1. ADMINISTRATIVE INFORMATION:

1.1. Title: Can Kangaroo Mother Care (KMC) during the first 72 hours lead to improved breastfeeding and growth among normal birth weight newborns? - A randomised controlled trial.

1.2. Trial registration: This trial will be registered with the Clinical Trials Registry of India (CTRI) (**CTRI/2024/01/062057)** and ISRCTN.

1.3. Protocol version: CEL/KMC_NormalBW/V3.0

1.4. Protocol Date: September 10, 2024

1.5. Funding: Indian Council of Medical Research

1.6. Roles and responsibilities:

SN.	Name, Designation & Institution	Project's Stake (PI/ Co-PI)	Specific Role in Trial
1.	Name: Aarti Kumar Designation: Principal Scientist Organization: CEL Email: aarti.kumar@celworld.org	Principal Investigator	Study conceptualization, design & methodology, mentorship & oversight, funding acquisition, reporting & manuscript writing, project administration, coordination with TAG & DSMB.
2.	Name: Dr. Vishwajeet Kumar Designation: Chief Scientist Organization: CEL Email: vkumar@celworld.org	Co-PI	Study conceptualization, design & methodology, leadership, analysis, reporting & manuscript writing
3.	Name: Dr. Rashmi Kumar Designation: Senior Director, Child Health Organization: CEL Email: rashmi.kumar@celworld.org; rashmik2005@gmail.com	Co-PI	Study design & methodology, research audit, analysis, manuscript writing
4.	Name: Dr. Ashok Kumar Designation: Professor (Paediatrics), In-charge (Neonatology) & Dean (Research) Organization: Institute of Medical Sciences, BHU, Varanasi Email:ashokkumar_bhu@hotmail.com	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing

5.	Name: Dr. Uma Pandey Designation: Professor & Head of Department (Obs. & Gynae.) Organization: Institute of Medical Sciences, BHU, Varanasi Email:uma.pandey2006@yahoo.com	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing
6.	Name: Dr. Neena Gupta Designation: Professor & Head of Department (ObGyn) Organization: GSVM Medical College, Kanpur Email: neena.gupta2211@gmail.com	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing
7.	Name: Dr. Arun Kumar Arya Designation: Professor & Head, Department of Paediatrics Organization: GSVM Medical College, Kanpur Email:arunped253@yahoo.com	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing
8.	Name: Dr. Yashwant Kumar Rao Designation: Professor, Department of Paediatrics Organization: GSVM Medical College, Kanpur Email: ykraoneo@yahoo.co.in	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing
9.	Name: Dr. Mala Kumar Designation: Professor & Head, Department of Paediatrics Organization: KGMU Lucknow Email: malakumar@kgmcindia.edu	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing
10.	Name: Dr. SN Singh Designation: Professor, Department of Paediatrics Organization: KGMU Lucknow Email: snsingh@kgmcindia.edu	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing
10.	Name: Dr. Anjoo Agarwal Designation: Professor & Head, Department of Obstetrics & Gynaecology Organization: KGMU Lucknow Email: anjooa@gmail.com	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing

11.	Name: Dr. SP Jaiswar Designation: Former Head of Department & Professor, Department of Obstetrics & Gynaecology, KGMU Lucknow Email: qmhobgynkgmu@gmail.com	Co-PI	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing
12.	Name: Dr. Salman Khan Designation: Senior Consultant, Paediatrics Organization: Veerangana Avanti Bai (VAB) Lucknow Email:salmankhankhansalman@yahoo.co.in	Co-investigator (Site PI, VAB)	Study design & methodology, investigation, site supervision and administration, reporting and manuscript writing.

2. Document Version History:

Version	Date	Section	Description	Author
CEL/KMC_NormalBW/V2.0	12 Oct, 2023	NA	- Original Protocol	Aarti Kumar
CEL/KMC_NormalBW/V2.0	12 Dec, 2023	PI and Co-PI	Following changes are done - Name of PI has changed from Dr. Vishwajeet Kumar to Ms. Aarti Kumar and Dr. Vishwajeet Kumar name is updated as Co-PI. - Name of Dr. Rupak Mukhopadhyay is removed from the study as Co-PI. - Specific roles "project administration, coordination with TAG & DSMB," of Dr. Rupak Mukhopadhyay in the trial are re-assigned to Ms Aarti Kumar (PI).	Aarti Kumar
CEL/KMC_NormalBW/V3.0	2 Aug, 2024	Administrative Information	CTRI Registration number updated Protocol version and date updated	
		PI and Co-PI	- Name of Dr. SN Singh added as Co-PI - Name of Dr. Anjoo Agarwal added as	

			Co-PIName of Dr. Salman Khan added as Co-investigator/ Site PI, VAB	
		Research question/ Hypotheses	Secondary research questions removed Primary hypothesis modified Addition of a new primary hypothesis regarding improved BBAT score	
		Objectives	- Primary objectives modified to evaluate the effect of prolonged KMC on mean percentage weight loss in the first 2 days + mean weigh gain velocity in the newborn period - Evaluating the Quality of breastfeeding through BBAT score has been added as a primary objective - Five secondary objectives added to compare intervention & control groups for: a) exclusive breastfeeding at 28 days of life b) compare experiences of mothers related to breastfeeding success using the Breastfeeding Experience Scale and Breastfeeding Self-Efficacy Scale between the intervention and control groups c) incidence of PSBI at 28 days of life d) incidence of maternal depression during newborn period. e) the Maternal-Infant Bonding Scale (MIBS) scores among mothers in the intervention and control groups at the end of the newborn period	
CEL/KMC_NormalBW/V3.0		Keywords	- Keywords have been updated	
		Study setting	- Names of Study sites have been finalised and updated	
		Study population & eligibility criteria	- Minor modifications in Inclusion & Exclusion criteria - Fig 1 describing study population was removed	

