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EFFECT OF EARLY INTERMITTENT KANGAROO MOTHER CARE ON WEIGHT GAIN AND LENGTH OF STAY IN LOW-BIRTH-WEIGHT INFANTS: A MULTI-SITE QUASI-EXPERIMENTAL STUDY
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ABSTRACT

Objective: **To assess the effect of early intermittent Kangaroo Mother Care (KMC) in improving neonatal weight gain and length of stay in stable Low-Birthweight (LBW) infants**
Design: **A multi-site quasi-experimental study. The intervention group was early intermittent KMC while the control group was conventional neonatal care.**
Setting: **Newborn units in 3 hospitals in Kenya from July 2016 to June 2017.**
Participants: **Stable LBW infants (N=343 (171 KMC infants and 172 control infants)) born weighing ≤2000 grams and their mothers.**
Interventions: **KMC infants received early (≤72 hours after birth) intermittent KMC for a cumulative period of 8 hours a day and were placed in incubators when not on KMC. The control infants received standard neonatal care.**
Main outcome measures: **Neonatal weight gain and length of stay**
Results: **Intervention infants had a significantly higher mean weight gain during the neonatal period (709.5g vs 471.5g, $p<0.0001$) than controls. Secondary level maternal education, toilet access, delivery complications and at least 3 meals a day during pregnancy were associated with better neonatal weight gain ($p<0.05$). Higher birthweight was associated with lower neonatal weight gain ($p<0.001$). The intervention shortened length of stay (7.1 days vs. 17.4 days, $p<0.0001$). Higher birthweight was associated with shorter length of stay ($p=0.001$). A pregnancy history of 1 or more pregnancy loss with 1 or more live births was associated with longer length of stay ($p=0.027$).**
Conclusion: **Early intermittent KMC was effective in improving neonatal weight gain and reducing length of stay in stable LBW infants.**

INTRODUCTION

Low-birthweight (LBW), defined by World Health Organization (WHO) as weight at birth <2500 grams, is a global public health problem (1). Most LBW infants occur in low- and middle-income countries (LMICs) with an estimated 13% prevalence in sub-Saharan Africa. LBW prevalence is likely higher as data is unreliable because many deliveries are not officially reported (1). A Kenya demographic survey estimated LBW prevalence at 8% in 2014, but this did not factor 34% of children whose birthweight data was not available (2).

The risk of neonatal mortality and morbidity, inhibited growth and cognitive development, and increased risk of noncommunicable diseases later in life is higher in LBW infants (1). Nearly all infants lose some weight early in life, with 5%-7% considered acceptable and majority regain their birthweight by age 10-14 days (3). Weight gain during the neonatal period is a common problem among LBW infants and represent about 25% of cases in some settings (4).

Prolonged hospital stay lengthens exposure to risks associated with hospital environment, while too early discharge exposes infants to risks of life-threatening events while increasing risk of rehospitalization (5). The length of stay for infants is influenced by many factors including medical conditions that may lead to longer stays, gestational age, low Apgar score, family's socioeconomic circumstances, hospital discharge policies and the ability to clear hospital bills (5,6).

Kangaroo Mother Care (KMC) involves care of LBW infants through early and prolonged Skin-to-Skin Contact (SSC) with the mother/caregiver (7). Continuous KMC (SSC between the LBW infant and caregiver for ≥20 hours/day) improves neonatal outcomes of LBW infants by enhancing breastfeeding practices, thermal and cardiorespiratory stability (7). However, lack of equipped KMC rooms has led to low implementation of continuous KMC in LMICs. Intermittent KMC (SSC alternated with incubators) is more feasible but there is inconclusive data on its effectiveness.

Some forms of KMC have been reported to improve neonatal weight gain among LBW infants (8). KMC promotes exclusive breastfeeding which contributes to neonatal weight gain (8). Other benefits of KMC include lower mortality, decreased risk of neonatal sepsis, hypothermia and hospital readmission and higher head circumference growth (9). More data on the effectiveness of intermittent KMC in different settings and doses (duration of SSC) to improve neonatal outcomes is needed (9).

We measured the effect of early KMC on neonatal weight gain and length of stay among stable LBW infants.

METHODS

Design: A multi-site quasi-experimental study. The intervention was LBW infants on early intermittent KMC while controls were LBW infants on standard care.

