

INFLUENCE OF MATERNAL FACTORS ON GROWTH PARAMETERS IN LOW-BIRTH-WEIGHT BABIES WITH KANGAROO MOTHER CARE

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ABSTRACT

Background: Kangaroo mother care (KMC) in low birth weight newborns has been found to be beneficial, but studies have shown that maternal factors might be of concern in the successful application of KMC.

Aim: To study the influence of maternal factors on growth parameters in low-birth-weight babies with KMC.

Methods: This is a prospective cohort study of 40 low birth weight newborns in our institutions. We randomly assigned the newborns to the group which received KMC and to the group which received conventional care. Maternal factors were recorded. We measured weight, length, and head circumferences of newborns daily for thirty days. Data was processed by SPSS x22.0.

Results: A total of 40 newborns were recruited into the study. Weight parameters were significantly higher in the KMC group than in the conventional group except for the Z scores. Regarding maternal characteristics, only gestational age was found to influence the initial and the last head circumference ($p=0.035$). There were no differences in maternal age, parity, maternal education, mode of delivery, fetal sex, and initial Apgar score with any of the growth parameters.

Conclusion: There were no maternal and fetal differences in the growth parameters of the groups, except in the delayed growth of head circumferences in preterm infants.

Keywords: Growth parameters, KMC method, low birth weight

Introduction

Low birth weights (LBW) in newborns is one of the leading causes of neonatal morbidity and mortality. As many as 16% of newborns worldwide have low birth weights with an annual incidence of 18 million. In developing countries, the incidence of LBW was two times higher than in developed countries (1). LBW is associated with many complications such as growth and cognitive disorders, and the development of chronic diseases of the elderly later in life (2).

Maternal factors such as age, multigravidity, narrow pregnancy interval, socio-economic factors, a low level of education, and weight gain during pregnancy increased the incidence of LBW (3-5). Other studies showed a 1.2 times increased risk of low birth weight in women with low socioeconomic status, and 1.7 times increased risk in women with low levels of education (6). LBW is also closely linked with maternal height (7) Mumbare et al. (8) by logistic regression showed that maternal weight <55 kg (OR 4.81, 95%CI 2.53-9.15), maternal height <145 cm (OR 4.13, 95%CI 2.04-8.37), and inadequate antenatal care (OR 4.98, 95%CI 2.64-9.39), were the most significant factors associated with LBW. Taha et al. (9) by logistic regression showed that only maternal age and parity had significant

effects on birth weight ($p=0.014$ and $p=0.008$). However, Negi et al. (10) on the other hand showed that only the primigravida had a higher risk of having an LBW baby (OR 3.21; $p<0.01$) and found no relationship between maternal age, maternal height and weight with LBW. In Indonesia, Trihardani et al. (11) showed that the risk factors associated with LBW were maternal body mass index (RP 5.4; 95CI 1.07-27.29), weight gain during pregnancy (RP 6.6; 95CI 1.30-33.01), and parity (RP=5.30; 1.24-22.56) while there was no significance between in maternal age, maternal height, frequency of antenatal care, and pregnancy interval, with LBW.

Pregnancy in women who were under 20 years of age or who were over 35 years old had an unmet need of adequate nutrition for fetal growth (12). A too narrow pregnancy interval also indicated a shared nutritional condition at risk; and an inadequate time for the recovery of the reproductive system so that the following fetal birth weight in utero would be affected (13).

LBW infants should be kept warm because of their vulnerability to hypothermia which could lead to life-threatening infection, apnea or massive bleeding (14). An incubator is a way to provide warmth for the LBW babies but it may prevent early maternal contact and

breastfeeding (15). Invasive procedures in the incubator also induced stress in babies as proven by some studies that showed increasing heart rates and breaths in infants treated in an incubator (16). Inspired by how marsupials keep their newborns warm, KMC was developed by Martinez and Rey in Bogota (1978)(17).

