede early SSC. Establishing delayed cord clamping and labor-room SSC drying protocols enables immediate initiation [8].
- 2) *Tertiary NICU & District SNCUs (Infant Clinical Barriers)*: Neonates on CPAP, high-flow oxygen, IV lines, or phototherapy face provider reluctance due to displacement fears [12]. Evidence confirms 'KMC under CPAP' and 'KMC phototherapy' are safe and feasible when nursing staff are trained in secure binder positioning [17, 18, 31].
- 3) *Mother-Newborn Care Units (MNCUs)*: Co-admitting mothers and sick neonates 24/7 provides zero separation, continuous monitoring, and parental empowerment [18, 19].
- 4) *Postnatal & Step-Down Wards*: Overcrowding, lack of privacy screens, and maternal physical fatigue post-caesarean delivery curtail KMC hours. Dedicated recliners, privacy curtains, and peer-mother mentorship enhance daily duration [11, 20].

- 5) *Home & Community*: Unshared household chores, lack of paternal support, and isolation drive post-discharge drop-off [21, 22]. Family counseling and ASHA home visits bridge this transition.

4. Quality Improvement, Family Redistribution, & Equity

- 1) *Quality Improvement (QI) in Facilities*: Applying Plan-Do-Study-Act (PDSA) cycles, designating physician/nurse KMC Champions, establishing protected daily KMC hours, utilizing bedside duration charts, and weekly audit-and-feedback can increase ward KMC adoption from <15% to >70% within 6–12 months [17, 23].
- 2) *Family Redistribution of Care*: Maternal exhaustion and domestic workload are primary drivers of home discontinuation. Training fathers and grandmothers as surrogate KMC providers redistributes domestic responsibilities and sustains home KMC duration [2, 24-26].
- 3) *Health Equity & Governance*: Rural and tribal households encounter severe poverty, lack of warm seating, and transport barriers. Scale-up requires free ergonomic wraps, transport support, and duration-sensitive indicators in HMIS (e.g., hours/day, 28-day retention) rather than binary check-boxes [23, 27].

5. Implementation Outcomes, Dose Thresholds, and Growth Milestones

- 1) *Dose Thresholds & Implementation Outcomes*: Following implementation science taxonomy (28), outcomes include acceptability, adoption, feasibility, fidelity, penetration, and sustainability. KMC dose must be categorized accurately: Intermittent (1–4 h/day), Prolonged (8–19 h/day), and Continuous (≥ 20 h/day) [5, 29].
- 2) *Candidate Growth Milestone (≥ 2.5 kg by 40 Weeks PMA)*: Preterm/LBW nutritional recovery is evaluated by the proportion of infants reaching body weight ≥ 2.5 kg by 40 weeks postmenstrual age (PMA) / term-equivalent age, daily weight velocity (g/kg/day), and linear growth [4, 30]. Because this endpoint is confounded by gestational age, SGA/AGA status, sepsis, BPD, and hospital stay, it should complement gestation-adjusted growth curves (Fenton / INTERGROWTH-21st) (31).

6. Community Models: ciKMC, HBNC, and HBYC Integration

The Lancet ciKMC trial demonstrated that community-initiated KMC delivered by frontline workers reduced 28-day ne-

onatal mortality by 30% (HR 0.70) and 180-day infant mortality by 25% (HR 0.75) in rural India (3).

Programmatic Alignment (HBNC vs. HBYC): India's community platforms serve distinct roles: (1) Home-Based Newborn Care (HBNC) is the primary neonatal follow-up platform, with ASHAs conducting visits on Days 1, 3, 7, 14, 21, 28, and 42 to verify KMC positioning, measure temperature, track weight, and identify danger signs [23, 32]; (2) Home-Based Care for Young Child (HBYC) extends follow-up from months 3 to 15 [at 3, 6, 9, 12, 15 months] focusing on complementary feeding, vaccination, and neurodevelopmental screening (32). Participatory women's groups (PLA) further mobilize collective community support [28, 33, 34, 37].

7. Digital Health Innovations: Biomonitoring & Decision-Support

- 1) *Wearable Biosensors*: Silicone-encapsulated chest/foot temperature sensors provide continuous, objective compliance tracking and hypothermia alerts [35, 36]. However, evidence is currently in pilot/feasibility stages; practical deployment must overcome unit hardware costs (\$15–\$40), false-alarm fatigue, battery charging limits, sensor cleaning, and rural connectivity gaps (37).
- 2) *mHealth Decision Support*: Frontline tablet apps (POSHAN Tracker, e-HBNC) and automated vernacular IVR calls to fathers reinforce home follow-up, improve scheduling fidelity, and encourage shared family care-giving [9, 38, 39].

8. Multilevel Implementation Matrices

Table 1. Setting-Specific Implementation Matrix Across Care Settings.

