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Effectiveness of Preterm Infant Oral Motor Intervention (PIOMI) with Kangaroo Mother Care (KMC) among Preterm Neonates

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Abstract

Preterm birth defined as neonates born before 37 weeks of pregnancy is a major concern. These neonates are more likely to have both immediate and long-term health issues. A common problem in preterm neonates is feeding difficulties, primarily due to their inability to suck, breathe, and swallow. To address these difficulties, a combined intervention Preterm Infant Oral Motor Intervention (PIOMI) with Kangaroo Mother Care (KMC) was introduced to enhance breast feeding efficiency. To evaluate the combined effectiveness of PIOMI and KMC in enhancing latching efficiency and weight gain among preterm neonates. This single-group repeated-measures study designed to evaluate feeding and weight gain in preterm neonates who received 6-week intervention of PIOMI with KMC. The LATCH score and weight were assessed at baseline, 2nd, 4th, and 6th week. A total of 50 preterm neonates were enrolled and all of whom completed the intervention protocol. A one-way repeated measures ANOVA results showed a significant time effect ($F(2.563) = 238.08$ $p < 0.0001$, $\eta p^2 = 0.829$), suggesting that the intervention had a significant effect on preterm neonates' ability to feed. Post-hoc comparisons showed improved latch score and weight gain across all-time intervals ($p < 0.0001$), reflecting a constant increase over the period of intervention. The structured intervention was found to be effective in improving weight gain and breastfeeding efficiency in preterm neonates. These results support the understanding that structured developmentally supportive interventions like PIOMI and KMC can be implementor in resource-constrained neonatal care settings.

Keywords: Child Wellbeing, Feeding Interventions, Health Policy Implementation, Kangaroo Mother Care (KMC), Preterm Infant Oral Motor Intervention (PIOMI), Preterm Neonates.

Introduction

Preterm birth, defined as birth before 37 weeks of gestation, is a major concern (1). These neonates are more likely to have both immediate and long-term health issues. A common problem in preterm neonates is feeding difficulties, primarily due to their inability to suck, breathe, and swallow (2, 3). As a result, many of these babies require tube feeding for longer periods of time, which can delay breastfeeding and have an impact on their development (4, 5). Targeted interventions have been developed to support the feeding development of preterm infants in order to address these issues. One such strategy is the Preterm Infant Oral Motor Intervention (PIOMI) a quick structured oral stimulation method designed specifically for stable preterm infants who are medically stable (6). By stimulating the lips, cheeks, tongue, jaw, and palate muscles. PIOMI enhances oral motor coordination and prepares the baby for safe and efficient oral feeding (7). PIOMI has been shown in studies to better weight gain, increased feeding efficiency, and a faster transition from tube feeding to full oral feeding (8). Another approach that shows efficient preterm care is Kangaroo Mother Care (KMC) (9). This approach encourages exclusive breastfeeding and skin-to-skin contact between the caregiver and the infant (10). According to World Health Organization (WHO), KMC is considered one of the most effective interventions to improve survival, lower infection rates, and promote growth and development in low birth weight and preterm infants (11). Along with promoting bonding and increasing the likelihood of a successful breast-

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feeding, KMC also aids in regulates the baby's body temperature, heart rate and breathing (12). KMC establishes a supportive environment that encourages breastfeeding behaviour and physiological stability, whereas PIOMI concentrates on enhancing the infant's oral motor readiness (13, 14). When combined these interventions may provide more advantages than applied separately. However, the effectiveness of PIOMI in clinical practice when combined with KMC has not been thoroughly studied.

