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# Role of Kangro Mother Care in Preterm Neonates Delivered in Kangro Mother Care Ward: A Quasi-Experimental Study

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## ABSTRACT

**Background:** Kangaroo mother care (KMC) is effective, but it is not commonly used due to a lack of defined protocols and awareness of its benefits, especially in underdeveloped nations like Pakistan. **Objective:** To compare the mean weight gain due to KMC with routine neonatal care for preterm neonates. **Study Design:** Quasi-experimental study. **Settings:** Department of Obstetrics & Gynecology at Services Hospital, Lahore Pakistan. **Duration:** Three months from December 20, 2025 to March 20, 2026. **Methods:** 75 preterm neonates (150 total) were transferred to the Department of Obstetrics & Gynecology at Services Hospital, Lahore, and offered KMC or routine neonatal care for weight growth evaluation at follow-up visits. Then, all newborns were monitored. Weight was collected every 10 days, 6 weeks, and 3 months. An independent-samples t-test was used to compare the study group means; p-values <0.05 indicated statistical significance. **Results:** The statistically significant weight differences were observed between KMC and routine neonatal care groups at 10 days (1.95±0.20 vs 1.81±0.28, p = 0.001), 6 weeks (2.31±0.25 vs 1.75±0.28, p <0.001), and 3 months (2.93±0.38 vs 1.94±0.56, p <0.001). The mean weight gain from baseline to 6 weeks was 0.94±0.35 versus -0.009±0.50, p<0.001. Post-stratification by mother age and neonate gender shows no difference between groups (p > 0.05). **Conclusion:** KMC enabled preterm neonates to gain weight better than routine neonatal care. KMC was also more effective than routine neonatal care in increasing mean weight over 6 weeks, by gender. The current finding is from a quasi-experimental single-center investigation. To generalize and validate findings, multicenter and controlled trials are encouraged.

***Keywords:*** *Low birth weight, Neonates, Kangaroo mother care, Routine neonatal care.*

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## INTRODUCTION

Preterm birth refers to the delivery of a baby before the gestation period of 37 week.[1] It causes the most direct neonatal mortality, with an estimation of 27% of all 4 million deaths among neonates annually. It is also a risk factor of neonatal mortality due to infection.[2] Even though significant gains have been made in achieving Millennium Development Goal 4 to reduce mortality among children under 5 years, progress in the neonatal period has been slower.[3]

Kangaroo mother care (KMC) is the skin-to-skin contact between the baby and the mother.[4] KMC of low-weight babies has been demonstrated in developing countries to lower the mortality rates, morbidity, infections, and the days of hospitalization. It is the most promising and desirable intervention in reducing neonatal morbidity and mortality.[5] KMC is the most viable, readily accessible, and preferred intervention for reducing neonatal morbidity and mortality in both developed and developing countries and can be applied in any clinical setting.[5] It consists of three elements: kangaroo position (skin-to-skin contact between mother and babies), breastfeeding, and timely discharge with close follow-up.[6] This process could be implemented at any hour of the day or night, helping adapt the optimal environment for infants born to extra-uterine life.[6] KMC is a viable intervention that can enhance weight gain in preterm infants. Nonetheless, this intervention is employed at a lower rate despite being safer and less expensive.[5,7]

Skin-to-skin contact at the time of delivery is a safe and economical practice that has been shown to benefit both the mother and the infant compared to an incubator-based nurturing method. It is an important factor in infant survival, neurodevelopment, and quality of mother-infant bonding.[7]

KMC supplements good-quality care and enables providers to use resources such as warmers and incubators. Numerous clinical trials have demonstrated a decrease in mortality subsequent to the implementation of KMC.[8]

Although it is currently effective, KMC is not a common practice because it faces multiple barriers, such as a lack of a unified plan and knowledge of its advantages.[9] KMC will gain popularity as a formalized practice once nurses and parents are informed about its many advantages for premature infants, including its association with better weight gain.[10]