KMC infants were 171 while control infants were 172 with data collected from July 2016 to June 2017 (10).

Setting: The intervention site was Pumwani Maternity Hospital, the largest public maternity referral hospital in Kenya. The control sites were Thika and Machakos Level 5 Hospitals, which were among the largest public hospitals in Kiambu and Counties respectively.

Study Population: Inclusion criteria were; infants weighing ≤2000g irrespective of gestational age, infants <72 hours of life, stable infants (cardiovascular and respiratory functions did not require continuous support), mother willing to practice KMC (intervention) and willing to give informed written consent. Infants with major congenital malformations and severe perinatal complications were excluded.

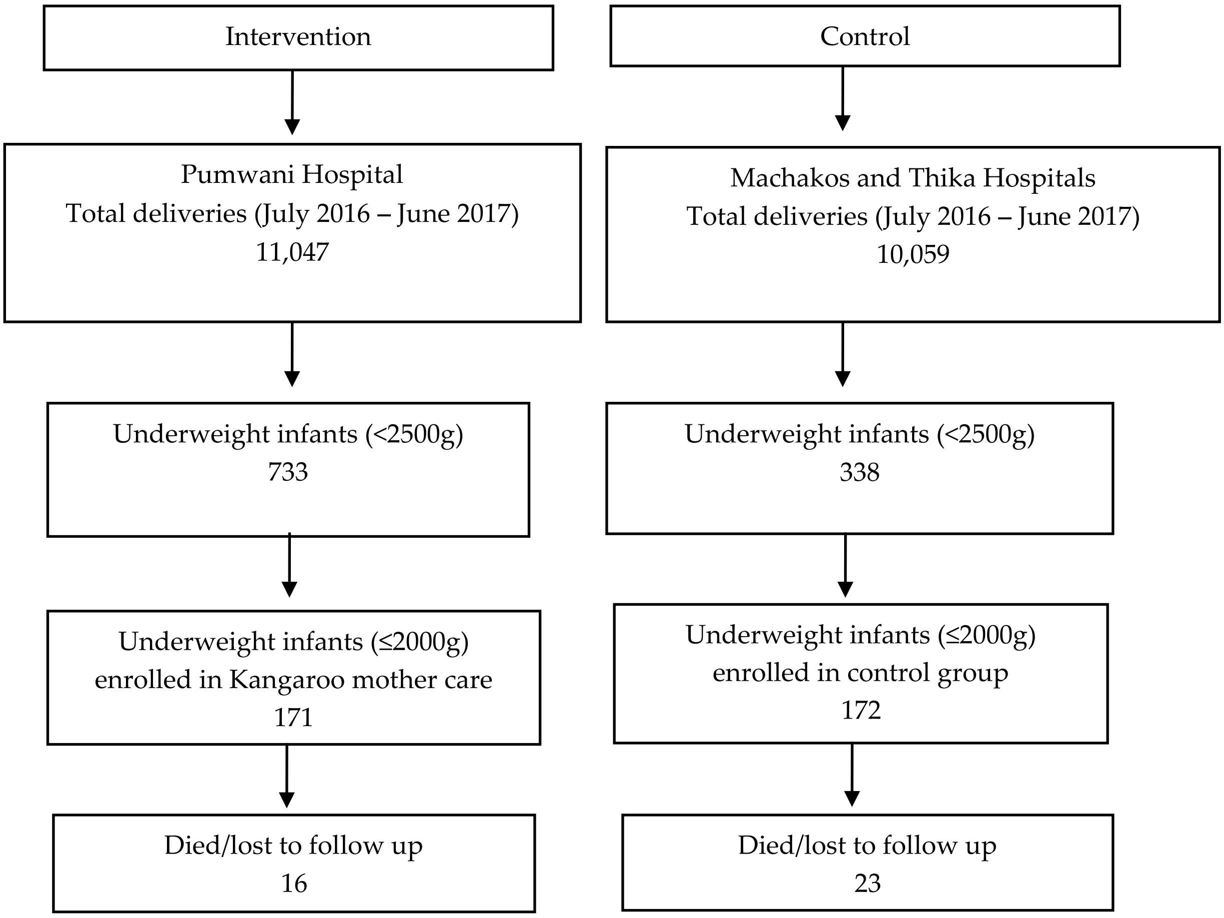

Figure 1 : Subjects included in analysis

Data collection: Research assistants (nurses) recruited eligible infants from neonatal unit admission register consecutively until a sufficient sample was attained. There was no sampling.