		Screening and consenting procedures	- Consenting procedures have undergone slight modification & elaborated accordingly	
		Intervention and Control	- The characteristics of the intervention group have been further defined and elaborated. A common minimum package for both the arms has also been defined and elaborated.	
		Primary outcomes	Primary outcome measures have undergone minor modification, addition of Quality of breastfeeding through BBAT score on Day 8 as a new outcome	
		Secondary outcomes	Secondary outcome measures have further been described - Addition of maternal breastfeeding experience and self-efficacy scales - Addition of Mother-to-infant bonding scale measured on day 29. - Morbidities, hospitalization rates and mortality have been removed	
		Other outcome measures	Other outcome measures as part of a sub-study have been added: a) Duration of hypothermia (axillary temperature < 36.5°C) over the first 48 hours of life, b) Heart rate variability during the first 48 hours of life.	
		Sample Size	The sample size section has been further elaborated	
		Severe adverse events	SAEs have been modified and further described	

		Data Collection	Modification of the days of follow-up from days 1, 2, 3, 7, 15 and 28 to days 1, 2, 4, 8, 15, and 29 The data collection team has been described- - Addition of a table listing various outcomes assessments at different time points.	

3. ABBREVIATIONS:

KMC	Kangaroo Mother Care
SSC	Skin-to-Skin Contact
LBW	Low Birth Weight
RCT	Randomised Control Trial
WHO	World Health Organization

4. Background and rationale

The early postnatal period is a critical phase for newborns, marked by intense physiological adaptations that involve thermoregulatory, metabolic, respiratory, cardiovascular, skin barrier and immune system adjustments that are vital for the newborn's survival, health and development.[1–3] While successful immediate transition should be completed within the first 6 hours of life, critical adaptive processes continue over the next 24-48 hours, and certain adaptive processes are maturational in nature and occur over a prolonged period.[1] Of these, the newborn's metabolic adaptation consists of transitioning from placental blood glucose as a continuous energy source into fast-feed cycles with an external energy source (e.g. via breastfeeding) to meet their energy needs (e.g. thermoregulation).[4–6] While each transition is complex and depends on multiple factors – gestational age, maternal and foetal health, antepartum and intrapartum events – the newborn's metabolic adaptation can be the most challenging as it is additionally dependent on multiple extrinsic factors.[1,5] The newborn's energy requirements vary based on the ambient temperature and several factors that influence the newborn's behavioural state (e.g. stress due to separation from the mother), and to meet these variable energy requirements, it needs to receive adequate nutrition from an external source.[1,5] Besides providing energy for various organ systems including the central nervous system and energy-consuming

adaptive transitions, the newborn's fuel sources through external nutrition and mobilisation of internal energy stores also provide energy to maintain the newborn's temperature within a narrow viable range to sustain the various biochemical reactions essential for maintaining vital processes.[1,5] Thus, the externally-modulated interdependent risks of hypoglycaemia, hypothermia and at an extreme end, hypoxia, can form a vicious cycle that can delay or prevent the successful energy transition of the newborn.[5,7] While these risks are further aggravated in compromised newborns that are preterm or low birth weight, they nevertheless also exist for healthy term newborns due to their dependence on external environmental factors.[1,5]

The first week of an infant's life, especially the first 48-96 hours until the onset of lactogenesis-II, is crucial for establishing successful lactation in mothers.[8,9] Breastfeeding initiation within the first hour of life is suboptimal in Uttar Pradesh, India, where only about 25% of newborns are breastfed within this critical window.[10] Initial feeding challenges during the first few days related to maternal-newborn separation and poor positioning and latching create a detrimental cycle characterised by reduced milk intake in infants leading to hypoglycaemic episodes that manifest as persistent hunger cues and frequent crying.[11–15] These factors potentially contribute to the perception of insufficient milk production by mothers, resorting to supplementary feeding (increasing the risk of illness), downregulation of the mother's milk supply and ultimately, a downregulation of the infant's metabolic processes.[16–19] This chain of events may ultimately contribute to growth impairment in infants.[20]

Effective newborn care during the intra-uterine to extra-uterine transition, particularly in regions with limited resources, is essential to minimize early growth deficits and prevent morbidities. Kangaroo Mother Care (KMC), defined by continuous skin-to-skin contact and exclusive breastfeeding, is recommended by the World Health Organization (WHO) as essential care for preterm and low-birth-weight infants due to its proven benefits in improving survival, stabilizing physiological functions, and promoting breastfeeding initiation and continuation.[21,22] However, while KMC is well-studied in vulnerable infants, its potential benefits for normal birth weight infants beyond early skin-to-skin contact during the first hour post birth remain underexplored, particularly for improving early breastfeeding success and growth outcomes.

Early skin-to-skin contact – an essential component of KMC – has demonstrated success in supporting breastfeeding initiation and continuity.[23] By fostering close mother-infant contact, providing KMC over a longer duration may support instinctual feeding behaviours, thereby promoting better latch, milk intake, and long-term breastfeeding exclusivity.[24–26] In addition to breastfeeding benefits, KMC provides thermoregulation, reduces stress responses, and stabilizes heart rate variability in preterm infants, which is particularly advantageous in the early postnatal period.[27] Studies indicate that KMC can significantly enhance maternal-infant bonding and alleviate maternal stress, potentially mitigating risks of postpartum depression.[28] Given the emerging evidence that even normal birth weight infants are at risk of early growth faltering, examining the effects of KMC on this population could extend its

benefits to a broader group of newborns, potentially improving early growth patterns and reducing morbidity in regions with high neonatal mortality.[29]

The proposed randomized controlled trial aims to assess whether early, prolonged KMC (at least 8-20 hours daily) for the first 72 hours in normal birth weight newborns can improve breastfeeding quality, support early weight gain, and foster maternal-infant bonding. If successful, these findings could support KMC as a universal standard for newborn care, especially in low-resource settings.