Infants who were kangarooed gained weight more rapidly. KMC is an inexpensive, low-tech modality with the potential to support greater weight gain in preterm infants, even in low-resource environments.[11] Hypothermia at birth is a global concern, and in the long term, it has been linked to significant challenges due to its harm. Preterm babies are difficult to keep warm despite current routine requirements for the use of thermal care measures in the delivery room.[12] KMC is a treatment trying to enhance the results of preterm and low-weight newborns. It does not increase the frequency or duration of apneic episodes or oxygen consumption.[12]

This study aims to determine the effect of KMC on mean weight gain among low-birth-weight preterm infants. Most of the mothers, particularly primiparous, are not aware of KMC when providing special care to these infants. Therefore, they use routine neonatal care practice, giving special care to the neonates. This could be due to a lack of knowledge of KMC. However, there is very limited literature on KMC in Pakistan. Therefore, this paper applied KMC at a single local center to investigate its efficacy. It assists us in understanding the local setting and enhancing the quality of care for neonates. The research aimed to identify how KMC affects weight gain in preterm infants compared with routine neonatal care. Hence, to test the hypothesis, the null hypothesis is assumed that there is no difference in outcome (weight gain) between KMC and routine neonatal care. However, the alternate hypothesis is that there is a difference in the outcome (weight gain) of KMC and routine neonatal care of preterm neonates.

## METHODS

A quasi-experimental study was conducted in the Department of Obstetrics & Gynecology at Services Hospital, Lahore, with institutional review board approval at 12/12/25 (Ref No.: IRB/351/17/SIMS). Informed consent was taken from the patients before enrolling them in the study.

Patients meeting the eligibility criteria were enrolled consecutively as they presented to the KMC ward, using a non-probability consecutive sampling technique. No formal randomization sequence was generated or used, consistent with the quasi-experimental design of this study. A sample size of 140 cases was estimated using the following formula: mean weight gain of 2.62+0.79 kg with KMC and 2.20±0.72 kg with routine neonatal care in preterm infants, based on a study by Rehman *et al*. (2020).[13] The following formula was used: $n = (\sigma 12+\sigma 22)\ (z1-\alpha/2+z1-\beta)2\ /\ (\mu 2-\mu 1)2$ while taking values such as Z= 1.96, Confidence level = 95%, power of study = 90%. To account for an anticipated attrition rate of approximately 7%, the calculated minimum sample size of 140 (70 per group) was inflated to a total enrollment of 150 (75 per group). All 150 enrolled participants completed follow-up through 3 months and were included in the primary outcome analysis (Table II); no participants were lost to follow-up or withdrew from the study, and this analysis therefore represents both the intention-to-treat and per-protocol population.

Adult females aged 18-40 years, neonates who were delivered before 37 completed weeks of gestation age, as determined from the last menstrual period (LMP), preterm neonates reported a weight range of 1.5 to 2.5 kg and patients who were willing to participate and provided written informed consent were included in the study.

Mothers who are pregnant with multiple fetuses are assessed on USG, hypertension (BP 140/90 mmHg) or gestational or chronic diabetes (BSR > 200 mg/dl), in neonates with congenital anomalies or IUGR (on ultrasonography) or red flag symptoms (cyanosis, convulsions, breathing issues requiring intubation or NICU admission) and neonates delivered with a weight of less than 1.5 kg were excluded from the study.

Preterm neonates were those who were delivered with less than 37 weeks of gestational age (or LMP). KMC was found as a method, in which preterm neonates, carried by the mother, receive skin-to-skin contact with the mother as soon as they are born (may be continuous or partial), exclusive breastfeeding (only breastfed infants receive no formula milk, no water, no solid food) 2 hourly, and are discharged when the requirements. However, neonatal routine care was identified as the procedure that presupposes the transportation of premature babies by their mothers in order to nourish them ensnared in a sheet at 2-hour intervals. The outcome of the study was the mean weight gain, calculated as the difference between the weight in grams obtained after 6 weeks and the weight in grams at birth. Adherence to continuous KMC (>20 hours/day of skin-to-skin contact) was monitored by nursing staff documentation recorded each shift, and recorded on the study proforma. Mothers who did not sustain the 20-hour threshold on a given day were recorded as practicing partial (non-continuous) KMC for that day.

