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Original Research Article

Factors affecting weight gain velocity in preterm infants getting kangaroo mother care in hospital and after discharge from neonatal intensive care unit

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ABSTRACT

Background: Preterm neonates with low birth weight are at heightened risk of suboptimal postnatal growth. kangaroo mother care (KMC) has proven to enhance neonatal survival, growth, and development. However, various maternal and neonatal factors may influence weight gain during KMC. Objective was to identify factors affecting weight gain velocity in preterm neonates receiving KMC.
Methods: This prospective observational study was conducted in the neonatal intensive care unit (NICU) of BMU from March 2022 to August 2023. Hemodynamically stable preterm neonates weighing ≤2000 gm who fulfilled inclusion and exclusion criteria were enrolled. Neonatal weights were recorded during hospitalization and weekly for four weeks post-discharge. Weight gain velocity at the fourth week was calculated, and factors influencing weight gain were analysed.
Results: Of 82 enrolled neonates, 66 completed four weeks of follow-up. The mean weight gain velocity was 15.05±3.57 gm/kg/day, with 57.6% achieving adequate gain (≥15 gm/kg/day). The adequate gain group started KMC earlier (3.61±1.57 versus 6.54±2.94 days, p<0.001), had longer daily KMC duration (5.55±0.83 versus 4.58±0.79 hours, p<0.001), and more total KMC days (33.84±3.83 versus 31.57±3.17 days, p=0.013). KMC interruptions were significantly higher among those with inadequate gain (60.7% versus 21.1%, p=0.001). Multivariate logistic regression identified earlier initiation, longer daily duration, and more total KMC days as positive predictors of weight gain, while interruptions negatively impacted growth.
Conclusions: Early initiation, longer duration, and uninterrupted KMC significantly improve weight gain velocity in preterm neonates both during hospital stay and after NICU discharge.

Keywords: Kangaroo mother care, NICU, Preterm, Weight gain, Weight gain velocity

INTRODUCTION

Globally, around 15 million children are born prematurely each year, accounting for more than 1 in 10 births.[1-3] Preterm birth and related complications are the leading causes of under-five mortality, responsible for over one million deaths annually.[4,5] The global incidence of preterm birth ranges from 4-16%, with most cases in southern Asia and sub-Saharan Africa.[6] Survival rates vary greatly between regions, being lowest in low-income countries due to limited access to essential interventions such as thermal care, breastfeeding support, infection prevention, and respiratory assistance.

Bangladesh, despite being a lower-middle-income country, has made progress in reducing child mortality, but neonatal deaths remain high. The 2022 Bangladesh Demographic and Health Survey reports a neonatal mortality rate of 20 per 1,000 live births, with preterm birth accounting for 30% of newborn deaths.[7,8]

Preterm infants also face increased risks of delayed physical and cognitive development.[9] Their low birth weight makes them vulnerable to respiratory problems, feeding difficulties, hypothermia, and infection, though three-quarters of these complications are preventable through cost-effective measures such as Kangaroo Mother Care (KMC).[10]

KMC involves continuous skin-to-skin contact between the mother (or caregiver) and baby, promoting warmth, breastfeeding, and emotional bonding. WHO recommends KMC as standard care for all preterm or low-birth-weight infants.[11] It is initiated once the infant is clinically stable and continued at home after discharge.

KMC consists of three components: kangaroo position, kangaroo nutrition, discharge and follow-up.[12,13]

According to a Cochrane review, KMC moderately improves somatic growth (weight, length, head circumference) and supports exclusive breastfeeding for up to three months.[14] It also reduces neonatal mortality, hospital stay, infections, hypothermia, apnea, and gastroesophageal reflux, while promoting growth and development.[15-18]

KMC provides a neutral thermal environment, conserving energy for growth, and enhances breast milk production.[19] It also improves infant sleep, reduces stress and pain, and supports better overall growth.

Weight gain velocity (grams/kg/day) is a key measure for assessing nutritional adequacy and growth in preterm infants.[20,21] Various maternal and infant factors- such as maternal age, gestational age, birthweight, hospital stay length, and Apgar score- affect weight gain.[22] Studies show that longer KMC duration directly correlates with better neonatal growth outcomes.[23]

Given limited data in Bangladesh, this study aimed to assess the weight gain velocity of neonates receiving KMC and identify factors influencing it.