KMC is effective in the treatment of low birth weight newborns. It is also easy to apply and it is inexpensive. It is very important in many remote areas in Indonesia due to the lack of modern health technology for resuscitation facilities (18). The majority of studies showed better results in infants treated with KMC than with the conventional method, although some of these results are still controversial (19-21). Pratiwi et al. (22) showed that the BBL \geq 1500 g (RR 0.4; 95%CI 0.23-0.73; $p=0.001$) and a neonatal age at the commencement of KMC $>$ 10 days (RR 2.69; 95% CI 1:14 to 6:32; $P = 0.003$) were related to the successful use of KMC. Gestational age \geq 34 weeks (RR 0.94; 95%CI 0.46-1.89; $p=1.00$), KMC duration \geq 65 minutes ($p=0.215$), and a high maternal education level ($p=0.408$) did not influence the incidence of LBW. There is no study that specifically assessed the maternal factors that contribute to the success of KMC in LBW. Neonatologists should be able predict the benefits at the beginning of a therapy because the neonatal period is the most vulnerable period in life and clinicians should apply a therapy that is of benefit.

The aim of the study was to determine the influence of maternal factors on growth parameters in low-birth-weight babies on KMC.

Methods

Study design

This was an analytical prospective cohort study that was conducted at the Adam Malik General Hospital and the Pirngadi Hospital, in Medan, Indonesia, from June to November 2015. Written informed consents were obtained from all parents. This study was approved by the Ethical Committee of University of Sumatera Utara.

Study population

In order to have a representative sample, we calculated the minimal sample size, and 20 babies were required in each study group. Forty consecutive low birth weight newborns, who were delivered in the two institutions, were enrolled into the study. A low birthweight is defined as a weight below 2500 g. The newborns were randomly assigned to the two groups. Randomization was done by computer generated-random numbers. In the first group, the newborn was given KMC and in the second group, they were cared in an incubator as the conventional method. This study only included babies with birth weight of 1000-2500 g, who were hemodynamically stable, who did not require oxygen therapy for most of the day, who had no need of continuous intravenous fluids, and with a mother who was healthy and willing to practice

KMC. This study excluded mothers who were exclusively breastfeeding because, from prior studies, breastfeeding could significantly affect KMC outcome. Exclusion criteria were patients who withdrew from the study or who were lost to follow-up, babies with congenital anomalies, severe perinatal complications that required NICU care, malignancies, metabolic and cardiovascular disorders and death.

Study protocols

The baseline information of maternal and fetal demographics was recorded. Maternal factors included maternal age, gestational age, the number of parity, maternal education, and mode of delivery. This study also included fetal demographics such as fetal sex and the initial Apgar Score.

In the conventional group, the babies were placed in an incubator, according to the standard guidelines of the hospitals. In the KMC group, KMC therapy was initiated as soon as the babies were stable. At enrolment, the mothers were taught how to practice KMC. Mothers were seated in a comfortable chair close to the babies' cradle. They were shown how to hold their babies vertically, strapped to the middle of their (mothers') chests, with skin to skin contact so that the babies' skins were touching their mothers' skin. At other times, when not on KMC, the babies were placed in the cradle with their bodies covered. KMC was applied for 4-6 hours each day. Babies in both the groups were provided with vitamin and mineral supplementation as per the protocol.

The subjects were followed up for 30 days, with daily anthropometric measurements. Babies were weighed naked on an electronic weighing scale (GEA). The weighing machine was calibrated daily. The lengths were measured with an infantometer (GEA) at birth, day 10, day 20, and day 30. The head circumferences were measured with a standard tape (Butterfly) at birth, day 10, day 20, and day 30. All measurements were carried out by two blinded investigators. The mean of both measurements was taken. During the follow-up, if there were sucking disorders, breathing disorders, or loss of consciousness, the babies were treated appropriately and were excluded from the study.

The babies' weights were plotted using Fenton's growth charts. We calculated the accurate weight gain velocity with the following formula $GV = [1000 \times (W_n - W_1)] : [(D_n - D_1) \times (W_n + W_1) / 2]$ and the estimated weight gain velocity with the formula $GV [1000 \times \ln (W_n / W_1)] : (D_n - D_1)$. The magnitude of errors was reflected in the percentage of absolute difference with the formula $100 \times (\text{Estimated } GV - \text{Accurate } GV) : \text{Accurate } GV$. We also calculated a z-score for weight in www.peditools.org/fenton/2013 at birth and day 30.