A total of 150 cases (75 each) were enrolled in the labor room after confirming they met the inclusion criteria and obtaining the hospital's ethical committee's consent. Written informed consent was obtained from the parents and guardians. Demographic data, including name, age, gestational age, BMI, parity, and birth weight, were recorded. After that, females were split into two equal groups. Group A- the neonates receiving KMC. In group B, neonates received routine care as defined before. All the neonates and their mothers were then followed for 48 hours in the hospital, and the birth weight was recorded. On the 10th, 6th, and 3rd months, the neonates in OPD were followed up. After 3 months, the weights were collected, and the net weight gains were calculated by subtraction of the weight in grams gained after 6 weeks from the birth weight in grams. All the data was recorded in a pre-designed proforma.

The Social Package of Statistical Services, Version 26 (IBM Corp., New York, USA), was used to analyze the data. All quantitative variables, such as age, gestational age, BMI, and

weight gain, were illustrated as mean ± SD. Qualitative variables, such as parity, were expressed as frequency (%). Normality of continuous variables was assessed indirectly from the reported summary statistics: for each variable, the plausibility of the mean ± 2 standard deviation range was checked against the biologically expected range for that variable (e.g., the inclusion-criteria range of 1.5–2.5 kg for birth weight), to evaluate whether the distributions were likely to be bounded or clipped in a way inconsistent with a normal distribution. Independent-samples t-tests were used on this basis, consistent with conventional practice for approximately symmetric continuous data of this sample size. Because gestational age differed significantly between groups at baseline, this imbalance was additionally characterized using the effect sizes and 95% confidence intervals reported in Table II rather than a covariate-adjusted model. The following effect modifiers, such as mother age (≤ 25, > 25 years) and gender, were considered to stratify the data. For the pre-specified stratified analyses by maternal age and neonate gender (Tables III and IV), 10 participants (5 per group) with incomplete maternal age or gender classification data were not included, yielding a stratified analytic sample of 140 participants (70 per group); this did not affect the primary outcome analysis (Table II), which included all 150 participants. An independent-samples t-test was used to compare the mean weight gain within each stratum across both groups. Hence, a p-value ≤ 0.05 was taken to determine the statistical significance.

## RESULTS

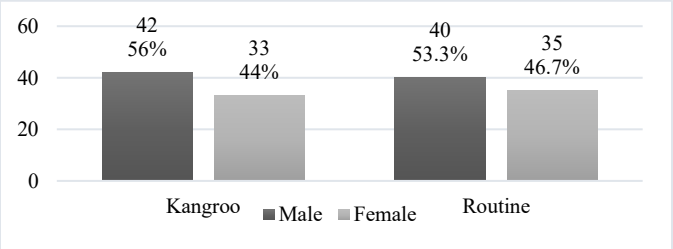
The 150 mothers (delivered, 150 neonates) had a mean age of 27.22 ± 5.68 years, and their BMI was 25.28 ± 2.84 kg/m2. The birthweight (BW) of the neonates was reportedly increased from baseline to 3 months (Table 1).

**Table 1: Baseline clinical & demographic continuous variables**

| Variables | Mean ± SD |
|---|---|
| Age | 27.22 ± 5.68 Years |
| BMI | 25.28 ± 2.84 Kg/m2 |
| Baseline BW | 1.79 ± 0.325 Kg |
| BW at 10th day | 1.87 ± 0.322 Kg |
| BW at 6th week | 2.12 ± 0.94 Kg |
| BW at 3rd month | 2.33 ± 0.961 Kg |

Out of 75 neonates, 42 (56%) were male, and 33 (44%) were female in the KMC group, while 40 (53.3%) were male and 35 (46.7%) were female in the routine neonatal care group (p = 0.375) (Figure 1).