5. RESEARCH HYPOTHESES:

5.1. Primary hypotheses: Prolonged KMC (at least 8 hours and ideally >20 hours of daily skin-to-skin contact along with exclusive breastfeeding) in the first 72 hours among normal birth weight infants when compared with standard care, will lead to:

- **5.1.1.** a 25% reduction in mean percentage weight loss during the first 2 days, and
- **5.1.2.** a 20% improvement in mean weight gain velocity measured during the first 28 days of life, and
- **5.1.3.** 50% fewer mother-baby dyads with moderate-to-poor Bristol Breastfeeding Assessment Tool (BBAT) score (<7 out of 8) (assessed at age 7 completed days).

6. OBJECTIVES:

6.1. Primary objectives: To evaluate the effect of prolonged KMC (at least 8 hours and ideally >20 hours of daily skin-to-skin contact along with exclusive breastfeeding) in the first 72 hours among normal birth weight infants on

- **6.1.1.** mean percentage weight loss observed during the first 2 days of life
- **6.1.2.** mean weight gain velocity during the newborn period (measured over the first 28 days of birth)
- **6.1.3.** quality of breastfeeding using the BBAT score (assessed at age 7 completed days)

6.2. Secondary objectives

- **6.2.1.** To compare the proportion of infants who are exclusively breastfed during the first 3 days and at age 28 days between the intervention and control groups.
- **6.2.2.** To compare experiences of mothers related to breastfeeding success using the Breastfeeding Experience Scale and Breastfeeding Self-Efficacy Scale between the intervention and control groups
- **6.2.3.** To compare the incidence of possible serious bacterial infection (PSBI) between the intervention and control groups during the first 28 days of life

6.2.4. To compare the incidence of maternal depression among mothers in the intervention and control groups

6.2.5. To compare the Maternal-Infant Bonding Scale (MIBS) scores among mothers in the intervention and control groups

7. KEYWORDS:

Kangaroo Mother Care; intrauterine-to-extrauterine transition; physiological care; breastfeeding; early weight loss; weight gain.

8. METHODOLOGY:

The study methodology is written according to the Standard Protocol Items: Recommendations for Interventional Trial Statements (SPIRIT)[1]

8.1. Study design

This is a multicenter, pragmatic, individually randomised controlled, open-label superiority trial, comparing two parallel groups of normal birthweight infants, (weighing ≥2500 grams at birth) - early and prolonged KMC for the first 72 hours after birth (intervention group) WITH standard care (control group). The unit of randomisation is the mother-infant dyad in a 1:1 ratio.

8.2. Study setting

The multi-center study will be conducted in two study facilities in Lucknow, Uttar Pradesh - Queen Mary Hospital (operated by King George's Medical University Lucknow) and Veerangana Avanti Bai District Women's Hospital. The selection of study sites was based on expected enrolment rates, feasibility of segregating the intervention and control mothers, and other pragmatic considerations.

8.3. Study population and eligibility criteria

We will enrol healthy singleton neonates of normal birthweight i.e., those weighing 2500 grams or more at birth, who are born in the study facility through uncomplicated vaginal deliveries and whose mothers are committed to staying in the study facility for 48 hours following birth (as per government guidelines) and who intend to breastfeed their infants over the first 28 days of life.

8.3.1. Inclusion criteria

Newborns:

[1] Chan AW, Tetzlaff JM, Gøtzsche PC, Altman DG, Mann H, Berlin JA, Dickersin K, Hróbjartsson A, Schulz KF, Parulekar WR, Krleza-Jeric K, Laupacis A, Moher D. SPIRIT 2013 explanation and elaboration: guidance for protocols of clinical trials. BMJ. 2013;346:e7586.

- Healthy singleton newborns with birth weight ≥2500 grams, born vaginally and screened and enrolled within 4 hours of birth

Mothers:

- Residing within the catchment area near the study facility
- Having singleton vaginal births in the study facility without any complications
- Willing to stay in the study facility for 48 hours post-delivery and continue recommended practices at home post-discharge
- Provide written informed consent for study participation within 4 (four) hours of birth.

8.3.2. Exclusion criteria

Newborns:

- Any condition that will require immediate admission to the neonatal intensive care unit (NICU/ SNCU) such as respiratory distress, birth asphyxia etc
- Newborn should not be enrolled in any other research study that would interfere with the intervention and outcomes.
- Having major congenital malformations which are apparent at birth that can interfere with the intervention like anencephaly, hydrocephaly, omphalocele, cleft lip, cleft palate, meningomyelocele, imperforate anus.

Mothers:

- Maternal Death
- Multiple births
- Caesarean section delivery
- Women with HIV opting for top feeding
- Any complications e.g. post partum haemorrhage (PPH), eclampsia, etc. identified within an hour of birth, requiring special or intensive care beyond routine postnatal care
- Any other problems, such as generalized skin rashes/ infection, that may hinder their ability to provide prolonged KMC

8.3.3. Criteria to discontinue Intervention among mother-baby dyads assigned to the intervention group

- Any complication in mother or baby which makes the continuation of the intervention unfeasible (as per discretion of the treating physician)
- Mother's unwillingness to continue

No post-hoc exclusions will be applied, therefore mothers who choose to discontinue the intervention or eligible infants who become sick post enrolment and require SNCU/ NICU care during the course of the study will not be excluded from primary intent-to-treat analysis.

8.4. Screening and consenting procedures

Verbal Consent for screening procedures prior to delivery

Verbal consent for conducting screening of the newborn baby and mother for assessing study eligibility will be administered to pregnant women upon admission to the facility prior to delivery. Pregnant women who reside within the catchment area near the study facility (considering the feasibility of post-discharge follow-up evaluation visits), are willing to stay in the study facility for 48 hours post-delivery, and intend to breastfeed their baby during the first 28 days of life, will be consented.

The verbal consent will inform the mother regarding the assessment process which will be conducted post-delivery to screen the baby and mother for eligibility for enrolment.