There is a knowledge gap regarding the combined effect of these interventions on feeding outcomes in preterm neonates, as most current research examines them separately. Feeding difficulties in preterm neonates represent not merely a functional impairment but a critical developmental bottleneck that influences growth, neurobehavioral organization, and readiness for hospital discharge (2, 4, 15, 16). Conceptually, feeding competence in preterm infants emerges from the dynamic interaction between oral motor maturation, autonomic regulation, behavioural state control, and caregiver–infant co-regulation (2, 15). Disruptions in any of these domains may delay the transition to effective oral feeding and prolong hospitalization (4, 17). While Preterm Infant Oral Motor Intervention (PIOMI) primarily targets the sensorimotor and neuromuscular components of feeding readiness by enhancing orofacial coordination and suck–swallow–breathe integration (7, 18-20), Kangaroo Mother Care (KMC) addresses higher-order physiological and affective regulation through continuous multisensory stimulation, autonomic stabilization, and caregiver involvement (21-24). Despite strong evidence supporting each intervention individually (8, 9, 25), there is limited empirical work that situates their combined application within a unified developmental framework. This conceptual gap underpins the present study, which examines whether integrating PIOMI with KMC can more effectively address the multidimensional nature of feeding immaturity in preterm neonates. From a neurodevelopmental and physiological perspective, PIOMI and KMC are expected to exert additive and potentially synergistic effects on feeding outcomes in preterm neonates. PIOMI provides targeted oromotor and sensorimotor stimulation that enhances cranial nerve activation, orofacial muscle coordination, and maturation of the suck–swallow–breathe pattern, which are frequently underdeveloped in preterm infants. In contrast, Kangaroo Mother Care offers continuous multisensory input through skin-to-skin contact, promoting autonomic stability, behavioural state regulation, and improved feeding readiness. The integration of bottom-up sensorimotor stimulation (PIOMI) with top-down affective and physiological regulation (KMC) may create an optimal neurobehavioral environment for feeding, thereby accelerating oral feeding maturation and improving breastfeeding efficiency beyond the effect of either intervention alone (13, 14).

Feeding success is a key determinant of hospital discharge readiness and overall health in preterm infants (15, 16). In addition to delaying discharge, difficulties in initiating and maintaining breastfeeding can lead to stunted growth and long-term developmental problems (17). Treatments that promote early and effective breastfeeding in preterm infants are crucial to achieving the WHO's recommendation of exclusive breastfeeding be used for the first six months of life (18).

Therefore, the primary objective of this study was to evaluate the effect of a combined Preterm Infant Oral Motor Intervention (PIOMI) and Kangaroo Mother Care (KMC) on weight gain and breastfeeding effectiveness in preterm neonates, assessed using longitudinal body weight measurements and the LATCH scoring system. A secondary objective was to examine the feasibility of this integrated, low-cost intervention approach in the neonatal intensive care unit (NICU) setting. The results may support evidence-based strategies that promote early oral feeding and improve the development and health of this vulnerable population.

Methodology

This single-group repeated-measures study was designed to evaluate feeding and weight gain in preterm neonates who received 6-week intervention of Preterm Infant Oral Motor Intervention (PIOMI) and Kangaroo Mother Care (KMC). A single-group repeated-measures study design was employed to allow each participant to serve as their own control, thereby reducing inter-individual variability associated with differences in gestational age, physiological maturity, and clinical status among preterm neonates. This design is particularly appropriate for early-phase

clinical investigations in neonatal intensive care settings, where ethical and logistical constraints may limit the feasibility of randomized controlled trials. Repeated assessment of outcomes across multiple time points enables robust evaluation of within-subject temporal changes in feeding performance and weight gain attributable to the intervention, while optimizing statistical power in studies with limited sample sizes. The Neonatal Critical Care Unit (NICU) at Saveetha Medical College and Hospital served as the study's setting. Prior to the commencement of the study Institutional Scientific Review Board on Human Subjects approval was acquired and all parents or guardians provided written informed consent. A consecutive sampling method was used, wherein all eligible preterm neonates admitted to the Neonatal Intensive Care Unit during the study period were recruited consecutively until the required sample size was achieved, thereby minimizing selection bias and enhancing the validity and replicability of the findings. A total of 50 preterm neonates who met the eligibility criteria were consecutively recruited after obtaining written informed consent from their parents or legal guardians.

Inclusion Criteria

Neonates were eligible for inclusion if they were born preterm with a gestational age between 26 and 33 completed weeks, were clinically stable at the time of enrolment, and had initiated oral feeding. Additional eligibility criteria included a birth weight greater than 1000 grams and a minimum baseline LATCH score of ≥3, indicating partial readiness for breastfeeding and the ability to safely participate in the intervention protocol.