Data analysis

Data were analyzed by SPSS (Statistical Product and Service Solutions, Chicago, IL, USA) 22.0 for Windows. Categorical data were expressed as number and continuous data as

mean \pm SD. Chi-square test (Fisher's exact test) was used to examine the relation between qualitative variables. T-independent, T-dependent, Pearson correlation were used to evaluate quantitative variables. The significance was taken at 95% with a p -value <0.05 .

Results

During the study period, from June to October 2015, there were 90 babies who were born with a low birth weight.

Two mothers were not willing to participate in KMC. Some newborns were excluded from the study. There were 45 newborns who needed NICU care; of these, 1 had a congenital anomaly, 1 with a cardiovascular disorder, and 1 was a newborn who was dead. 40 newborns were eligible for the study and were successfully enrolled. There was no loss to follow up or from withdrawal from the study.

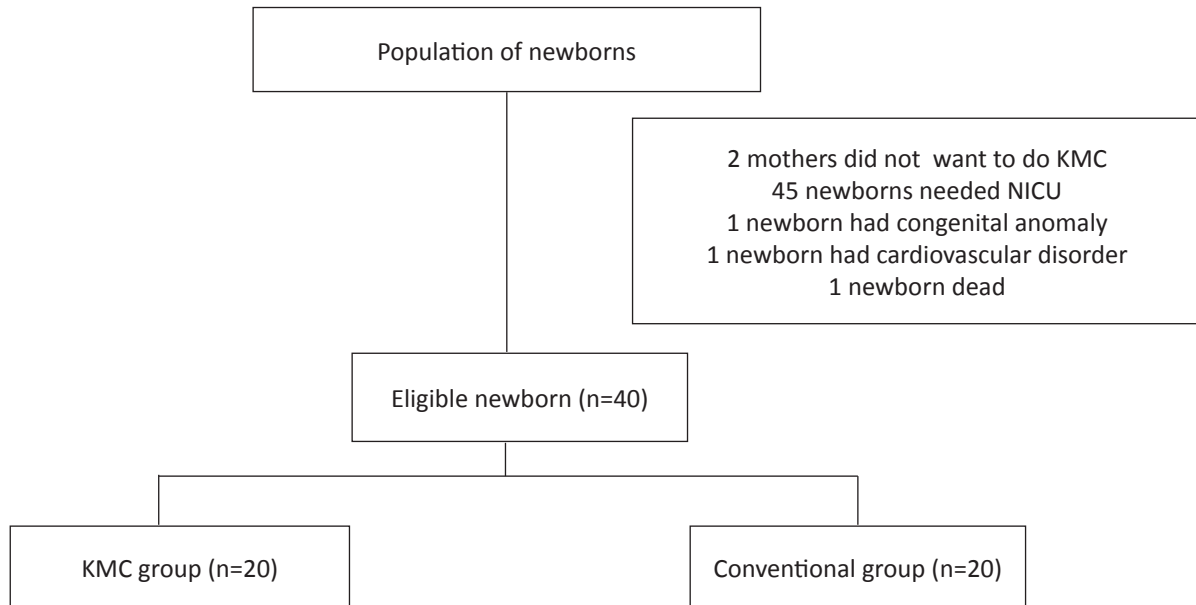


Figure 1: Flow chart of the study

Maternal and fetal demographic characteristics were shown in Table 1. No differences were found between maternal age, parity, gestational age, maternal education, mode of delivery, fetal sex, and the Apgar score between KMC and conventional group. The initially measured weight, length, and head circumferences were similar in both groups ($p=0.100$; $p=0.353$; $p=0.088$, respectively) making the study results more accurate. The last measured weight was significantly higher in the KMC group than in the conventional group (2187.5 ± 371.04 vs 1899 ± 242.55 ; $p=0.015$). The difference of the mean, the initial and the last weight was also higher in the KMC group than the conventional group (205.5 ± 147.451 vs 96 ± 68.702 ; $p=0.001$). To determine the accuracy of the weight parameter, we calculated the weight gain velocity. The accurate weight gain velocity was 5.098 ± 2.155 g/day, and

the estimated weight gain velocity was 5.112 ± 2.168 g/day. Accurate weight gain velocity, estimated weight gain velocity, and absolute difference percentage were found to be significantly higher in the KMC group than in the conventional group ($p=0.01$; $p=0.009$; $p<0.001$). But, there were no differences in the last measured weight Z score between both groups ($p=0.364$).