Post-delivery assessment of eligibility of the mother-newborn dyad to participate in the study

A calibrated Seca 334 or equivalent weighing scale will be placed in the labour room throughout the study period which will be utilised by the hospital nurses to measure the birth weight of all babies. Nurses will be trained and standardised on the weighing of newborns using the weighing scale. All singleton infants born vaginally will be weighed by a hospital nurse, in the presence of a study nurse in the labour room, using the calibrated weighing scale soon after receiving uninterrupted skin-to-skin contact and breastfeeding initiation in the first golden hour. Throughout the study, newborns will be measured using the same type of weighing scale - thus ensuring comparability of weight measures from time to time. Once the weighing is done, other screening information for newborns and mothers will be documented from hospital records, and confirmed with treating doctors. A thorough physical assessment of newborns for congenital anomalies will be conducted by the study nurse and confirmed with the paediatrician on duty, before confirming the eligibility of the mother-newborn dyad for enrolment into the study.

Obtaining informed written consent

If the mother-baby dyad is found to be eligible for enrolment, the study team will attempt to administer the informed written consent once the mother is relaxed and in a position to understand the study procedures and provide her consent. The study team will rely upon the assessment of the treating physicians/ nurses regarding the readiness of the mother and will take permission from her and her family before administering the written informed consent. This will be done within 4 hours after birth –

every measure will be taken to conduct the consenting and enrolment process as soon as possible after birth, while balancing the comfort and needs of the mother.

8.5. Randomisation, allocation and recruitment

This is an open-label individually randomised controlled study. The study biostatistician will generate a randomisation scheme with random permuted blocks of variable sizes between 2 to 6 using a computer program for each facility. The random allocation file for each facility will be electronically stored in the secure RedCap application database. During the enrolment process after securing informed written consent, the application will automatically assign the infant to the study group corresponding to the next sequence number and record the assigned group in the database, without making it visible in the case report forms. The study nursing team who will be conducting the screening and enrolment, will be able to access the study group assigned to enrolled infants. The study nursing team will also be responsible for overall strengthening of care in the study facilities, and will be referred to as the Screening, Enrolment and Systems Strengthening (SESS) team.

As an open-label trial, the SESS team, the intervention team (known as the 'KMC team'), and the participants will be aware of the assigned study group. However, special measures will be taken to reduce the risk of bias. The independent outcome assessment (IOA) team will be masked to the group allocation. The SESS team will ensure that a common minimum package of care is provided similarly to mother-baby dyads in both the study groups (please see section 8.7). Quality control measures will be adopted to ensure that the standard operating procedures are being duly followed and any deviation from the protocol will be documented. Measures to reduce the risk of bias will include standardised data collection in both the groups with well-defined monitoring and quality protocols.

8.6. Intervention

Mother-to-newborn:

The intervention from the mother to the baby will include continuous and prolonged skin-to-skin contact (SSC) (ideally >=20 hours, but at least >=8 hours daily), along with breastfeeding on demand in the KMC position (on-demand, as initiated by the newborn as per his/her needs while in SSC) during the first 72 hours of life. Post the first 72 hours and through the newborn period, mothers will be recommended to continue with SSC as per their desire and comfort, and be advised to continue to breastfeed in the KMC position to the extent possible. .

Counseling and support to the mother:

A team of lay workers trained in KMC support (called the KMC team) will be responsible for providing counselling and support to mothers on KMC during the first 48 hours of facility admission.

Mothers will be counselled on the potential benefits of Kangaroo Mother Care, and will be supported in providing prolonged KMC in the facility with the help of a binder. The KMC team will counsel and support the mother in placing the baby appropriately in skin-to-skin position, teaching her the use of binder and breastfeeding while the baby is in the KMC position. SSC during hospital stay will involve the infant and mother remaining bare-chested in the KMC position, with the baby's head covered by a cap, and feet kept warm with socks. All measures will be taken to keep the baby safe in the SSC position. This will include keeping the mother in a semi-reclined position at an angle of at 30-45 degrees (or in ambulatory position when the mother wishes) and securing the baby with a binder firmly to the chest and a shirt that provides containment in the KMC position. All routine care will be provided in SSC. Any interruptions in SSC will be documented to determine the duration for which the intervention was provided per day (dose). The KMC team will take all measures to ensure that mothers provide continuous KMC, with >= 20 hrs of daily SSC without removing the baby for breastfeeding, to the extent possible.

Post 48 hours, the mother-baby dyad will be discharged from the facility in ambulatory KMC (provided there are no signs of complications in either mother or baby that require a longer duration of hospital stay). The KMC team will ensure that the mother-baby dyad is discharged in the KMC position along with counselling on continuing KMC similarly for at least 1 more day at home. The KMC team will remind mothers/ family members telephonically in the morning and afternoon of the day after discharge to encourage the provision of prolonged KMC (ideally >=20 hours, but at least >=8 hours). Post 72 hours, on Day 4, the KMC team will make a final call to mothers and family members to recommend them to continue keeping the baby in SSC for as long as they wish, as per their desire and comfort, and be advised to continue to breastfeed in the KMC position throughout the newborn period.

8.7. Common minimum care package for both the study groups

Both groups will receive the standard of care as per the facility norms by facility health providers. This may include basic counselling including lactation, record-keeping, general assessment, vaccinations, etc. by the nurses and doctors in the facility.

The SESS team will strengthen the care at the study facilities, including ensuring skin-to-skin contact and breastfeeding initiation within the first golden hour with accurate measurement of the birth weight on the calibrated study weighing scale for all babies. Measures will be taken to ensure privacy for mothers and ensuring optimal ambient temperature in the labour room and wards.

The SESS team will supervise the provision of counselling on essential newborn care by facility nurse providers to ensure an equivalent counselling package to both the groups. This will include counselling on thermal care (without mentioning SSC), exclusive breastfeeding with basic lactation counselling, hygiene including handwashing and cord care, danger signs and care-seeking. Mothers in both the

groups will be provided a “baby kit”, with cap, mittens, socks, blanket, diapers, and a bottle of hand sanitizer.