Exclusion Criteria

Neonates were excluded if they had major congenital anomalies, craniofacial malformations, or neurological impairments that could interfere with oral feeding. Infants with neonatal sepsis, severe respiratory distress, or those requiring mechanical ventilation at the time of enrollment were also excluded. To avoid confounding effects, neonates receiving any concurrent oral motor or oral stimulation therapy other than the study intervention were not included. Additionally, neonates were excluded if parental or legal guardian consent was not provided.

Sample Size Calculation

The sample size required for a repeated measure ANOVA with post hoc power analysis (1 group, 4 time points) was estimated using G*Power 3.1.9.7 with an effect size of 0.25, $\alpha = 0.05$, and sample size = 50 showed a power of 0.9919.

Preterm neonates received both Premature Infant Oral Motor Intervention (PIOMI) and the Kangaroo Mother Care (KMC). A trained therapist administered PIOMI once a day for approximately 5 minutes and 2 to 3 hours of KMC, delivered 6 days per week over a period of 6 weeks. On average, the neonates received 35.20 sessions during the study, with a standard deviation of 0.90, reflecting consistent adherence to the intervention schedule.

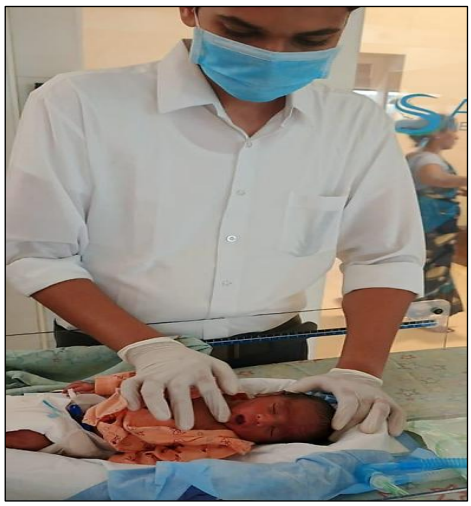

Figure 1: Therapist Providing C-Stretch Technique to Promote Oral Flexibility in a Preterm Neonate

Figure 2: Therapist Performing Gentle Gum Massage on a Preterm Neonate

Figure 3: Therapist Administering Palate Stimulation to a Preterm Neonate

Figure 4: Parent Administering Kangaroo Mother Care (KMC) to a Preterm Neonate

During the intervention period, Preterm Infant Oral Motor Intervention (PIOMI) combined with Kangaroo Mother Care (KMC) was administered with the neonate maintaining in a midline position, the head gently flexed, and the chin slightly tucked to promote postural stability and neuromuscular relaxation (19). A planned sequence of mild oral stimulations was used in each session. After 30 seconds of gentle C-shaped strokes along the infant's cheeks followed by slow deliberate motions to roll and stretch the upper and lower lips (Figure 1). This was then followed by a gentle gum massage, also lasting approximately 30 seconds (Figure 2).

Gentle stimulation was applied for approximately 15 seconds along the sides of the tongue and the inside of the cheeks, followed by 30 seconds across the middle of the tongue and along the hard palate (Figure 3). After that the baby was gently stimulated for 15 seconds to promote their innate sucking reflex. To encourage bonding and feeding readiness, a two-minute non-nutritive sucking

period was offered at the mother's breast to end the session. A pacifier or the gloved finger of a caregiver was utilized as a suitable substitute for the mother when mother was unavailable. PIOMI sessions lasted approximately five minutes each and were conducted once a day for a period of six weeks.

Immediately following PIOMI, Kangaroo Mother Care (KMC) was provided to ensure warmth, support, and constant contact (Figure 4). The neonates were placed upright between the mother's or caregivers' breasts, skin-to-skin on bare chest, and securely wrapped in a cloth (20). KMC was offered for at least an hour each session throughout the course of the intervention, the combined PIOMI and KMC approach was continuously used to improves oromotor development, encourage feeding readiness, boost general growth, and physiological stability in preterm neonates.