METHODS

Study design

It was a prospective observational study.

Place of study

The study took place at the department of neonatology, Bangladesh Medical University, Shahbag, Dhaka.

Study population

Preterm (<37 weeks) newborns having birth weight of ≤2000 gm admitted to NICU, BMU during the study period.

Inclusion criteria

Hemodynamically stable preterm newborns (≤2000 gm) receiving KMC whose parents could attend weekly follow-ups.

Exclusion criteria

Clinically unstable newborns, those with major congenital or surgical conditions, referred cases, infants discharged against medical advice, and those whose parents were unable or unwilling to attend follow-ups for four weeks post-discharge.

Sample size

A total of 66 neonates were included in the study.

Study procedure

This prospective observational study was conducted from March 2022 to August 2023 in the department of neonatology, BSMMU, Dhaka. Preterm neonates (≤2000 gm) eligible for KMC were enrolled after obtaining informed written consent from parents or legal guardians, ensuring confidentiality.

KMC was provided according to the NICU protocol. Anthropometric measurements (weight, length, OFC) were taken by the researcher and recorded in data forms. Weight was measured daily using a KINLEE EBST-20 digital scale (sensitivity ±5 gm). Length and OFC were measured using standard procedures. Maternal and neonatal history was collected from interviews and medical records.

Parents and caregivers received counselling on KMC practices by the principal investigator and NICU staff. During hospitalization, infants received standard care and appropriate nutrition as per clinical condition. The KMC record form documented duration, weight change, and vital signs.

At discharge, parents received home KMC diaries to record daily hours and note any problems. They were instructed to attend weekly follow-ups for four weeks, and were contacted by phone every three days to ensure compliance. Caregivers were trained to detect hypothermia and other neonatal danger signs.

During follow-up visits, anthropometric data and KMC adherence were recorded. Weekly weight change (gm/day) was calculated, and the next appointment

scheduled. After four weeks, the final measurements and KMC feedback were collected.

After the end of four weeks' follow up, Weight gain velocity (gram/kg/day) was calculated by the 2-point average method by the following formula:

$$\text{Weight gain velocity (gram/kg/day)} = \frac{[1000 \times (Wn - W1)]}{(Dn - D1) \times \left[\frac{(Wn + W1)}{2}\right]}$$

Here, W_1=weight in grams at beginning of time interval; Wn=Weight in grams at the end of time interval; Dn – D1= days between beginning and end; $\frac{(Wn+W1)}{2}$ = average weight.[24-26]

Adequate weight gain was defined as ≥15 gm/kg/day.[27] Factors such as KMC duration, interruptions, and maternal/neonatal variables were analysed for association with weight gain.

Statistical analysis

Data were entered and analysed using SPSS version 25 (IBM, USA). Qualitative data were expressed as proportions/percentages; analysed using Chi-square test. Quantitative data were expressed as mean±SD or median; analysed using independent t-test or Mann-Whitney U test. Logistic regression identified factors associated with weight gain velocity. A p value <0.05 was considered statistically significant.

RESULTS

A total of 108 preterm newborns (≤2000 gm) were assessed, of whom 82 met eligibility criteria. After exclusions and losses, 66 completed the 4-week follow-up and were analyzed (Figure 1).