Data was collected through an entry questionnaire, abstraction from patient's files and KMC register (intervention group) and exit questionnaire administered at 28 days of age. Tools were pretested. Infants were followed up to 28 days of life.

Study procedures:

A KMC room was identified and staff trained for one week using a custom curriculum of theory and practice led by a pediatrician and newborn unit nurse manager (intervention site). The trainers supervised KMC implementation. KMC register was introduced. KMC was started soonest possible after birth and ≤72 hours. SSC involved placing neonates vertically between mother's breasts, firmly attached to the chest for 8 hours cumulatively. The 8-hour period was done in 8 sessions a day with each session lasting one hour. This duration was monitored and documented by nurse on duty. During SSC, infants were naked and only wore a diaper, hat, and/or socks. When not on SSC, neonates were placed on incubators and treated for any presenting complaints. KMC practice was continued in-hospital or post-discharge, until infants attained ≥2500g.

Conventional care was provided at control sites and included thermal care (incubators) and treatment of presenting complaints. KMC training was not done at control sites.

At all study sites, infants discharged before end of neonatal period were brought back at 28 days of age to assess baby's condition and take anthropometric measurements. Anthropometric measurements were taken at nearest hospitals for infants unable to make to come back.

Data analysis

Descriptive statistics were used to summarize baseline characteristics and outcome measures of the study. Independent t-test was used to compare the mean neonatal weight gain and length of stay. Bivariate analysis of baseline characteristics and outcomes (neonatal weight gain and length of stay) was done using linear regression, independent t test (or Wilcoxon rank-sum), one-way ANOVA (or Kruskal-Wallis test) as appropriate. Where appropriate, post hoc Dunn's pairwise comparison was computed with Bonferroni adjustment to control for familywise error rate. Mixed-effects linear regression analysis was conducted to control for confounders. Sub-group analysis was conducted to adjust for difference in birthweights for very low birthweights (VLBW) and LBW (≤1500g and >1500g). P-values ≤0.05 were considered statistically significant. Analysis was done using Stata: Release 15.

Ethics: Ethical approval was given by Kenyatta National Hospital Ethics Review Committee (KNH-ERC/Mod&SAE/326). Permission was obtained from study hospitals. Confidentiality was ensured and data collection was preceded by informed consent signed by mothers of neonates.

RESULTS

Baseline characteristics: The intervention site contributed 171(49.9%) of the 343 subjects. The subjects were equitably distributed between the control sites with Machakos hospital having 85(24.8%) subjects. Majority of baseline characteristics were fairly similar between the two groups. Mean birthweight in intervention group was 1555.4±272g vs. 1430.1±265g in control group. Control group had more female infants than intervention group (70.9% vs. 48.5%).

Table 1

Baseline characteristics of study subjects

Variables	**Kangaroo mother care group**	**Control group**	**P value**
	Frequency (%)/Mean ±standard deviation	**Frequency(%) Mean±standard deviation**	
Age of mother (years)	25.8±5.5	25.0±5.0	0.1239[&]
Employment status			
Employed	76(54.4%)	110(64.3%)	**<0.001***
Unemployed	95(45.6%)	61(35.7%)	
Monthly household income (Kenya Shilling)			
<6000	64(40.5%)	46(28.4%)	**<0.001***