We also found no differences of the last measured length and head circumference Z-score between both groups (Figure 2). Although the mean difference of initial and last head circumference (cm) showed a significant difference ($p=0.004$), other parameters regarding head circumferences did not show any difference. Duration of hospital stay was higher in the conventional group than in the KMC group, but this was not significantly different (28.4 ± 5.020 vs 23.15 ± 5.184 ; $p=0.42$).

2D Graph 6

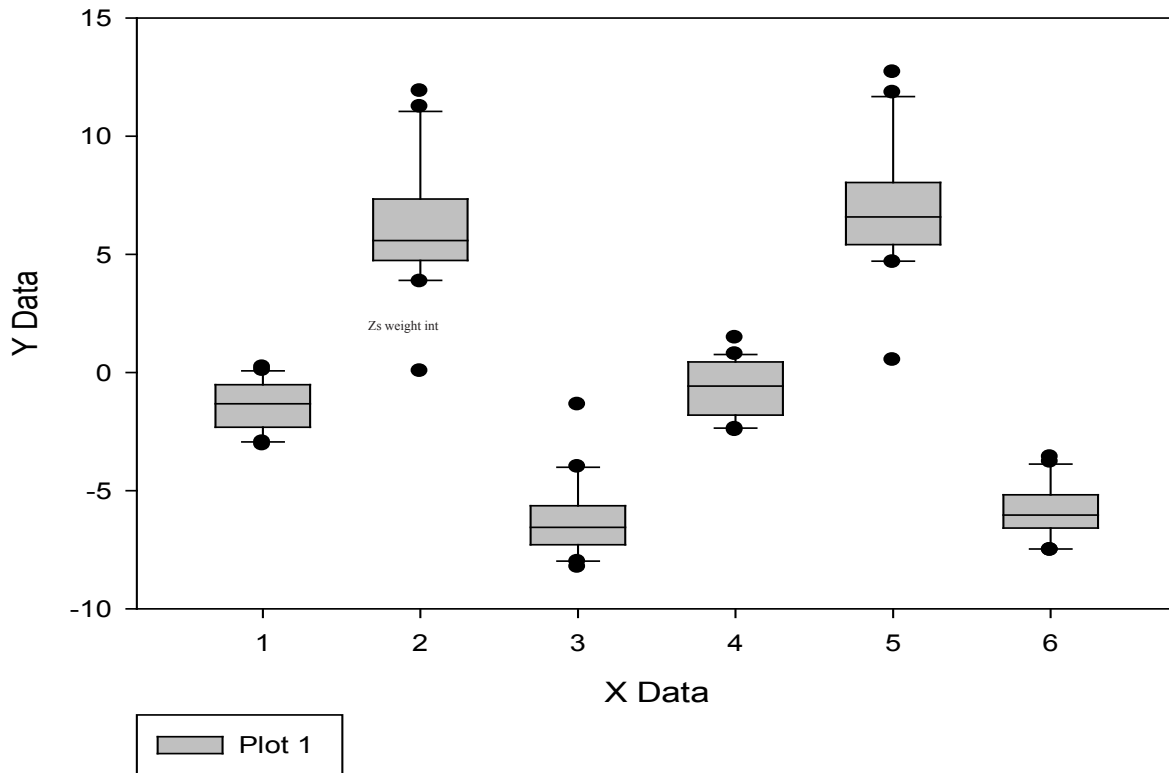


Figure 2: Distribution of Z-score for babies’ weight, length, and head circumference (HC) at initial (int) and day (last) 30 measurement

Table 1: Demographic characteristics of maternal, fetal, and measured parameters.