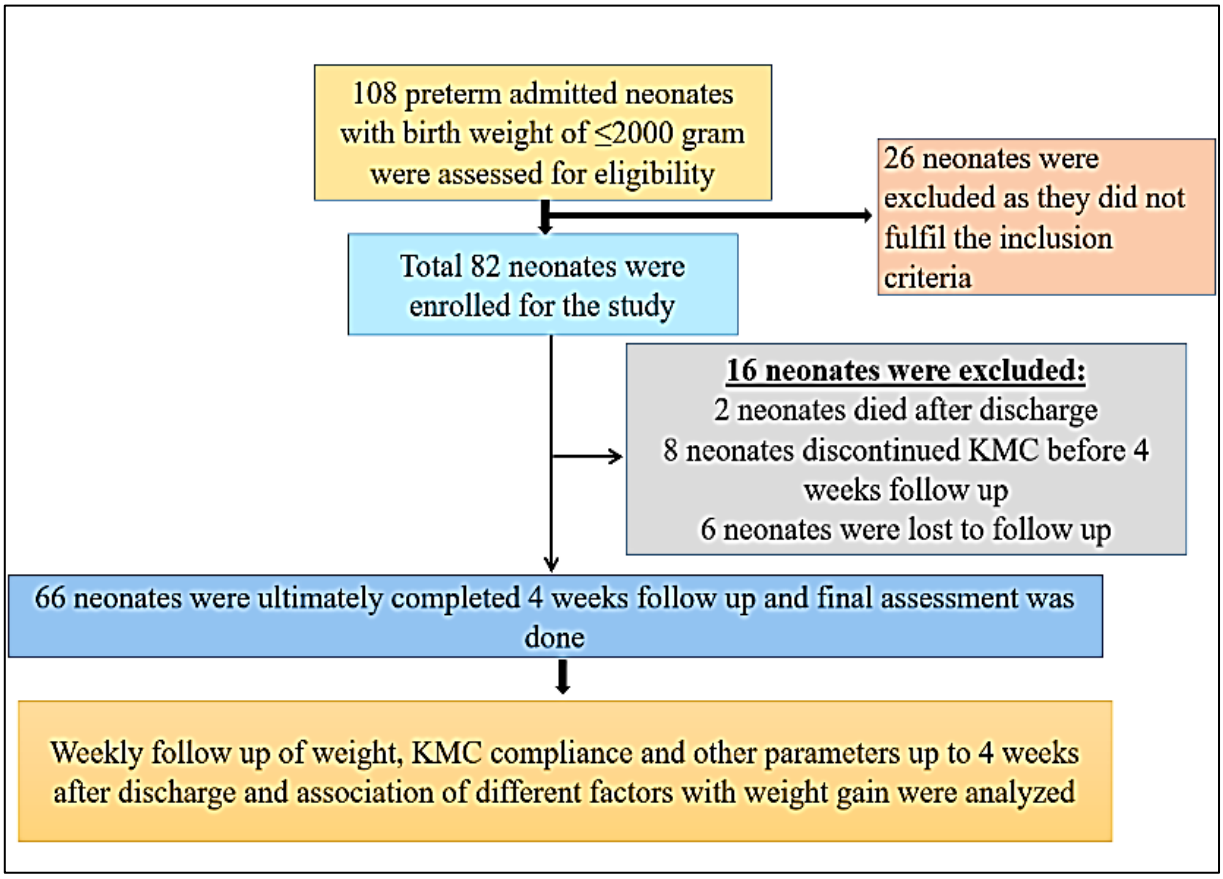

Figure 1: Patient enrollment.

The mean age of KMC initiation was 4.85±2.63 days, with an average daily duration of 5.14±0.94 hours and a highest daily duration of 6.65±1.33 hours. KMC interruption occurred in 37.9% of cases, mainly due to sepsis (36%), lack of caregiver (32%), and jaundice (24%) (Table 1).

After discharge, mean daily weight gain progressively increased from 10.48±17.21 gm/day at discharge to 27.14±6.90 gm/day by the 4th week (Figure 2).

Mean weight-gain velocity at 4 weeks was 15.05±3.57 gm/kg/day, with 57.6% achieving adequate gain (≥15 gm/kg/day) (Table 2).

Table 1: KMC characteristics of the enrolled neonates (n=66).

Parameter	Value (n=66)
Age of starting KMC in days, Mean±SD	4.849±2.632
Average daily KMC duration in hours, Mean±SD	5.136±0.943
Highest daily duration of KMC in hours, Mean±SD	6.652±1.330
Interruption of KMC (≥24 hours) (%)	25 (37.9)
Cause of interruption (%)	
Sepsis	9 (36)
Lack of caregiver	8 (32)
Neonatal jaundice	6 (24)
Other causes	2 (8)

Infants with adequate gain showed significantly higher growth in weight (17.13±2.75 versus 12.22±2.42 gm/kg/day), length (1.01±0.26 versus 0.77±0.25 cm/week), and OFC (0.52±0.23 versus 0.38±0.16 cm/week; p<0.05) (Table 3).