6000 to 15000	65(41.1%)	44(27.2%)	
>15000	29(18.4%)	72(44.4%)	
Mother's education level			
None and Primary	65(38%)	53(30.8%)	0.305*
Secondary	79(46.2%)	93(54.1%)	
Tertiary	2(15.8%)	26(15.1%)	
ANC attendance			
No	12(7.1%)	11(6.5%)	0.840*
Yes	158(92.9%)	158(93.5%)	
Micronutrient use			
No	72(42.1%)	31(18.0%)	**<0.001***
Yes	99(57.9%)	141(82.0%)	
Delivery place			
Study hospital	139(81.3%)	130(75.6%)	0.433*
Different hospital	20(11.7%)	27(15.7%)	
Home	12(7%)	15(8.7%)	
Delivery mode			
Cesarean section	30(17.7%)	27(15.7%)	0.629*
Normal	140(82.4%)	145(84.3%)	
Delivery complications			
No	131(76.6%)	120(70.2%)	0.178*
Yes	40(23.4%)	51(29.8%)	
Multiple births			
No	116(67.8%)	126(74.1%)	0.201*
Yes	55(32.2%)	44(25.9%)	
Pregnancy history			
Never pregnant	83(51.9%)	29(17.2%)	**<0.001***
No pregnancy loss with 1/more live births	65(40.6%)	104(61.5%)	
1/more pregnancy loss with 1/more live births	9(5.6%)	29(17.2%)	
1/more pregnancy loss with live births	3(1.9%)	7(4.1%)	
Maternal diabetes, hypertension or heart disease			
No	154(90.1%)	144(83.7%)	0.082*
Yes	17(9.9%)	28(16.3%)	
Maternal HIV status			
Negative	153(90.5%)	148(92.5%)	0.523*
Positive	16(9.5%)	12(7.5%)	
Toilet access			
No	32(18.7%)	50(29.1%)	**0.025***
Yes	139(81.3%)	122(70.9%)	
Maternal alcohol/smoking during pregnancy			
No	160(93.6%)	170(98.8%)	**0.011***
Yes	11(6.4%)	2(1.2%)	
Infant sex			
Female	83(48.5%)	122(70.9%)	**<0.001***
Male	88(51.5%)	50(29.1%)	

Birthweight (grams)	1555.4±272	1430.1±265	**<0.001**[&]
Mother's average number of meals per day during pregnancy			
Less than 3 meals	39(22.8%)	17(9.9%)	**0.001***
3 meals or more meals	132(77.2%)	154(90.1%)	

** =Chi square test; & =Independent t test*

Neonatal weight gain: Intervention group had a significantly higher mean neonatal weight gain (709.5g vs 471.5g, t=-7.2267, p<0.0001) than controls. Mean neonatal weight gain in intervention group was significantly higher (Mean=686.8, 95% CI=611.4-762.2) than control infants (Mean=528.1, 95% CI=495.7–560.6), [[t=4.2524, p<0.0001] for both cohorts with a birthweight ≤1500g. Similarly, mean neonatal weight gain among intervention group was significantly higher (Mean=729.3, 95% CI=645.5–813.0) than control infants (mean=352.3, 95% CI=296.2–408.4), [t= 6.3532, p<0.0001] for both cohorts with birthweight >1500g.

Infants from households with access to a toilet had significantly better weight gain than those without access (623.9 vs 481.1, t= 3.3626, p=0.0009). Male infants had significantly better weight gain than female infants (648.5 vs 558.0, t=-2.4947, p=0.0131). There were no significant differences in neonatal weight gain among the other baseline characteristics.

Table 2

Association of baseline characteristics with neonatal weight gain

Predictor variables	Mean/Coefficient*/Rank sum¥	Standard deviation/error£	95% confidence interval	R-square/t/f	P value
Kangaroo mother care (all infants)					
No	471.5	15.7£	440.4-502.6	-7.2267	**<0.0001**[&]
Yes	709.5	28.5£	653.2-765.9		
Kangaroo mother care (birthweight ≤1500g)					
No	101	528.1	495.7-560.6	-4.2524	**<0.001**[&]
Yes	72	686.8	611.4-762.2		
Kangaroo mother care (birthweight >1500g)					
No	48	352.3	296.2-408.4	-6.3532	**<0.001**[&]
Yes	83	729.3	645.5-813.0		
Maternal age (years)	-0.33*	3.32£	-6.87-6.22	0.0	0.922[$]
Employment status					
Employed	572.75	22.1£	529.1-616.4	-1.25	0.2110[&]
Unemployed	617.6	28.9£	560.6-674.7		
Monthly household income (Kenya Shilling)					
<6000	608.7	385.7		0.23	0.7922[#]
6000 to 15000	578.2	311.6			
>15000	584.7	241.5			
Mother's education level					
None/primary	548.01	271.3		1.63	0.1970[#]
Secondary	610.3	330.0			