Statistical Analysis

Data were analysed using IBM SPSS Statistical Software version 22.0 (IBM Corp., Armonk, New York, United States). To summarize the results at each of the four time points, descriptive statistics such as mean and standard deviation were employed. Normality of data distribution was assessed using the Shapiro–Wilk test. A repeated measures Analysis of Variance (RM-ANOVA) was performed to assess changes over time. Bonferroni-adjusted post hoc comparisons were used to identify specific differences between the time points when significant effects were observed. The P value for time interaction was set at $P<0.0125$ (0.05/4) (21). Partial eta squared (ηp^2) was used to calculate effect sizes to indicate the strength of intervention's impact was used for the statistical analyses. P-value were set at $P<0.05$.

Results

Demographic and Clinical Characteristics of Neonates and Mothers

A total of 50 preterm neonates were enrolled and all of whom completed the intervention protocol. The gestational range was 26 to 33 weeks with a mean gestational age at birth of 28. 96 ± 1. 86 weeks. 11 neonates (22%) were categorized as extremely preterm (<28 weeks), 33 neonates (66%) as very preterm (<28 to 32 weeks), and 6 neonates (12%) as moderate to late preterm (<32 to 37 weeks) according to the World Health Organizations classification of prematurity (Table 1).

There were more females (n = 33, 66%) in the cohort than males (n = 17, 34%). During the study period, the average number of intervention sessions received was 35.20 ± 0.90, indicating consistent protocol adherence. One minute after delivery, the mean APGAR score was 6.42 ± 1.07 indicating a moderate level of newborn vitality and adjustment (Table 1).

Different clinical indications led to different type of deliveries. Premature labor or rupture of membranes (n = 11, 21.6%) and abnormal antenatal ultrasound Doppler findings (n = 11, 21.6%) were the most commonly reported causes. Placenta previa or abruptio placentae (n = 10, 19.6%), severe pre-eclampsia or eclampsia (n = 9, 17.6%), and severe oligohydramnios (n = 9, 17.6%) were also mostly observed. Of the mothers, 17 (33.3%) were multiparous and 33 (64.7%) were primiparous. Regarding the mode of delivery, the majority of births were by lower segment cesarean section (LSCS) (n = 37, 72.5%), while vaginal delivery was reported in 13 cases (25.5%) shown in Table 1.

Table 1: Demographic and Clinical Characteristics of Preterm Neonates (n = 50)

Variable	Mean (SD) (n=50)
Gestational Age (Weeks)	28.96 (1.86)
Extremely preterm n (%)	11 (22)
Very preterm n (%)	33 (66)
Moderate to late preterm n (%)	6 (12)
Gestational Age range (Weeks)	26-33
Gender	
Male n (%)	17 (34)
Female n (%)	33 (66)
Indication of Delivery n (%)	
Premature labor / Rupture of membranes	11 (21.6)
Severe pre-eclampsia / Eclampsia	9 (17.6)
Antenatal ultrasound Doppler changes	11 (21.6)

Placenta previa / Abruptio placentae	10 (19.6)
Severe oligohydramnios	9 (17.6)
Parity n (%)	
Primiparous	33 (64.7)
Multiparous	17 (33.3)
Mode of Delivery n (%)	
LSCS	37 (72.5)
Vaginal Delivery	13 (25.5)
Intervention Duration (Sessions) Mean (SD)	35.20 (0.90)
1-min APGAR Score	6.42 (1.07)

Table 2: Comparison of LATCH Score and Weight across Four Time Points Using Repeated Measures

ANOVA	Mean (SD)			One-way RM ANOVA (1 groups × 4 times) Time Effect	
Baseline (T0)	**2nd Week (T1)**	**4th Week (T2)**	**6th Week (T3)**	**df; F**	**p value (η_p^2) [a]**
LATCH Score					
4.04 (0.75)	4.78 (0.61)	6.14 (0.83)	7.52 (1.07)	2.563(238.08)	0.0001 (0.829)
Weight (Kg)					
1.33 (0.11)	1.66 (0.15)	2.02 (0.18)	2.27 (0.199)	2.70 (418.62)	0.0001 (0.895)