Characteristics	KMC group	Conventional group	p
Maternal characteristics			
Maternal age (years old)	28.6 ± 2.703	28.7 ± 4.485	0.263
Parity (n)	2.25 ± 0.786	2.1 ± 0.852	0.765
Gestational age			
<37 weeks	7 (35%)	5 (25%)	0.490
>37 weeks	13 (65%)	15 (75%)	
Maternal education			
Non-educated	5 (25%)	4 (20%)	0.705
Educated	15 (75%)	16 (80%)	
Maternal morbidity			
Preeclampsia	3 (15%)	5 (25%)	0.429
Placenta previa	1 (5%)	0 (0%)	
Gestational diabetes	0 (0%)	0 (0%)	
Other causes	16 (80%)	15 (75%)	
Mode of delivery			
Spontaneous delivery	9 (45%)	5 (25%)	0.185
Vaginal delivery	11 (55%)	15 (75%)	

Characteristics	KMC group	Conventional group	p
Fetal characteristics			
Fetal sex			
Male	11 (55%)	15 (75%)	0.320
Female	9 (45%)	5 (25%)	
Initial Apgar score	8.2 ± 0.696	8 ± 0.795	0.672
Measured parameters			
Initial measured weight			
Weight (kg)	1882 ± 293.125	1803 ± 217.234	0.100
Weight Z score	-1.385 ± 1.019	-1.483 ± 1.070	0.901
Last measured weight			
Weight (kg)	2187.5 ± 371.014	1899 ± 242.55	0.015*
Weight Z score	6.316 ± 2.232	5.414 ± 1.814	0.364
Initial measured length			
Length (cm)	41.025 ± 2.993	39.75 ± 2.653	0.353
Length Z score	-6.121 ± 1.613	-4.076 ± 11.878	0.117
Last measured length			
Length (cm)	42.28 ± 2.938	40.625 ± 2.665	0.340
Length Z score	-0.623 ± 1.165	-1.305 ± 1.030	0.290
Initial measured head circumference (HC)			
HC (cm)	30.325 ± 3.001	29.225 ± 1.824	0.088
HC Z score	7.134 ± 2.202	6.008 ± 1.83	0.444
Last measured head circumference (HC)			
HC (cm)	30.96 ± 1.762	30.035 ± 1.719	0.800
HC Z score	-5.86 ± 1.088	-6.351 ± 1.418	0.394
Accurate weight gain velocity (g/day)	5.098 ± 2.155	1.763 ± 1.220	0.010*
Estimated weight gain velocity (g/day)	5.112 ± 2.168	1.764 ± 1.221	0.009*
Absolute difference percentage (%)	0.214 ± 0.162	0.032 ± 0.029	<0.001*
Mean difference of initial and last weight (kg)	205.5 ± 147.451	96 ± 68.702	0.001*
Mean difference of initial and last length (cm)	1.255 ± 0.305	0.875 ± 0.215	0.513
Mean difference of initial and last head circumference (cm)	0.635 ± 2.494	0.81 ± 0.354	0.048*
Duration of hospital stay	23.15 ± 5.184	28.4 ± 5.020	0.420

*Significant difference

From the maternal characteristics, only gestational age was found to influence the mean differences of initial and last head circumference (-0.314 ± 3.746 vs 1.415 ± 1.064 ; $p=0.035$). However, gestational age was not associated with other parameters. There were no differences in maternal age, parity, maternal education, mode of delivery, fetal sex, and initial Apgar score with accurate weight gain

velocity, estimated weight gain velocity, absolute difference percentage, and mean differences of initial and last weight, length, and head circumferences (Table 2).

We plotted a mean weight gain graph. Peak weight gains were shown on day 16, 18, and 29. Although the graph showed irregular weight gain, on the last day, the increase in weight was greater than the initial weight (Figure 2).