Tertiary	629.6	317.0			
ANC attendance					
No	663.5	83.3£	486.9-840.2	0.9575	0.3391&
Yes	589.2	18.4£	553.1-625.4		
Micronutrient use					
No	613.3	36.5£	540.8-685.8	0.7494	0.4542&
Yes	584.1	20.1£	544.5-623.8		
Delivery place					
Study hospital	604.9	329.2		0.92	0.3991#
Different hospital	558.5	245.3			
Home	528.7	181.4			
Delivery mode					
Cesarean section	595.0	49.9£	494.7-695.3	0.0733	0.9416&
Normal	591.5	19.0£	554.0-628.9		
Delivery complications					
No	579.8	20.2£	540.0-619.6	-1.2967	0.1957&
Yes	633.2	37.7£	558.1-708.2		
Multiple births					
No	594.7	20.4£	554.4-635.0	-0.0133	0.9894&
Yes	595.2	36.3£	523.0-667.4		
Pregnancy history					
Never pregnant	16918.0¥				0.0630€
No pregnancy loss with 1/more live births	20350.5¥				
1/more pregnancy loss with 1/more live births	4735.0¥				
1/more pregnancy loss with live births	774.5¥				
Mother with non-communicable disease (diabetes, hypertension/heart disease)					
No	597.5	19.5£	559.2-635.9	0.6606	0.5093&
Yes	563.0	43.1£	476.0-650.1		
Maternal HIV status					
Negative	605.4	19.3£	567.3-643.5	1.3991	0.1629&
Positive	510.4	52.8£	400.9-620.0		
Household toilet access					
No	481.1	29.0£	423.1-539.0	-3.3626	**0.0009**&
Yes	623.9	20.9£	582.8-665.0		
Maternal alcohol/smoking during pregnancy					
No	591.0	18.0			0.5831π
Yes	637.5	108.6			
Infant sex					
Female	558.0	20.7£	517.1-598.9	-2.4947	**0.0131**&
Male	648.5	31.7£	585.7-711.4		
Birthweight(grams)	-0.077*	0.064£	-0.20-0.05	0.0048	0.229$
Mother's average number of meals per day during pregnancy					

<3	563.0	46.0£	470.4-655.7	-0.7172	0.4738&
≥3	598.8	19.4£	560.6-637.0		
Apgar score					
1-5	528.7	35.2£	458.1-599.3	-1.8961	0.0590&
6-10	620.0	22.2£	576.2-663.8		

$ = *Linear regression analysis;* & *=Independent t test; #= one-way ANOVA; * =Coefficient;* £ *=Standard error;* ¥ *=Rank sum;* € *=Kruskal-Wallis test;* π *=Wilcoxon rank-sum*

At multivariable level, early intermittent KMC remained a significant predictor of neonatal weight gain (p <0.0001). Infants of mothers with secondary level education also had significantly better neonatal weight gain compared to those with none or primary level education (p=0.039). Similarly, delivery complications were associated with higher neonatal weight gain (p=0.037) as well as having access to toilet (p=0.038), birthweight (p<0.0001) and mother having an average of 3 or more meals during pregnancy compared to those who had less than 3 meals (p=0.019).

Table 3

Association of baseline characteristics with neonatal weight gain

Predictor variables	**Coefficient**	**Standard error**	**95% Confidence Interval**	**P Value**
Kangaroo mother care				
No	Reference			
Yes	281.8	40.7	202.0-361.7	**<0.0001**
Employment status				
Employed	Reference			
Unemployed	54.1	37.6	-19.7-127.9	0.151
Mother's education level				
None/primary	Reference			
Secondary	86.6	42.0	4.4-168.9	**0.039**
Tertiary	90.2	56.5	-20.5-201.0	0.110
Delivery complications				
No	Reference			
Yes	85.3	40.8	5.3-165.2	**0.037**
Pregnancy history				
Never pregnant	Reference			
No pregnancy loss with 1 or more live births	-7.7	40.1	-86.2-70.9	0.848
1/more pregnancy loss with 1 or more live births	28.8	64.8	-98.1-155.8	0.656
1/more pregnancy loss with live births	-158.8	104.1	-362.9-45.2	0.127
Household has access to a toilet				
No	Reference			
Yes	96.4	46.5	5.3-187.6	**0.038**
Birthweight(grams)	-0.27		-0.4–(-0.1)	**<0.0001**
Mother's average number of meals per day during pregnancy				