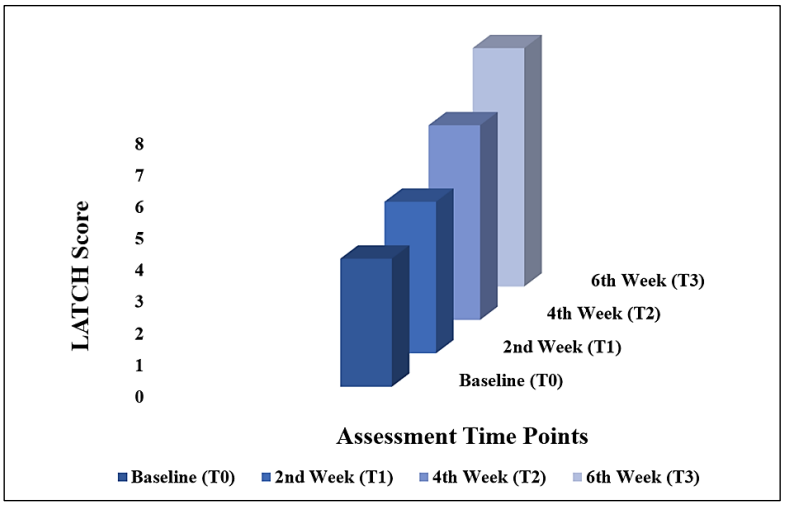

Figure 5: LATCH Score Progression from T0 to T3 among Preterm Neonates

Effect of Intervention on LATCH Score and Weight over Time

Over time, there was a progressive improvement in the LATCH score which measures how well an infant's latch and breastfeeds. The average score was 4.04 ± 0.75 at baseline (T0) to 4.78 ± 0.61 at the second week (T1), 6.14 ± 0.83 at the fourth week (T2), and 7.52 ± 1.07 at the sixth week (T3). A one-way repeated measures ANOVA results showed a significant time effect (F (2.563) = 238.08 $p < 0.0001$, $\eta p^2 = 0.829$), suggesting that the intervention had a significant effect on preterm neonates' ability to feed (Table 2, Figure 5). Likewise, the newborns' weight (kg) increased steadily over the period of six-week from 1.33 ± 0.11 kg at baseline to 2.27 ± 0.199 kg at the end of six-weeks. Intermediate weights were recorded as 1.66 ± 0.15 kg (T1) at the second week and 2.02 ± 0.18 kg (T2) at the fourth week. This was also determined that this result was statistically significant (F (2.70) = 418.62, $p < 0.0001$, $\eta p^2 = 0.895$), indicating a very large effect size, reflects better feeding readiness and nutritional intake (Table 2, Figure 6).

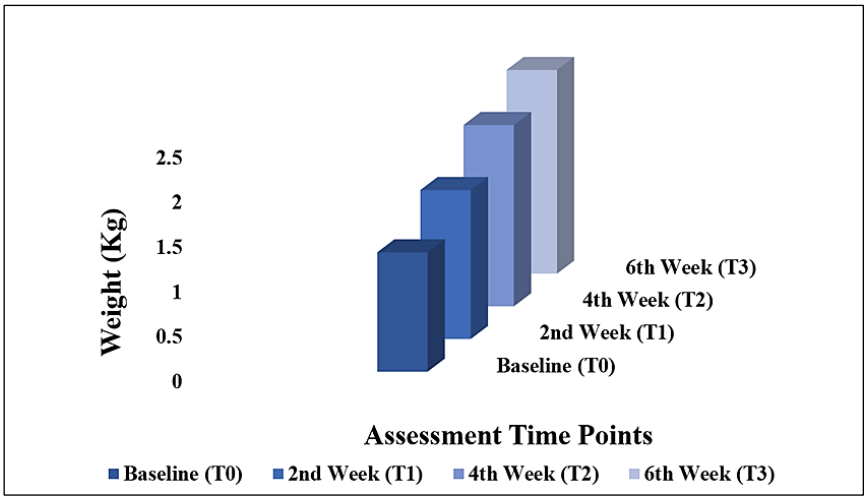

Figure 6: Weight (kg) Progression from T0 to T3 among Preterm Neonates

Pairwise Comparisons across Time Points

Bonferroni-adjusted post hoc comparisons were used to confirm that improvements in weight and LATCH scores were statistically significant across time points. There has been a consistent and notable increase in breastfeeding efficiency as indicated by the highly significant pairwise comparisons for the LATCH score ($p < 0.001$). Similarly, comparisons of weight gain revealed statistically significant differences between all-time intervals ($p < 0.0001$), reflecting a constant increase over the period of intervention (Table 3).