8.8. Outcomes, assessment and measurement

8.8.1. Primary outcome measures

Primary Outcome Measures	
Outcome 1: Percentage weight change over the first 48 hours after birth.	**Description:** Percentage weight change over the first 48 hours after birth is defined as: $$\frac{Weight\ taken\ at\ (48\ \pm\ 6)\ hours\ -\ Birth\ weight}{Birth\ weight} \times 100$$ All singleton infants will be weighed by workers trained and standardised in anthropometry assessments using a calibrated Seca 334 or equivalent digital weighing scale, accurate to ±5 grams.
Outcome 2: The weight gain velocity during the newborn period	**Description:** Weight gain velocity will be calculated as: $$\frac{Weight\ at\ day\ n\ -\ Birth\ weight}{Birth\ weight} \times \frac{1}{n} \times 100$$ where n is the completed age of the baby at last follow-up, between 28-32 (included)
Outcome 3: Quality of breastfeeding as measured through the Bristol Breastfeeding Assessment Tool (BBAT) score on Day 8 (i.e. at 7 completed days of age).	**Description:** The BBAT assessment assigns numerical scores (0, 1, or 2) to four key breastfeeding components (position, attachment, sucking and swallowing) and summarising to a scale-score between 0-8, with a higher rating indicating better breastfeeding performance. The BBAT score is categorised into 3 categories: poor (0-2), moderate (3-6) and good (7-8).

8.8.2. Secondary outcome measures

Secondary Outcome Measures	
Outcome 1: Exclusive Breastfeeding at day 28 of birth.	**Description:** Exclusive breastfeeding is defined as feeding an infant with only breast milk and no additional food, water, or other liquids (with the exception of medicines and vitamins, if needed). This will be assessed on Day 29 follow up visit using 24 hour dietary recall method for exclusive breastfeeding. Exclusive breastfeeding will be measured in a manner consistent with the Infant and Young Child Feeding indicators recommended by WHO and UNICEF.
Outcome 2: Score on the Breastfeeding Experience	**Description:** The Breastfeeding Experience Scale is a 19-point scale of potential negative experiences that the mother may have had

Scale as reported by mother on follow-up day 8 to assess early challenges with breastfeeding.	since birth (e.g., sore nipples and other breast-related problems, infant-related challenges to breastfeeding success, mother's own perceptions and anxiety, etc.), and the degree to which those experiences posed a challenge to breastfeeding. We will aim to compare both the score on the number of negative experiences as well as the degree to which these experiences influenced breastfeeding between the intervention and control groups.
Outcome 3: Possible Serious Bacterial Infection (PSBI) among infants on follow-up days (days 4, 8, 15 and 29).	**Description: Possible serious bacterial infection** commonly known as PSBI is defined as the presence of any of the following clinical signs in the infants: • Convulsions • Not able to feed at all • No movement at all • Low body temperature (< 35.5°C) • Not feeding well • Movement only when stimulated • Severe chest indrawing • High body temperature (38°C or above) • Fast breathing (60 breaths per minute or more) in infants < 7 days The PSBI signs will be assessed by trained and standardised workers during follow-up visits as per IMNCI assessment protocol on days 4, 8, 15 and 29.
Outcome 4: Maternal depression measured at 15days after birth.	**Description:** **The Edinburgh Postnatal Depression Scale** (EPDS) The scale consists of 10 short statements. Responses are scored 0, 1, 2 and 3 based on likert scale. Items 3, 5 to 10 are reverse scored (i.e., 3, 2, 1, and 0). The total score is calculated by adding together the scores for each of the 10 items. Mothers scoring above 13 will be considered as suffering from depression. The EPDS will be administered by trained and standardised workers on the follow-up day 15 visit.
Outcome 5: Mother-to-infant bonding scale measured on day 29.	**Description:** **The Mother-to-infant Bonding Scale** (MIBS) The scale was developed in London and consists of 8 different self-reported feelings of mothers towards their babies, and aims to assess how often mothers experience these feelings towards their babies. Each of the 8 items is scored on a 0-3 Likert scale. The total score is calculated by adding together the scores of the 8 items. It is reverse-scored - so a low score indicates better attachment and a high score indicates worse attachment. There is a slight variation of this scale validated in the Japanese context, consisting of 10 items. We may use the latter scale, given that it is from an Asian context. The MIBS will be administered to mothers on follow-up day 29 visit.
Outcome 6: Breastfeeding self-efficacy scale (short form) measured on day 29.	**Description:** **The Breastfeeding Self-Efficacy Scale-Short Form (BSES-SF)** The Breastfeeding self-efficacy scale was developed to assess maternal confidence in breastfeeding to identify mothers at risk of weaning as well as evaluate the effectiveness of various interventions in supporting breastfeeding. It consists of 14 items scored on a 5-point Likert scale, where 1 indicates 'not at all confident' and 5

	indicates 'always confident'. The total score is calculated by adding together the scores on all 14 items. The BSES-SF will be administered to mothers on follow-up day 29 visit.

Other outcome measures (sub-sample)	
Mechanistic sub-study	
Duration of hypothermia (axillary temperature < 36.5°C) over the first 48 hours of life. This will be assessed in a sub-sample of 40 newborns each in the intervention and control groups as part of a mechanistic sub-study.	**Description:** Continuous ambulatory temperature monitoring of the newborn will be done to compare hypothermia prevalence in infants of both groups using validated sensors (device to be decided). **Hypothermia is classified into three grades:** Mild (36.0°C – 36 .5°C), moderate (32.0°C – 35.9°C), and severe (<32.0°C) hypothermia. The total duration of time when the device records a temperature < 36.5°C will be measured over the first 48 hours for every infant.
Heart rate variability during the first 48 hours of life. This will be assessed in a sub-sample of 40 newborns each in the intervention and control groups as part of a mechanistic sub-study.	**Description:** Continuous heart rate monitoring of the newborn will be done over the first 48 hours using a pulse oximeter (plethysmograph, device to be decided). Heart rate variability for various time intervals (first 6 hours, 6-24 hours, 24-48 hours) will be calculated using standard techniques. Heart rate variability in newborns is associated with stress as well as human touch and maternal-infant synchrony.[30–32]

8.9. Sample size

Assuming that unexposed newborn infants born with normal birth weight lose an average of 6% (SD 3.6%) of their birth weight within the first 2 days of life (based on a previous pilot study in community settings), in order to detect a 25% reduction in early weight loss at 95% confidence level and 90% power, and a design effect of 2.0, we will need 244 infants in each group, i.e., ~122 infants per group in each facility.