<3	Reference			
≥3	120.1	51.2	19.7-220.4	**0.019**
Apgar score (1 minute)				
1-5	Reference			
6-10	72.8	45.2	-15.8-161.3	0.107

Length of stay: Infants in intervention arm spent significantly shorter length of stay (days) (mean=7.1, 95% CI=6.3-7.9) than those on control arm (mean=17.4, 95% CI=16.2 - 18.6), [t = 14.5009, p<0.0001]. At sub-group analysis for birthweight ≤1500g, intervention infants spent a significantly shorter duration (mean=7.7, 95% CI=6.5-8.9) than control infants (mean=17.5, 95% CI=16.1 -18.9), [t = 10.3, p<0.0001]. For infants with birthweight >1500g, intervention infants spent a significantly shorter duration (mean=6.4, 95% CI=5.4-7.4) than control infants (mean=17.3, 95% CI=15.1 – 19.5), [t = 9.99, p<0.0001].

Some baseline characteristics were associated with short length of stay. These were micronutrient use (p=0.002), pregnancy history (p=0.0001), access to a toilet (p=0.0001), maternal use of alcohol or smoking during pregnancy (p=0.0104), male infant sex (p=0.0001) and birthweight (p<0.0001). A post hoc Dunn's pairwise comparison of length of stay by pregnancy history was computed with Bonferroni adjustment. The never pregnant category had a significantly lower length of stay than those in "no pregnancy loss with 1 or more live birth" group (p<0.0001) and those in "1 or more pregnancy loss with 1 or more live births" group (p<0.0001). There was no statistically significant difference between the "never pregnant" and those in "1 or more pregnancy loss with no live births" group (p=0.0799). There were no significant differences between other categories (p>0.05).

Table 4

Association of baseline characteristics with length of hospital stay (days)

Predictor variables	Mean/Coefficient*/Rank sum¥	Standard deviation / error£	95% confidence interval	R-square/t/f	P value
Kangaroo mother care (all infants)					
No	17.4	0.6£	16.2-8.6	14.5009	**<0.0001&**
Yes	7.1	0.4£	6.3-7.9		
Kangaroo mother care (birthweight ≤1500g)					
No	101	17.5	16.1-18.9	10.3128	**<0.001&**
Yes	83	7.7	6.5-8.8		
Kangaroo mother care (birthweight >1500g)					
No	51	17.3	15.2-19.5	9.9861	**<0.001&**
Yes	71	6.4	5.4-7.4		
Maternal age(years)	0.05*	0.09£	-0.12-0.2	0.0009	0.597$
Employment status					
Employed	12.9	0.6£	11.7-14.1	1.7611	0.0792&

Unemployed	11.3	0.7£	9.9-12.6		
Monthly household income (Kenya Shilling)					
<6000	12	9		0.31	0.7344#
6000 to 15000	12	8			
>15000	13	7			
Mother's education level					
None/primary	13	9		0.30	0.7431#
Secondary	12	8			
Tertiary	11	8			
ANC attendance					
No	12.6	1.9£	8.6-16.4	0.1838	0.8543&
Yes	12.2	0.5£	11.3-13.2		
Micronutrient use					
No	10.0	0.8£	8.5–11.6	-3.1211	**0.0020&**
Yes	13.1	0.6£	12.0–14.2		
Place of delivery					
Study hospital	36236.0¥				0.3509€
Different hospital	6201.5¥				
Home	4533.5¥				
Mode of delivery					
Cesarean section	12.4	1.3£	9.9–15.0	0.2375	0.8124&
Normal	12.1	0.5£	11.2–13.1		
Delivery complications					
No	12.1	0.5£	11.0–13.1	-0.5739	0.5665&
Yes	12.7	0.9£	10.9–14.4		
Multiple births					
No	12.5	0.6£	11.4–13.6	1.1646	0.2451&
Yes	11.3	0.8£	9.7–13.0		
Pregnancy history					
Never pregnant	11121.0¥				**0.0001€**
No pregnancy loss with 1/more live births	24545.0¥				
1/more pregnancy loss with 1/more live births	5963.0¥				
1/more pregnancy loss with live births	1736.0¥				
Mother with non-communicable disease (diabetes, hypertension/heart disease)					
No	12.0	0.5£	11.0–12.9	0.6606	0.1659&
Yes	13.8	1.3£	11.3–16.4		
Maternal HIV status					
Negative	39127¥			0.5882	0.9772π
Positive	3651¥				
Toilet access					
No	15.9	1.1£	13.6–18.1	4.7031	**<0.0001&**
Yes	11.0	0.5£	11.1–11.9		
Maternal alcohol/smoking					