Table 3: Bonferroni Post-hoc Test of LATCH Score and Weight (Kg) Across Time Points

Outcome	T0 vs T1	T0 vs T2	T0 vs T3	T1 vs T2	T1 vs T3	T2 vs T3
LATCH Score	0.001*	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
Weight (Kg)	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*

*Indicating Statistically Significance ($p < 0.0125$)

Discussion

The current study assessed the impact of combining Preterm Infant Oral Motor Intervention (PIOMI) combined with Kangaroo Mother Care (KMC) on preterm neonates' weight gain and feeding outcomes. The results show a significant improvement in body weight and LATCH scores over a six-week intervention period, suggesting improved nutritional status and breastfeeding efficiency. These findings offer new insights into the combined effects of PIOMI and KMC, while also corroborating and contributing evidence demonstrating their individual benefits.

Improvement in Feeding Efficiency

The study found that the preterm neonates had improved oral feeding as evidenced by the gradual and statistically significant increase in LATCH scores. These results support earlier studies showing the effectiveness of oral motor interventions in promoting feeding preparedness. Similarly, structured oral stimulation programs such as PIOMI enhanced preterm infants sucking abilities and accelerate the transition from tube feeding to oral feeding (22). The stimulation provided by PIOMI likely improves the coordination of the suck-swallow-breathe patterns, which are frequently immature in this population (23).

Meanwhile, KMC provides the newborn with multisensory stimulation through extended skin-to-skin contact, which improves vagal tone, stabilizes vital signs, and encourages the start of breastfeeding (24). Improved neurosensory feedback and oromotor performance were probably facilitated by the synergy between PIOMI and KMC (25, 26). During KMC, the neonates state regulation is further improved by tactile and thermal inputs, making feeding sessions more effective and less stressful for the mother and neonate (27).

Weight Gain Reflects Growth and Development in Preterm Infants

Weight gain is a crucial clinical outcome in neonatal care, as it shows the overall nutritional intake and metabolic growth (28). From the beginning of the intervention to the sixth week, our study found a constant weight increased and gradually averaging about 940 grams. This is a noteworthy finding, especially when considering preterm newborns are highly susceptible to extra-uterine growth restriction due to physiological immaturity and inadequate caloric intake.

Improved milk intake from more efficient oral feeding and improved energy conservation from reduced stress during KMC are probably the causes of the observed weight gain (29). These results align consistent with evidence demonstrating that KMC significantly increases breastfeeding rates, weight gain, and reduces morbidity in infants with low birth weight (30). Additionally, the inclusion of PIOMI might have improved calorie intake and accelerated growth trajectories by enabling infants to extract milk more effectively (31).

Additionally, feeding habits and weight gain were shown to be positively influenced by integrating sensory-motor interventions with maternal–infant bonding activities (23, 32). The combined results of these studies support the clinical utility of our dual-intervention strategy in promoting the physical development of preterm infants.

Neurobehavioral and Developmental Implications of Early Stimulation

It is important to understand how early interventions significantly impact neurodevelopmental outcomes over the long-term. Although the current study concentrated on short-term feeding and growth outcomes. Existing literature provides compelling evidence that structured oromotor stimulation and maternal-infant bonding practices can improve early childhood and infant cognitive, language, and motor development (33, 34). PIOMI may promote more effective feeding behaviors and potentially better neurodevelopmental outcomes by activating cortical regions and cranial nerve pathways involved in oromotor control (35).

Beyond its nutritional benefits, KMC has been linked with better sleep cycles, brain development, lower cortisol levels, and stable attachment styles in later life (36). These effects are attributed to heightened oxytocin levels and coordinated physiological regulations that occur during skin-to-skin care are responsible for these effects (37). Combining PIOMI and KMC creates a rich environment that supports early learning and brain plasticity by offering both top-down (affective) and bottom-up (sensorimotor) stimulation (25, 38).