$n = ((Z_{\alpha/2}+Z_{\beta})^2 * 2 * \sigma^2 / d^2) \times DE$

where Zα/2 is the critical value of the Normal distribution at α/2 (e.g. for a confidence level of 95%, α is 0.05 and the critical value is 1.96), Zβ is the critical value of the Normal distribution at β (e.g. for a power of 90%, β is 0.1 and the critical value is 1.28), σ2 is the population variance, and d is the difference between the two groups (25% of 6% = 1.5%). DE is the design effect assumed to be 2.0. Assuming a loss to follow up of 5%, we will need to enroll 129 infants per group in each facility, i.e. 258 infants in both groups per facility, giving a total sample size of 516 normal birth weight infants.

This sample size will allow us to detect a 20% improvement in cumulative weight gain at age 28 days at 95% confidence level and 80% power (assuming an average increase of 25%, SD 10% in birth weight in control infants). It will also allow us to detect a 50% reduction in mother-baby dyads with a low-moderate BBAT score of < 7 in the intervention arm as compared to control arm at 95% confidence level and 80% power (assuming 30% of dyads in the control group have a BBAT score of < 7).

8.10. Severe adverse events (SAEs)

The following have been identified as reportable SAEs:

Newborns

- Newborn death
- Admission to a Level-2 or above newborn care unit

During the postnatal stay of the mother-newborn dyad, newborns will be under round-the-clock monitoring of the hospital team. Newborn deaths and admission to neonatal intensive care will be notified to the study team, and documented using the SAE forms. During post-discharge follow-up, SAEs will be documented by study evaluation workers on visit days based on information and records provided by the family.

Upon identification of an SAE, it will be verified and notified within 24 hours by the Principal Investigator to the data and safety monitoring board (DSMB). All SAEs will also be communicated to the ethics committee on a monthly basis.

A masked interim analysis will be performed by the DSMB to review the safety of the trial once 50% of participants have completed the follow-up, where relative incidence rates and severity of events in the two arms will be compared.

Due to the low-risk nature of the study, no stopping rules have been defined.

8.11. Data collection

Infants will be followed up on days 1 (24 hours after birth), 2 (48 hours after birth), 4, 8, 15 and 29 for various outcomes, including vital status, weight, infant feeding practices (observation and 24-hr recall questionnaire), other care practices (24-hour recall questionnaire), etc. The IOA team responsible for conducting the data collection will be masked to the study group. There will be a pair of assessors – a male and female assessor, conducting each follow-up visit. This is because

some of the assessments, such as breastfeeding observation and maternal mental health are sensitive and require a female assessor. The male assessors have been included for logistical reasons and will focus on gender-neutral measures like anthropometry, PSBI assessment, socio-economic status.

STUDY PERIOD								
	Screening		**Post Randomization**					**Close -out**
Timepoint	Labor	<4hr	**D1**	**D2**	**D4**	**D8**	**D15**	**D29**
SCREENING:								
Verbal Consent & Registration	X							
Eligibility Screening		X						
Informed Written Consent		X						
Randomization & Enrolment		X						
INTERVENTION:								
Skin-to-skin contact log			X	X				
OUTCOME ASSESSMENT:								
A. Newborn weight		X	X	X	X	X	X	X
B. PSBI Module					X	X	X	X
C. Anthropometry Measurement (length, head circumference, MUAC)			X					X
D. Breastfeeding Observation (BBAT)				-		X		
E. Feeding Module			X	X	X	X	X	X
F. Newborn Care Practices (SSC)			X	X	X	X	X	X
G. Maternal history					X			
H. Breastfeeding Experience Scale						X		
I. Maternal Depression							X	

J. Mother-infant bonding								X
K. Breastfeeding Self-Efficacy								X
L. Socio Economic Status						X		
Mechanistic sub-study* (continuous temperature + plethysmography)			<——	——>				

* Sub-sample of 40 infants each from intervention and control groups (Mechanistic cohort)

8.12. Piloting, standardization and quality control

The study instruments will be piloted by experienced data collectors, and their feedback incorporated to finalize the questionnaires. SOPs for data collection and quality assurance will be developed. The IOA team conducting anthropometric measurements will be rigorously standardised in accordance with the established protocols. The IOA team will also be standardised on all the questionnaires, assessments and scales, including the BBAT, PSBI assessment, EPDS, MIBS, etc. The study coordinator will directly supervise the IOA team – random spot checks will be made for 10% of all visits.

The SESS team will be standardised on newborn weighing, support of breastfeeding initiation through SSC during the first hour, eligibility screening and enrolment procedures, and supporting facility nurses in the provision of essential newborn care counselling. Hospital nurses, who are responsible for measuring the birth weight of newborns, will be trained in the standardized measurement of birth weight. The SESS team will oversee the measurement of birth weight by the hospital nurses for all newborns whose mothers have been consented for screening. The same digital infant weighing scale (Seca 334 or equivalent) will be used across all study centres for each time point of data collection from birth to age 28 days. A dedicated team lead will supervise the SESS team and will conduct random spot-checks for 10% of interactions in the labour room and wards.

The KMC team will be trained and mentored by experienced workers on supporting mothers in providing prolonged KMC to their babies. A dedicated team lead will supervise the KMC team and will conduct daily facility visits to ensure quality and standardised delivery of the intervention.