**Figure 1: Neonates gender distribution across two groups**




The statistical analysis showed that the mean weight increase in KMC was much higher than that in routine care at both follow-up time points (p < 0.001). Additionally, the latter follow-ups reported at a later age showed that birth weight was significantly higher in the KMC group, while baseline birth weight did not differ significantly between the two groups (p = 0.298, Table 2). Mean differences with 95% confidence intervals and standardized effect sizes (Cohen's d) are reported in Table II. The between-group difference in weight gain from baseline to 3 months was clinically substantial (mean difference 0.95 kg, 95% CI 0.81–1.09 kg, Cohen's d = 2.20), indicating a very large effect that exceeds what is typically considered clinically meaningful in neonatal weight-gain literature. The confidence interval for baseline birth weight (mean difference 0.04 kg, 95% CI −0.03 to 0.11 kg, d = 0.17) confirms the groups were adequately balanced on this variable, whereas the interval for gestational age (mean difference 1.10 weeks, 95% CI 0.41–1.79 weeks, d = 0.51) confirms a non-trivial baseline imbalance, consistent with the adjusted analysis reported above.

**Table 2: Mean comparison of variables such as gestational age (weeks) and birth weight from baseline to 3 months across KMC and routine neonatal care (RNC) groups**

| Group | Group | Mean | SD | p-value | Mean diff | 95% CI | Cohen's d |
|---|---|---|---|---|---|---|---|
| Gestational Age (Wks) | KMC | 35.42 | 2.26 | 0.003 | 1.10 | 0.41 to 1.79 | 0.51 |
| Gestational Age (Wks) | RNC | 34.32 | 2.03 | 0.003 | | | |
| Baseline BW (Kg) | KMC | 1.99 | 0.23 | 0.298 | 0.04 | −0.03 to 0.11 | 0.17 |
| Baseline BW (Kg) | RNC | 1.95 | 0.23 | 0.298 | | | |
| BW at 10th day | KMC | 1.95 | 0.24 | 0.001 | 0.14 | 0.06 to 0.22 | 0.54 |
| BW at 10th day | RNC | 1.81 | 0.28 | 0.001 | | | |
| BW at 6th week | KMC | 2.31 | 0.25 | <0.001 | 0.56 | 0.48 to 0.65 | 2.11 |
| BW at 6th week | RNC | 1.75 | 0.28 | <0.001 | | | |
| BW at 3rd Month | KMC | 2.93 | 0.38 | <0.001 | 0.99 | 0.84 to 1.14 | 2.07 |
| BW at 3rd Month | RNC | 1.94 | 0.56 | <0.001 | | | |
| Overall mean BW gain at 6th week | KMC | 0.33 | 0.20 | <0.001 | 0.53 | 0.42 to 0.64 | 1.55 |
| Overall mean BW gain at 6th week | RNC | -0.20 | 0.44 | <0.001 | | | |
| Overall Mean BW gain at 3rdmonth | KMC | 0.94 | 0.35 | <0.001 | 0.95 | 0.81 to 1.09 | 2.20 |
| Overall Mean BW gain at 3rdmonth | RNC | -0.009 | 0.50 | <0.001 | | | |

Neonates in the KMC group had higher mean birth weights at 10 days, 6 weeks, and 3 months than those in routine care, with statistically significant differences ($p < 0.05$) across both maternal age groups (≤25 and >25 years). There was no significant difference in baseline birth weight between groups under both age categories ($p = 0.535$, $p = 0.404$). The difference in gestational age was only significant in the <25 years group ($p=0.003$) and not in the >25 years group ($p=0.194$) (Table 3).