during pregnancy					
No	46019.5¥				**0.0104**π
Yes	951.5¥				
Infant sex					
Female	13.7	0.6£	12.5–14.9	4.0215	**0.0001**&
Male	9.9	0.7£	8.6–11.2		
Birthweight(grams)	-0.006*	0.002£	-0.01-(-0.003)	0.0470	**<0.0001**$
Mother's average number of meals per day during pregnancy					
<3	10.5	1.0£	8.4–12.6	-1.6448	0.1010&
≥3	12.5	0.5£	11.5–13.5		
Apgar score (1 minute)					
1-5	12.1	0.9£	10.2–13.9	-1.8961	0.9755&
6-10	12.1	0.6£	11.0–13.2		

*$=Linear regression analysis; &=Independent t test; #=one-way ANOVA; * =Coefficient; £=Standard error; ¥=Rank sum; €=Kruskal-Wallis test ; π=Wilcoxon rank-sum*

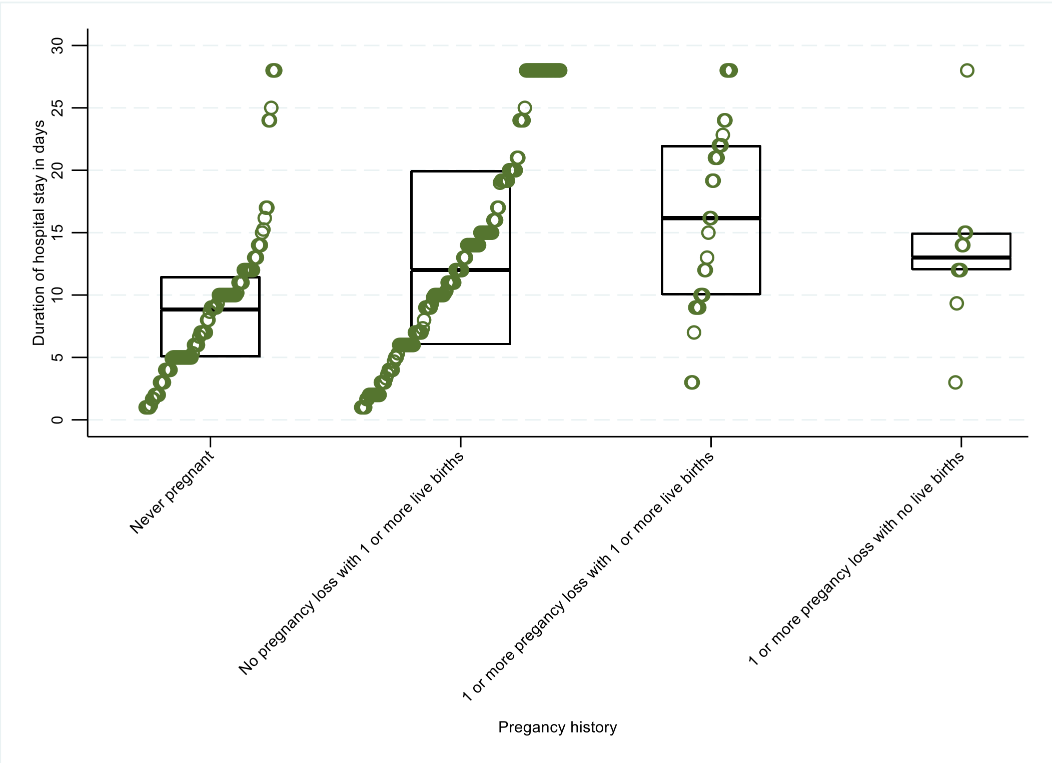

Figure 2: Length of stay among low-birthweight infants

At multivariable level, early intermittent KMC remained a significant predictor of length of stay (p=0.005). Pregnancy history of 1 or more pregnancy loss with 1 or more live births was significantly associated with a longer length of stay than other pregnancy history categories (p=0.027). Higher birthweight was significantly associated with shorter length of stay (p=0.001). All other covariates were non-significant predictors of length of stay.