8.13. Data management

Data management will be a crucial aspect of our study, ensuring the accuracy, integrity, and confidentiality of the collected data. All study data will be collected on electronic case report forms on Android-enabled devices using a common data management platform. It will be stored in a secure, cloud-based password-protected database, accessible only to authorized personnel. We will

implement strict data quality control procedures, including range checks, consistency checks, and periodic audits, to minimize data entry errors and ensure data validity. All electronic data will be backed up regularly, with copies stored in a separate secure location. Consent forms and any other physical data will be stored in a locked cabinet in a secure area, with access restricted to authorized study personnel only. The data will be anonymized and coded to maintain participant confidentiality. The data management team will collate reports based on data received from all the study sites, conduct statistical analysis and support data monitoring. Each site will also review its own data for quality purposes, and present findings during monthly steering committee review meetings. Any requests for data access for secondary analyses will be reviewed by the study team, and approval will be contingent upon ethical considerations and relevance to the study objectives.

8.14. Statistical analysis

The detailed analysis plan based on the following high-level plan will be finalized a priori before initiating any analysis of the study data. Statistical analysis will be conducted using R or STATA.

Baseline characteristics will be compared between the intervention and control groups using independent samples t-tests for continuous variables and chi-square tests or Fisher's exact tests for categorical variables. This will help ensure that randomization has successfully balanced potential confounders across groups.

For the primary outcomes of average weight loss and weight gain as a proportion of birth weight, two-sided independent samples t-tests will be used. The standardised effect size will be calculated using Cohen's d. A 95% confidence interval for the mean difference will be calculated. A p-value of <0.05 will be considered statistically significant. Multivariable regression analysis will be employed to adjust for potential confounders, such as birth weight, maternal age, socioeconomic status, etc. Stratified analysis will be conducted to assess the effect of KMC within each hospital. Sensitivity analysis will be conducted to assess the robustness of the results.

Analysis of secondary outcomes will be conducted based on the type of variable. For outcomes such as exclusivity of breastfeeding and perceived milk sufficiency, chi-square tests will be used, and odds ratios with 95% confidence intervals will be calculated. For outcomes measured on an ordinal scale, such as the severity of maternal depression, Kruskal-Wallis tests will be used, and cumulative odds ratios or proportional odds ratios with 95% confidence intervals will be calculated. For continuous outcomes, such as the duration of moderate to severe hypothermia, two-sided independent samples t-tests will be used, and mean differences or median differences with 95% confidence intervals will be calculated.

Masked interim analysis will be conducted for the DSMB upon completion of 50% sample size.

8.15. Monitoring & oversight

Governance & coordination:

A technical advisory group (TAG) consisting of three independent external experts will be constituted. TAG members will review the final study protocol, manual of operations, case record forms and consent forms, and may advise on practical implementation issues. They will be kept updated on the progress of the study at regular intervals. A Data Safety Monitoring Board consisting of 3-4 members will be established to monitor the trial on an ongoing basis. The DSMB will monitor the integrity of the trial and its conduct as per the study protocol and its progress as per the recruitment timeline, and assess its safety, including reviewing the incidence of SAEs.

A Steering Committee will be established, consisting of all PIs and co-PIs from the study sites. Depending upon their availability, an independent member from the ICMR child health secretariat will also be included. The steering committee will be responsible for finalizing the research protocol, manuals, CRFs, consent forms, data management, analysis plans, and interpretation and dissemination of study results.

A Trial Coordination Centre will be established at CEL, consisting of the data management team, technical expert(s), and assisted by a small team of researchers. Data from the study sites will be centrally managed, and an enrolment progress dashboard along with quality metrics with de-identified information will be reviewed during Steering Committee meetings held on a monthly basis. The Trial Coordination Centre will be responsible for the oversight of the study and in supporting the various sites in conducting research of the highest quality. Regular visits by the Trial Coordination Centre will be planned to assess the quality of the study implementation in each of the study sites and advise on study implementation, as necessary.

Study implementation teams at each site: Each site will have a screening team that will be responsible for screening every infant after birth based on their weight and other inclusion/ exclusion criteria to assess their eligibility to participate in the study, administer consent, and follow the randomized allocation procedures. A team of intervention nurses will be trained in intervention procedures and will counsel, support, supervise and keep a documented record of KMC and breastmilk feeding episodes. Each site will also have a team of independent data collectors who will collect the data on each enrolled infant at specified timepoints based on a pre-defined schedule.

8.16. Ethical considerations

8.16.1. Key Issues

The ethical considerations for this study are paramount and will be thoroughly addressed to protect the well-being and rights of the participating infants and their mothers. Informed consent will be obtained from the mothers before their inclusion in the study, ensuring that they are fully informed about the study's purpose, procedures, potential risks, and benefits. The study will be conducted in accordance with the principles of the Declaration of Helsinki and will be approved by the relevant institutional review boards or ethics committees at each participating center.

Participation in this study is completely voluntary and an informed consent will be taken, respecting participants' freedom to choose and the option to withdraw consent at any point of time without repercussions. The intervention is known to be extremely safe for preterm and low birth weight infants as well as unstable infants, and therefore expected to be safe for normal birth weight infants without complications as well. Special attention will be paid to the potential risks and discomforts associated with KMC, such as potential for hyperthermia, discomfort, or fatigue for the mother, and any potential adverse effects on the infant's health. Appropriate measures will be taken to minimize these risks, including continuous monitoring of the infant's temperature, and ensuring that the mother is comfortable and supported during KMC sessions.

8.16.2. Research Ethics Approval

The ethical approval for this study will be sought from the Institutional Ethics Committee of Community Empowerment Lab (CEL-IEC) and institutional ethics boards of the participating medical institutes. Any necessary protocol amendments will be re-submitted for review by the Ethics Committees. The study will be registered with the Clinical Trial Registry of India (CTRI).

8.16.3. Confidentiality & Data Protection

Participant confidentiality and data protection will be rigorously maintained, with data anonymized and stored securely. Participants will have the right to withdraw from the study at any time without any adverse consequences. Any adverse events or unintended effects of the intervention will be closely monitored, documented, and addressed promptly. The study's results will be disseminated in a transparent and unbiased manner, contributing to the scientific community's understanding of the benefits and potential risks of KMC in normal birth weight infants.

8.16.4. Declaration of Interests

We declare no conflict of interest.