KMC began earlier (3.61±1.57 versus 6.54±2.94 days, p<0.001) and lasted longer daily (5.55±0.83 versus 4.58±0.79 hours, p<0.001) in the adequate-gain group. They also had more total KMC days (33.84±3.83 versus 31.57±3.17, p=0.013) and fewer interruptions (21.1% versus 60.7%, p=0.001) (Table 4).

Maternal characteristics, pregnancy details, and neonatal baseline factors showed no significant group differences (Tables 5 and 6). However, sepsis (10.4% versus 39.3%, p=0.006) and feeding intolerance (7.9% versus 28.6%, p=0.026) were more frequent among infants with inadequate gain (Table 7).

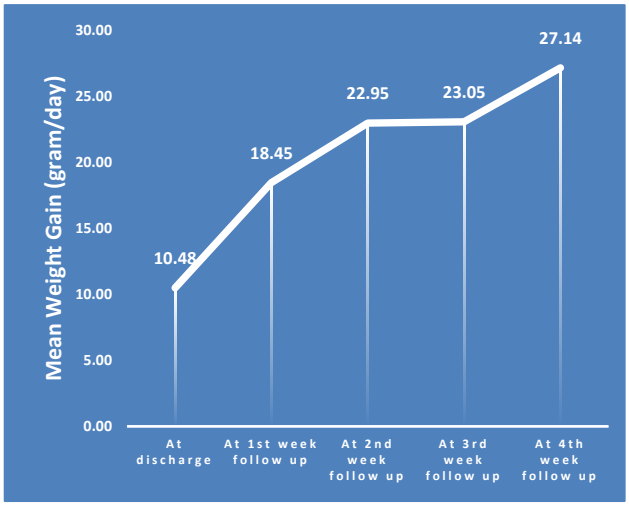

Figure 2: Weight gain (gram/day) pattern at discharge and follow up after discharge.

Table 2: Weight gain velocity at 4th weeks follow-up after discharge of the enrolled neonates (n=66).

Parameters	Value (n=66)
Weight gain velocity at 4th week (gram/kg/day), mean±SD	15.046±3.567
Weight gain velocity (%)	
Adequate (≥15 gram/kg/day)	38 (57.6)
Inadequate (<15 gram/kg/day)	28 (42.4)

Table 3: Comparison of growth parameters between the adequate and inadequate weight gain velocity group (n=66).

Parameters	Adequate weight gain velocity (≥15 gm/kg/day) (n=38)	Inadequate weight gain velocity (<15 gm/kg/day) (n=28)	P value
Weight gain velocity gm/kg/day, mean±SD	17.13±2.75	12.22±2.42	<0.001[s]
Increment of length cm/week, mean±SD	1.012±0.259	0.772±0.250	<0.001[s]
Increment of OFC cm/week, mean±SD	0.516±0.231	0.384±0.163	0.039[s]

OFC: Occipitofrontal Circumference; SD: Standard Deviation; s-significant.

Table 4: Comparison of KMC characteristics between the adequate and inadequate weight gain velocity group (n=66).

Parameters	Adequate weight gain velocity (n=38)	Inadequate weight gain velocity (n=28)	P value
Mean age of starting KMC in days, mean±SD	3.61±1.57	6.54±2.94	<0.001
Average daily KMC duration in hours, mean±SD	5.55±0.83	4.58±0.79	<0.001
Total KMC duration in days, mean±SD	33.84±3.83	31.57±3.17	0.013
Highest daily duration of KMC in hours, mean±SD	7.08±1.30	6.07±1.15	0.002
Interruption of KMC (≥24 hours) (%)	8 (21.1)	17 (60.7)	0.001

Table 5: Comparison of maternal baseline and clinical characteristics between the adequate and inadequate weight gain velocity group (n=66).