Table 5

Association of baseline characteristics with length of stay (days)

Predictor variables	Coefficient	Standard error	95% Confidence Interval	P Value
Kangaroo mother care				
No	Reference			
Yes	-9.7	3.5	-16.6–(-2.9)	**0.005**
Micronutrient use				
No	Reference			
Yes	0.9	0.8	-0.7–2.4	0.278
Place of delivery				
Study hospital	Reference			
Different hospital	0.6	1.1	-1.5–2.7	0.567
Home	1.1	1.2	-1.4–3.5	0.395
Mode of delivery				
Cesarean section	Reference			
Normal	-1.4	1.0	-3.3–0.6	0.163
Delivery complications				
No	Reference			
Yes	-1.0	0.8	-2.6–0.6	0.230
Multiple births				
No	Reference			
Yes	0.9	0.7	-2.4–0.5	0.199
Pregnancy history				
Never pregnant	Reference			
No pregnancy loss with 1/more live births	0.5	0.8	-1.0–2.1	0.521
1/more pregnancy loss with 1/more live births	2.7	1.2	0.3–5.1	**0.027**
1/more pregnancy loss with live births	-0.9	1.9	-4.7–2.9	0.634
Birthweight(grams)	-0.004	0.001	-0.007–(-0.002)	**0.001**
Mother's average number of meals per day during pregnancy				
<3	Reference			
≥3	-0.8	1.0	-2.7– 1.1	0.428

DISCUSSION

Early intermittent KMC was effective in improving neonatal weight gain in LBW infants, overall and at sub-group analysis. Neonatal weight gain was evident even after controlling for differences in the birthweight, gestational age, infant sex, Apgar score (≤5 and >5) and other baseline characteristics.

Our findings are consistent with results from a review which showed KMC infants usually have better weight gain compared to conventional care neonates (8). When started early, KMC infants had less weight loss within the first few hours of life and this may account for the better overall net neonatal weight gain (8).

There are findings of non-significant neonatal weight changes between KMC and conventional care infants (11). Different forms of KMC are practiced in many settings with variations on timing of initiation and duration of each session. KMC promotes early initiation of breastfeeding compared to conventional care method (12) while the positive impact of KMC on breastfeeding has been documented (7,8).

We found that secondary level maternal education and toilet access was associated with better weight gain. Access to improved sanitation has been associated with reduced risk of undernutrition (13) while higher levels of maternal education have been associated with favorable growth (14). Delivery complications were associated with higher weight gain which is contrary to some reported findings (3). Infants of mothers who had at least 3 meals a day during pregnancy were associated with better weight gain. This could be an indicator of level of optimized nutrition during lactation. Balanced maternal nutrition can impact infant supply of some nutrients through breastmilk (15).

We reported that higher birthweight was associated with lower neonatal weight gain which would be consistent with literature earlier study on early-life predictors of higher body mass index in healthy children. This study reported slower weight gain trajectories during the first year among high birthweight infants (8).

Our findings showed that KMC infants had shorter length of stay. A study in Kenya for LBW infants weighing 1000g to 1750g with eight-hour period of SSC per day also reported shorter duration of hospital stay (6). A trial in in Bangladesh reported statistically insignificant shorter duration of hospital among KMC infants (16).

Birthweight was a strong negative predictor of length of stay in our study. Normal birthweight neonates usually have shorter length of stay than VLBW often require specialized neonatal care (17). We found that pregnancy history of 1 or more pregnancy loss with 1 or more live births was associated with longer length of stay. With a history of pregnancy loss, it is likely that hospitals modify care for "precious babies" which may prolong length of stay.

The interpretation of hospital stay in KMC settings should be done with the lens that KMC as a package involves early hospital discharge and hospital policies on discharge may differ from one region to another.

CONCLUSION

Early intermittent KMC was effective in improving neonatal weight gain in stable LBW infants (≤2000g). Neonatal weight gain was evident at sub-group analysis of different birthweight categories. The intervention was significantly associated with shorter length of stay. More research is recommended to explore effects of early intermittent KMC on other neonatal complications.

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