Setting	Dominant Barriers	Key Enablers	Priority Strategies	Responsible Actors	Indicators to Monitor
Delivery Room	Early clamping, swaddling, transfer to warmers.	Delayed clamping, immediate drying on chest.	Workflow redesign; simulation for immediate SSC.	Obstetricians, Midwives, Nurses	SSC in 1st hour (%); time to first breast contact.
Tertiary NICU / SNCU	CPAP, lines, phototherapy, visiting limits.	Trained staff, family participation, wraps.	MNCU remodeling; 'KMC under CPAP'; KMC champions.	Neonatologists, SNCU Nurses	Age at initiation; daily hours in SNCU; line safety.
MNCU	Space reallocation, cross-departmental coordination.	Co-admission 24/7, maternal beds by monitors.	Institutional policy; bedside maternal coaching.	Joint Peds-OB Teams, QI Teams	Daily KMC hours/day; zero-separation rate (%).
Postnatal Ward	Overcrowding, privacy lack, post-cesarean pain.	Recliner chairs, privacy screens, peer modeling.	Install screens/recliners; protected KMC routines.	Postnatal Nurses, Counselors	Proportion achieving ≥ 8 h/day pre-discharge.
Home / Community	Domestic burden, fatigue, paternal disengagement.	Surrogate care (fathers/grandmothers), wraps.	Family counseling; ASHA HBNC visits (Days 1–28); PLA.	ASHAs, ANMs, Fathers, Mothers	Continuation at Day 7, 14, 28; wt ≥ 2.5 kg by 40w PMA.
Policy / Systems	Binary HMIS documentation, lack of budget lines.	National policy (INAP), digital monitoring.	Duration-sensitive HMIS metrics; MNCU accreditation.	MoHFW, State NHM, IAP, NNF	District KMC coverage; operational MNCUs (%).

Table 2. Multilevel Determinant-Strategy-Actor-Outcome Matrix.

Level & setting	Barrier / Determinant	Strategy (Standardized)	Actor	Evidence	Implementation Outcome	Clinical / Growth Outcome
Micro (Infant) - NICU	CPAP, phototherapy, line displacement fears.	Clinical adaptation ('KMC under CPAP'); nurse support.	Bedside Nurses	High (RCTs)	Adoption; protocol fidelity.	Earlier full feeds; reduced sepsis/stay.

Level & setting	Barrier / Determinant	Strategy (Standardized)	Actor	Evidence	Implementation Outcome	Clinical / Growth Outcome
Micro (Mother) - Ward/Home	Postpartum pain, fatigue, lack of privacy.	Privacy curtains, ergonomic recliners, counseling.	Lactation Counselors	Moderate (QI)	Acceptability; increased daily duration.	Reduced maternal depression/stress.
Micro (Family) - Home	Domestic workload, lack of paternal support.	Family discharge counseling; training surrogate caregivers.	ASHAs, Fathers	High (Cluster RCTs)	Home KMC retention; family adoption.	Weight velocity; ≥ 2.5 kg by 40w PMA.
Meso (Provider) - SNCU	Misconceptions on stability, nursing workload.	Simulation training, clinical mentorship, KMC Champions.	QI Teams, Faculty	Moderate/High	Provider fidelity; knowledge.	Reduced time to KMC initiation.
Meso (Facility) - Hospital	Parent-infant physical separation.	MNCU zero-separation conversion; PDSA cycles.	Hospital Admins	High (MNCU Trials)	Penetration; sustainability.	25% mortality reduction (iKMC).
Meso (Community) - Sub-Centre	Disconnected post-discharge tracking.	Integration into ASHA HBNC visits (Days 1, 3, 7, 14, 21, 28).	ASHAs, ANMs	High (ciKMC Trial)	Follow-up completeness; coverage.	30% neonatal mortality reduction.
Macro (Policy) - State/National	Binary HMIS reporting, fragmented funds.	Revise HMIS to duration metrics; accreditation standards.	MoHFW, State NHM	Moderate (HPSR)	Institutionalization; equity.	Accelerated progress toward SDG 3.2.

9. Conclusion

Translating KMC efficacy into universal coverage across India requires closing implementation bottlenecks across micro-, meso-, and macro-levels. Restructuring neonatal units into zero-separation MNCUs, embedding hospital PDSA quality improvement routines, empowering ASHA-led HBNC home follow-up, engaging fathers and family surrogate caregivers, deploying pragmatically validated digital tools, and capturing duration-sensitive HMIS metrics are essential to ensure sustainable, continuous KMC and optimize newborn survival and neurodevelopment.

Abbreviations

ANM	Auxiliary Nurse Midwife
ASHAs	Accredited Social Health Activists
HBNC	Home-Based Newborn Care
HBVC	Home-Based Care for Young Child
HMIS	Health Management Information System
iKMC	Immediate KMC
KMC	Kangaroo Mother Care
LBW	Low Birth Weight
MNCUs	Mother-Newborn Care Units
QI	Quality Improvement
SSC	Skin-to-skin Contact

Author Contributions

Ritika Rupal: Conceptualization, Data curation, Formal Analysis, Methodology, Project administration, Resources, Software, Writing – original draft

Gajendra Singh: Supervision, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declares no conflicts of interest.

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