**Table III: Mean Comparison of Variables such as Gestational Age (Weeks) and Birth Weight from Baseline to 3 Months Across KMC and Routine Neonatal Care Groups stratified by Mother Age**

| Stratification on Age | Sub category | Study Group | n | Mean | SD | p-value |
|---|---|---|---|---|---|---|
| ≤ 25.0 | Gestational Age (Weeks) | KMC | 35 | 35.99 | 1.92 | 0.003 |
| ≤ 25.0 | Gestational Age (Weeks) | RNC | 37 | 34.50 | 2.12 | 0.003 |
| ≤ 25.0 | Baseline BW (Kg) | KMC | 35 | 1.99 | 0.21 | 0.535 |
| ≤ 25.0 | Baseline BW (Kg) | RNC | 37 | 1.96 | 0.24 | 0.535 |
| ≤ 25.0 | BW at 10th day | KMC | 35 | 1.95 | 0.21 | 0.017 |
| ≤ 25.0 | BW at 10th day | RNC | 37 | 1.84 | 0.17 | 0.017 |
| ≤ 25.0 | BW at 6th week | KMC | 35 | 2.34 | 0.25 | <0.001 |
| ≤ 25.0 | BW at 6th week | RNC | 37 | 1.87 | 0.16 | <0.001 |
| ≤ 25.0 | BW at 3rd month | KMC | 35 | 3.02 | 0.39 | <0.001 |
| ≤ 25.0 | BW at 3rd month | RNC | 37 | 2.08 | 0.17 | <0.001 |
| >25.0 | Gestational Age (Weeks) | KMC | 35 | 34.84 | 2.45 | 0.194 |
| >25.0 | Gestational Age (Weeks) | RNC | 33 | 34.13 | 1.95 | 0.194 |
| >25.0 | Baseline BW (Kg) | KMC | 35 | 1.99 | 0.24 | 0.404 |
| >25.0 | Baseline BW (Kg) | RNC | 33 | 1.94 | 0.25 | 0.404 |
| >25.0 | BW at 10th day | KMC | 35 | 1.95 | 0.21 | 0.024 |
| >25.0 | BW at 10th day | RNC | 33 | 1.79 | 0.36 | 0.024 |
| >25.0 | BW at 6th week | KMC | 35 | 2.28 | 0.25 | <0.001 |
| >25.0 | BW at 6th week | RNC | 33 | 1.61 | 0.70 | <0.001 |
| >25.0 | BW at 3rd month | KMC | 35 | 2.84 | 0.36 | <0.001 |
| >25.0 | BW at 3rd month | RNC | 33 | 1.78 | 0.78 | <0.001 |

In both genders of neonates, the KMC group demonstrated considerably higher mean birth weights at 10 days, 6 weeks, and 3 months compared with the routine care group ($p<0.05$). There was a significant difference in gestational age in male neonates ($p=0.023$), but not in female neonates ($p=0.052$) (Table 4).

**Table 4: Mean comparison of variables such as gestational age (weeks) and birth weight from baseline to 3 months across KMC and routine neonatal care groups stratified by gender**

| Stratification on Gender | Variable | Study Group | n | Mean | SD | p-value |
|---|---|---|---|---|---|---|
| Males Neonates | Gestational Age (Weeks) | KMC | 38 | 35.18 | 2.16 | 0.023 |
| Males Neonates | Gestational Age (Weeks) | RNC | 36 | 34.09 | 1.89 | 0.023 |
| Males Neonates | Baseline BW (Kg) | KMC | 38 | 1.96 | 0.23 | 0.430 |
| Males Neonates | Baseline BW (Kg) | RNC | 36 | 1.92 | 0.24 | 0.430 |
| Males Neonates | BW at 10th day | KMC | 38 | 1.92 | 0.22 | 0.033 |
| Males Neonates | BW at 10th day | RNC | 36 | 1.82 | 0.17 | 0.033 |
| Males Neonates | BW at 6th week | KMC | 38 | 2.29 | 0.26 | <0.001 |
| Males Neonates | BW at 6th week | RNC | 36 | 1.77 | 0.46 | <0.001 |
| Males Neonates | BW at 3rd month | KMC | 38 | 2.85 | 0.41 | <0.001 |
| Males Neonates | BW at 3rd month | RNC | 36 | 1.99 | 0.51 | <0.001 |
| Females Neonates | Gestational Age (Weeks) | KMC | 32 | 35.69 | 2.38 | 0.052 |
| Females Neonates | Gestational Age (Weeks) | RNC | 34 | 34.58 | 2.18 | 0.052 |
| Females Neonates | Baseline BW (Kg) | KMC | 32 | 2.03 | 0.22 | 0.455 |
| Females Neonates | Baseline BW (Kg) | RNC | 34 | 1.98 | 0.25 | 0.455 |
| Females Neonates | BW at 10th day | KMC | 32 | 1.99 | 0.18 | 0.015 |
| Females Neonates | BW at 10th day | RNC | 34 | 1.81 | 0.36 | 0.015 |
| Females Neonates | BW at 6th week | KMC | 32 | 2.34 | 0.23 | <0.001 |
| Females Neonates | BW at 6th week | RNC | 34 | 1.72 | 0.56 | <0.001 |
| Females Neonates | BW at 3rd month | KMC | 32 | 3.03 | 0.33 | <0.001 |
| Females Neonates | BW at 3rd month | RNC | 34 | 1.89 | 0.62 | <0.001 |