Our results pave the way for future longitudinal studies assessing cognitive, language, and motor outcomes in children who received this early dual stimulation even though neurodevelopmental assessments were beyond the scope of this study.

Implications for Clinical Practice and Health Policy

The findings of this research have significant implications for neonatal intensive care units (NICUs), particularly in Low- and Middle-Income Countries (LMICs), where access to technology-intensive feeding support may be limited (39, 40). Both KMC and PIOMI are parent-driven, low-cost, non-invasive interventions that can be easily incorporated into standard care practices. Early discharge may reduce risk of hospital-acquired infections and lower healthcare expenses could result from this effective implementation (41).

KMC has been firmly supported by the World Health Organization (WHO) as an essential part of care for preterm and low birth weight babies due to its ability to lower neonatal mortality and promoting early exclusive breastfeeding (11). Oral motor stimulation is a key component of parent-involved, developmentally supportive care models that are promoted by recent neonatal care frameworks (42).

Implementing such interventions into national neonatal care policies may support the achievement of international goals, such as the United Nations Sustainable Development Goal 3.2, which aims to end preventable newborn deaths by 2030 (43). This study contributes to the increasing body of evidence highlighting the benefits of holistic, low-resource approaches in enhancing the health and survival of vulnerable new-borns.

Conclusion

Over a six weeks period, the structured intervention was found to be effective in improving weight gain and breastfeeding efficiency in preterm neonates. The steady improvement in LATCH scores over all time points

indicates a notable improvement in the newborn's capacity to latch, suck, and feed efficiently which is a critical developmental milestone for both successful breastfeeding and general neonatal growth. Concurrently, the statistically significant rise in body weight indicates better nutritional intake, enhanced physiological maturation, and improved readiness for feeding, all of which are essential for preterm infants' survival and long-term health.

The existing literature highlights the importance of early, focused interventions in neonatal care especially those that enhance feeding skills and promote maternal-infant bonding. The findings of this study are consistent with existing studies. The degree of improvement in newborns reinforces the potential of this protocol to improve clinical outcomes and lower the risk of extended hospitalization and associated morbidities, while also demonstrating its feasibility for implementation in NICU settings.

Limitations

A number of limitations must be acknowledged. While the sample size is sufficient for initial analysis, but it limits the generalizability of the findings. Additionally, the absence of a randomized control group makes it more difficult to prove effectiveness across group. Uncontrolled variables such as maternal parity, mode of delivery, and lactation counseling may have influenced feeding outcomes. Future research should employ randomized controlled trial (RCT) designs to assess the individual and combined effects of PIOMI and KMC. Findings on neurodevelopmental outcomes at 6- and 12-months post-discharge would be crucial in determining the long-term advantages of early interventions. Moreover, qualitative assessments of mothers' experiences and satisfaction could offer a more comprehensive understanding of the interventions' impact.

Abbreviations

ηp^2: Partial eta squared, KMC: Kangaroo Mother Care, LSCS: Lower Segment Cesarean Section, NICU: Neonatal Intensive Care Unit, PIOMI: Premature Infant Oral Motor Intervention, RCT: Randomized Controlled Trial, RMANOVA: Repeated Measures Analysis of Variance, SD: Standard Deviation, SDG: Sustainable Development Goal, WHO: World Health Organization.

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Author Contributions

Anees Ahmed FM: conceptualization, study design, data collection, manuscript drafting, corresponding author responsibilities, Kranthi Kumar Kambam: data analysis, interpretation of results, critical revision of the manuscript, Jeevarathinam Thirumalai: intervention planning, methodology design, supervision of study procedures, Vinodhkumar Ramalingam: data collection, statistical support, manuscript editing. Santosh Kumar Kamalakannan: literature review, critical appraisal, final manuscript approval.

Conflict of Interest

No Conflict of Interest.

Declaration of Artificial Intelligence (AI) Assistance

The authors declare that artificial intelligence–based tools were used only for language refinement and grammatical editing of the manuscript. QuillBot was used solely to improve clarity and language quality. No AI tools were used for study design, data analysis, interpretation, or content generation.

Ethics Approval

This study was approved by Institutional Scientific Review Board, Saveetha College of Physiotherapy, Saveetha Institute of Medical and Technical Sciences, India.
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