Characteristics	Adequate weight gain velocity (n=38)	Inadequate weight gain velocity (n=28)	P value
Maternal age in years, mean±SD	27.37±5.75	28.04±4.93	0.62
Maternal education (%)			
<High school	3 (6.1)	1 (3.6)	0.74
High school and above	23 (60.5)	17 (60.7)	
Degree and equivalent	12 (31.6)	10 (35.7)	
Parity (%)			
Primipara	15 (39.5)	14 (50)	0.39
Multipara	23 (60.5)	14 (50)	
Type of gestation (%)			
Single	25 (65.8)	18 (64.3)	0.89
Multiple	13 (34.2)	10 (35.7)	
Delivery mode (%)			
NVD	8 (21.1)	3 (10.7)	0.26
LSCS	30 (78.9)	25 (89.3)	
Antenatal corticosteroid (%)	28 (73.7)	22 (76.8)	0.57
Hypertension (%)	20 (52.6)	11 (39.3)	0.28
Gestational diabetes (%)	7 (18.4)	6 (21.4)	0.76
Hypothyroidism (%)	5 (13.2)	4 (14.3)	0.89
PROM (%)	8 (21.1)	4 (14.3)	0.48
UTI (%)	2 (5.3)	0 (0)	0.21

NVD: normal vaginal delivery, LSCS: lower segment caesarean section.

Table 6: Comparison of baseline neonatal characteristics between the adequate and inadequate weight gain velocity group (n=66).

Parameters	Adequate weight gain velocity	Inadequate weight gain velocity	P value
	(n=38)	**(n=28)**	
Gestational age in weeks Mean±SD	32.79 + 1.19	32.62 + 2.01	0.731^{ns}
Gestational age category (weeks) (%)			
<28 weeks	0	1 (3.6)	0.624^{ns}
28 to <32 weeks	11 (28.9)	6 (21.4)	
32 to <34 weeks	12 (31.6)	9 (32.1)	
≥34 weeks	15 (39.5)	12 (42.9)	
BW (grams), Mean±SD	1463.95±250.49	1590.01±292.52	0.065^{ns}
BW category (%)			
VLBW (1000-1499 gm)	22 (57.9)	11 (39.3)	0.135^{ns}
LBW (1500-1999 gm)	16 (42.1)	17 (60.7)	
SGA (%)			
Yes	10 (26.3)	3 (10.7)	0.115^{ns}
No	28 (73.7)	25 (89.3)	
IUGR (%)			
Yes	8 (21.1)	2 (7.1)	0.119^{ns}
No	30 (78.9)	26 (92.9)	
Gender of the baby (%)			
Male	21 (55.3)	18 (64.3)	0.214^{ns}
Female	17 (44.7)	10 (35.7)	
Place of delivery (%)			
Inborn	26 (68.4)	23 (82.1)	0.208^{ns}
Out born	12 (31.6)	5 (17.9)	

BW: birth weight; VLBW: very low birth weight; LBW; low birth weight; SGA: small for gestational age; IUGR: intrauterine growth restriction; ns-not significant.

Table 7: Comparison of neonatal morbidities and clinical characteristics between the adequate and inadequate weight gain velocity group (n=66).

Parameters	Adequate weight gain velocity (n=38)	Inadequate weight gain velocity (n=28)	P value
APGAR Score <7 (%)			
1st minute	12 (31.6)	6 (21.4)	0.360
5th minute	0	0	
Respiratory distress, N (%)	35 (92.1)	23 (82.1)	0.220
Neonatal jaundice, N (%)	36 (94.7)	23 (82.1)	0.101
Neonatal Sepsis, N (%)	4 (10.4)	11 (39.3)	0.006
Hypothermia, N (%)	6 (15.8)	3 (10.7)	0.553
Shock, N (%)	4 (10.5)	3 (10.7)	0.980
Patent ductus arteriosus (PDA) (%)	4 (10.5)	3 (10.7)	0.980
Intraventricular hemorrhage (IVH) (%)	1 (2.6)	0 (0)	0.387
Feeding intolerance (%)	3 (7.9)	8 (28.6)	0.026
Necrotizing enterocolitis (NEC) (%)	1 (2.6)	2 (7.1)	0.385
Duration of hospital stay (days), Mean±SD	8.53±4.54	9.54±7.95	0.517
Time to reach full enteral feed (days), Mean±SD	5.53±3.07	6.01±3.95	0.586

Binary logistic regression (Table 8) revealed that earlier KMC initiation (OR=0.594, p=0.041), longer daily duration (OR=8.799, p=0.027), and more total KMC days (OR=1.519, p=0.011) were positively associated with adequate weight-gain velocity, while KMC interruption reduced the likelihood of adequate gain (OR=0.044, p=0.016). Sepsis and feeding intolerance were not significant after adjustment.