References

1. Michel, A. & Lowe, N. K. The Successful Immediate Neonatal Transition to Extrauterine Life. *Biol. Res. Nurs.* **19**, 287–294 (2017).
2. Graves, B. W. & Haley, M. M. Newborn transition. *J. Midwifery Womens. Health* **58**, 662–670 (2013).
3. Swanson, J. R. & Sinkin, R. A. Transition from fetus to newborn. *Pediatr. Clin. North Am.* **62**, 329–343 (2015).
4. Morton, S. U. & Brodsky, D. Fetal physiology and the transition to extrauterine life. *Clin. Perinatol.* **43**, 395–407 (2016).
5. Ward Platt, M. & Deshpande, S. Metabolic adaptation at birth. *Semin. Fetal Neonatal Med.* **10**, 341–350 (2005).
6. Hillman, N. H., Kallapur, S. G. & Jobe, A. H. Physiology of transition from intrauterine to extrauterine life. *Clin. Perinatol.* **39**, 769–783 (2012).
7. Aylott, M. The neonatal energy triangle. Part 1: Metabolic adaptation. *Paediatr. Nurs.* **18**, 38–42; quiz 43 (2006).
8. Neville, M. C. & Morton, J. Physiology and endocrine changes underlying human lactogenesis II. *J. Nutr.* **131**, 3005S–8S (2001).
9. Neville, M. C., Morton, J. & Umemura, S. Lactogenesis. The transition from pregnancy to lactation. *Pediatr. Clin. North Am.* **48**, 35–52 (2001).
10. International Institute for Population Sciences (IIPS) & ICF. *National Family Health Survey (NFHS-5), 2019-21*. (2021).
11. Christensson, K., Cabrera, T., Christensson, E., Uvnäs-Moberg, K. & Winberg, J. Separation distress call in the human neonate in the absence of maternal body contact. *Acta Paediatr.* **84**, 468–473 (1995).
12. Bystrova, K. *et al.* Early lactation performance in primiparous and multiparous women in relation to different maternity home practices. A randomised trial in St. Petersburg. *Int. Breastfeed. J.* **2**, 9 (2007).
13. Righard, L. & Alade, M. O. Sucking technique and its effect on success of breastfeeding. *Birth* **19**, 185–189 (1992).

14. Winberg, J. Mother and newborn baby: mutual regulation of physiology and behavior--a selective review. *Dev. Psychobiol.* **47**, 217–229 (2005).
15. Crenshaw, J. T. Healthy Birth Practice #6: Keep Mother and Newborn Together-It's Best for Mother, Newborn, and Breastfeeding. *J. Perinat. Educ.* **28**, 108–115 (2019).
16. Oliva-Pérez, J. & Oliver-Roig, A. Relationship of delayed lactogenesis II to maternal perception of insufficient milk: A longitudinal study. *Enferm. Clín. (Engl. Ed.)* **32**, 413–422 (2022).
17. Y. Yakovlev, Y. Perceived insufficient milk supply (PIMS) in lactating mothers. in *Multiple Pregnancy - New Insights [Working Title]* (IntechOpen, 2022).
18. Huang, Y., Liu, Y., Yu, X.-Y. & Zeng, T.-Y. The rates and factors of perceived insufficient milk supply: A systematic review. *Matern. Child Nutr.* **18**, e13255 (2022).
19. Gatti, L. Maternal perceptions of insufficient milk supply in breastfeeding. *J. Nurs. Scholarsh.* **40**, 355–363 (2008).
20. Victora, C. G. *et al.* Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *Lancet* **387**, 475–490 (2016).
21. *WHO Recommendations for Care of the Preterm or Low-Birth-Weight Infant*. (2022).
22. *Kangaroo Mother Care: A Transformative Innovation in Health Care. Global Position Paper*. https://www.who.int/publications/i/item/9789240072657.
23. Moore, E. R., Bergman, N., Anderson, G. C. & Medley, N. Early skin-to-skin contact for mothers and their healthy newborn infants. *Cochrane Database Syst. Rev.* (2016) doi:10.1002/14651858.CD003519.pub4.
24. Colson, S. D., Meek, J. H. & Hawdon, J. M. Optimal positions for the release of primitive neonatal reflexes stimulating breastfeeding. *Early Hum. Dev.* **84**, 441–449 (2008).
25. Svensson, K. E., Velandia, M. I., Matthiesen, A.-S. T., Welles-Nyström, B. L. & Widström, A.-M. E. Effects of mother-infant skin-to-skin contact on severe latch-on problems in older infants: a randomized trial. *Int. Breastfeed. J.* **8**, 1 (2013).
26. Bigelow, A. E. & Power, M. Mother-Infant Skin-to-Skin Contact: Short- and Long-Term Effects for Mothers and Their Children Born Full-Term. *Front. Psychol.* **11**, 1921 (2020).

27. Sivanandan, S. & Sankar, M. J. Kangaroo mother care for preterm or low birth weight infants: a systematic review and meta-analysis. *BMJ Glob. Health* **8**, e010728 (2023).
28. Pathak, B. G., Sinha, B., Sharma, N., Mazumder, S. & Bhandari, N. Effects of kangaroo mother care on maternal and paternal health: systematic review and meta-analysis. *Bull. World Health Organ.* **101**, 391-402G (2023).
29. Ross, E. S. *et al.* Early growth faltering in healthy term infants predicts longitudinal growth. *Early Hum. Dev.* **85**, 583–588 (2009).
30. Della Longa, L., Dragovic, D. & Farroni, T. In Touch with the Heartbeat: Newborns' Cardiac Sensitivity to Affective and Non-Affective Touch. *Int. J. Environ. Res. Public Health* **18**, (2021).
31. Feldman, R., Magori-Cohen, R., Galili, G., Singer, M. & Louzoun, Y. Mother and infant coordinate heart rhythms through episodes of interaction synchrony. *Infant Behav. Dev.* **34**, 569–577 (2011).
32. Oliveira, V. *et al.* Early Postnatal Heart Rate Variability in Healthy Newborn Infants. *Front. Physiol.* **10**, 922 (2019).