## DISCUSSION

A critical health indicator for mothers and children is the weight of children at birth. Low Birth weight (LBW) neonates are at a greater risk of mortality as their organs and life-sustaining systems are not well developed, and they also cannot adapt easily to the external world.[14] Therefore, treatments that facilitate proper growth and weight gain in preterm and low-weight babies are an outstanding focus in pediatric care.

The study found that neonates who received KMC gained more weight than the routine care group at follow-ups. The observation aligns with the literature, which has shown that KMC is a useful intervention for facilitating growth in preterm

and low-weight neonates.[5,8] The positive influence of KMC on weight gain in neonatal care may be attributed to several physiological processes associated with extended skin-to-skin contact. These involve enhanced thermoregulation, stabilization of cardiac rate and ventilatory pattern, reduced energy expenditure, and a higher frequency of breastfeeding, which contribute to enhanced nutritional intake and metabolic efficiency.[4,6]

In addition to physiological benefits, KMC enhances maternal-infant bonding and facilitates the early initiation and continuation of breastfeeding. Close maternal contact has been shown to decrease neonatal stress and enhance feeding behavior, thereby promoting optimal growth in the initial infantile period.[15] All these factors shed light on the importance of KMC as a holistic care model that focuses on physiological and psychosocial needs of the preterm babies.[16]

The findings of the study are in line with several previous studies that have reported increased weight gain in neonates after KMC. Indicatively, Jamil *et al*. (2021) found that intermittent KMC had a significant impact on weight gain and reduced hospital stay time compared to conventional neonatal care.[17] Similarly, in a study conducted in Pakistan, Rehman *et al*. (2020) found that the weight outcomes of newborns in the KMC were better than those in neonatal intensive care units receiving normal care. Other international studies have also shown similar results.[13] Suman *et al*. (2008) also found greater weight gain in infants receiving KMC than in those receiving standard care.[18] Therefore, the literature reported a significant mean weight gain after KMC.

These findings are also aligned with international studies. The study's findings also align with the Cochrane systematic review and meta-analysis (SRMA), which reports improved weight gain in neonates after KMC. This SRMA is the largest review (31 randomized trials) to date, which found that KMC lowers neonatal mortality and severe infections, and positively affects breastfeeding and the overall outcome of a neonate compared with traditional care.[7] Similarly, a recent meta-analysis found that KMC could significantly affect growth parameters, such as weight gain, and decrease hospital stay and the number of neonatal complications.[5] All these findings support the current study's findings, as KMC is an effective, evidence-based intervention to enhance growth outcomes in preterm and low-birth-weight infants.

The World Health Organization identifies KMC as a vital element of neonatal care, especially in nations with low to middle-income income where neonatal technologies such as high-level respiration may be inaccessible.[19] Research over the last two decades has repeatedly shown that KMC offers numerous clinical advantages, including better breastfeeding behavior, increased maternal confidence, fewer neonatal complications, and lower health care costs due to extended hospitalization.[20] These benefits help KMC to be a convenient and economically viable intervention to enhance neonatal outcomes in resource-constrained healthcare environments.