Table 8: Logistic regression analysis of the factors affecting achievement of adequate weight gain velocity among the enrolled neonates (n=66).

Factors	Exp (B)	95% C.I. of Exp (B)		P value
		Lower	Upper	
Sepsis	0.182	0.007	4.928	0.312
Feeding intolerance	0.190	0.014	2.588	0.213
Age of starting KMC in days	0.594	0.360	0.980	0.041
Average daily duration of KMC in hours	8.799	1.277	60.641	0.027
Total days of KMC	1.519	1.100	2.098	0.011
Interruption of KMC (≥24 hours)	0.044	0.004	0.553	0.016

DISCUSSION

Kangaroo mother care (KMC) is a skin-to-skin (STS) care method for preterm or low birth weight (LBW) infants aimed at maintaining body temperature and promoting growth and development. Once considered an alternative to incubator care, KMC is now a standard practice globally, associated with reduced mortality, infections, shorter hospital stays, improved breastfeeding, and enhanced weight gain.[17] Preterm infants face growth and nutritional challenges, making adequate weight gain- defined as ≥15 gm/kg/day during follow-up- a key target.[28]

In this prospective study, 57.6% of preterm neonates achieved adequate weight gain velocity (≥15 gm/kg/day) by the 4th week of follow-up. Weight gain rose steadily from 10.48±17.21 g/day at discharge to 27.14±6.89 g/day at the 4th week, with a mean velocity of 15.05±3.57 gm/kg/day. Similar to findings by Nobre et al and Penalva and Schwartzman, weight gain was slower during the NICU stay but improved after discharge.[29,30] Initial postnatal weight loss of up to 10-15% is common in preterm infants, with steady gain beginning around the 2nd week under stable clinical conditions.[20,31]

The mean age of KMC initiation was 4.85±2.63 days; infants with adequate weight gain started earlier (3.61±1.57 versus 6.54±2.94 days, p<0.001). Early KMC promotes earlier breastfeeding, fewer infections, and reduced stress. Studies have shown early KMC leads to quicker attainment of full feeding, fewer feeding intolerances, and higher discharge weights, while others report shorter hospital stays and improved survival.[32-34]

Duration of KMC was a major determinant of growth. Infants with adequate gain received longer daily KMC (5.55±0.83 hours) and more total KMC days (33.84±3.83

versus 31.57±3.17 days, p=0.013). Longer KMC duration has been linked to better growth, faster feeding progression, improved neurobehavioral outcomes, and better thermoregulation.[19,35,36]

Interruptions in KMC (≥24 hours), seen in 37.9% of neonates, significantly reduced weight gain. Causes included absence of a caregiver, sepsis, and jaundice, aligning with previous findings.[37,38] The inadequate weight gain group had higher rates of sepsis and feeding intolerance- factors known to increase metabolic stress and reduce feeding- but these were not significant after adjustment.[39,40]

Maternal and baseline neonatal characteristics (age, parity, education, gestational age, birthweight, and Apgar score) did not significantly affect weight gain, consistent with prior studies. Although Nobre et al. found some associations with maternal age and gestational factors, this study did not observe similar trends.[29]

Overall, these findings reinforce that early initiation, longer daily duration, and uninterrupted continuation of KMC are crucial for achieving optimal weight gain in preterm and LBW infants. Sustaining and strengthening KMC practices can further enhance neonatal survival and growth outcomes in resource-limited settings.

Limitations of the study are lack of direct observation of home KMC. Mode of feeding, amount of calorie could not be evaluated during home KMC.

CONCLUSION

Earlier age of starting KMC, a greater number of KMC days and higher daily duration of getting KMC are associated with better weight gain velocity. Interruption of KMC due any reason significantly slows the rate of weight gain in hospital and after discharge from NICU.

Recommendations

Initiatives can be taken to start KMC early, increase total daily duration of KMC and to address the causes of interruption. Further multi-center prospective studies on a larger scale and quality improvement initiatives can be taken to validate the study result.

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