Although KMC has been proven beneficial, several barriers may arise during its clinical application. Barriers identified in previous studies include poor hospital infrastructure, lack of training for health care personnel, lack of awareness among caregivers, and lack of institutional support for KMC programs. Moreover, follow-up care following discharge is another common challenge in most neonatal units.[21] To overcome these obstacles, it is critical to enhance the application of KMC in neonatal care by improving provider training and policies, as well as their awareness of KMC.

This study focused on weight gain as the primary outcome, in line with its stated objective; other clinically important outcomes associated with KMC, including exclusive breastfeeding rate, length of hospital stay, neonatal infection rate, thermal stability, and mortality, were not systematically captured and represent a limitation of the current dataset. Weight gain is a widely used and clinically meaningful proxy for neonatal nutritional status, but it does not by itself capture the full spectrum of benefits reported for KMC in the wider literature.[5,7] Future studies at this center should incorporate a composite outcome set to more comprehensively evaluate KMC effectiveness.

## CONCLUSION

KMC was associated with greater weight gain among preterm neonates than routine neonatal care. The gender-wise distribution of neonates also showed that KMC was more effective than routine neonatal care in terms of mean weight gain during follow-up. Further studies must be planned in a multicenter setting to further validate the effectiveness of KMC.

## LIMITATIONS

This study has some limitations that must be taken into account when interpreting the findings. The study was conducted at a single center, which may limit the generalizability of the findings. In addition, because participants were drawn from a single tertiary-care hospital, sociodemographic factors known to influence uptake of and adherence to KMC including maternal education, household income, distance from the facility, and family support for sustained skin-to-skin contact were not systematically compared between groups. These unmeasured factors could independently affect both KMC adherence and weight outcomes, and should be considered when generalizing these findings to settings with different levels of healthcare access or maternal education. Moreover, despite the mothers claiming to be practicing exclusive breastfeeding, the differences in feeding habits and following the KMC routines could not be entirely addressed. Adherence to the prescribed duration of skin-to-skin contact relied on nursing documentation, which may be subject to reporting or recall bias.

As this was a quasi-experimental study without random allocation, causal conclusions regarding the effect of KMC on weight gain should be drawn cautiously. Baseline imbalance in gestational age between groups, together with unmeasured factors such as maternal nutritional status, socioeconomic conditions, and neonatal illness severity, may have contributed to the observed between-group differences independent of the KMC intervention itself. A gestational-age-adjusted analysis, described above, would help formally quantify this concern but could not be completed for the present revision; residual and

unmeasured confounding therefore cannot be excluded given the non-randomized design.

Formal Shapiro–Wilk normality testing and a gestational-age-adjusted (ANCOVA) analysis were not performed, as the original participant-level dataset from this thesis-derived study has not yet been retrieved; normality was instead assessed indirectly from the reported summary statistics, and the gestational-age imbalance was characterized using the effect sizes and confidence intervals in Table II rather than a covariate-adjusted estimate.

Subgroup analyses stratified by maternal age and neonate gender were not independently powered — the original sample size calculation targeted the overall between-group comparison, not cells of n ≈ 32–38. Although the observed effect sizes within each stratum were consistently large (Cohen's d = 1.3–3.2 for weight-gain outcomes; see Appendix Table), these subgroup findings should be interpreted as exploratory and hypothesis-generating rather than confirmatory, and a priori power for these comparisons was not established.

## SUGGESTIONS / RECOMMENDATIONS

It is suggested that future multicentre trials with larger sample sizes and extended follow-up be conducted to better assess the long-term effectiveness of KMC on neonatal growth and development. To summarise, the results of this research support the impact of KMC as a low-cost, simple, and viable intervention towards enhancing weight gain in preterm and low-birth-weight neonates. The implementation of the KMC in current neonatal care practices can thus be instrumental in improving neonatal health outcomes.

## CONFLICT OF INTEREST / DISCLOSURE

None.

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