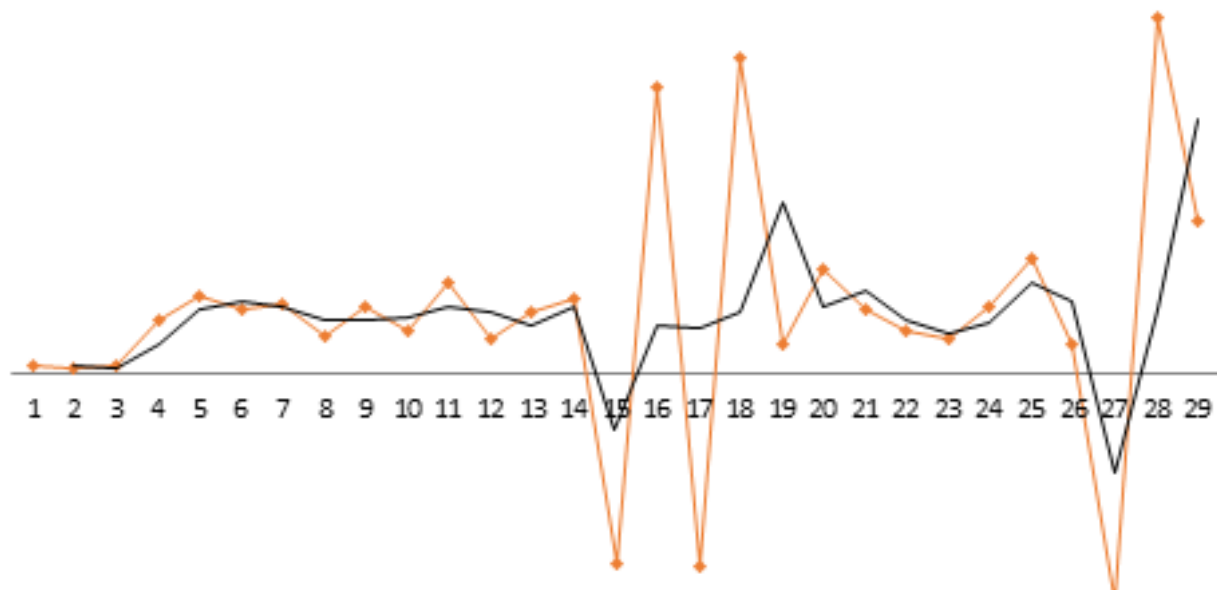


Figure 3: Mean weight gain in KMC group (red line showed the real weight gain and black line showed smoothed out curve)

Discussion

This is the first study that specifically determined the effect of maternal factors on the successful use of Kangaroo Mother Care in low birth weight babies compared with conventional therapy. Pratiwi et al. (2015) showed that high levels of maternal education had no effect ($p=0.408$) (22) and Rodriguez et al. (2007) showed no difference in weight gain with the application of KMC in LBW newborns, whether with spontaneous delivery or cesarean section (23).

The maternal-fetal skin-to-skin contact therapy of KMC is applied as soon as possible after birth (24), helping mothers in their role as providers of biological and psycho-emotional needs for their child (25, 26). According to WHO guidelines, continuous KMC is indicated in infants with BBL below 2000 g. Intermittent KMC can also be useful in infants hospitalized in NICU, but this still needs further research (27).

The importance of KMC is in the enhanced bonding of mother and child. Feldman et al. (2002) successfully demonstrated the positive impact in the relationship between mother and child (28). Athanasopoulou et al. (2014) showed that KMC resolved negative moods of maternal anxiety and depression (29). KMC also increased the confidence and competence of the mother to care for her baby and significantly reduced stress. These all contribute to the improvement in the growth and development of the newborns (30).

In this study, an assessment of growth was based on the infant's weight, length, and head circumference, which are the important markers of a child's health (31,32). Bera et al. (2014) showed that in infants receiving KMC, the growth parameters and mental development were better than in infants who were treated conventionally (33).

However Ali et al. (2009) showed that infants treated in an incubator had a higher weight gain per day (19.3 vs.10.4 g, $p<0.001$), shorter duration of stay (6.9% vs. 23.2% $p = 0.014$), lower infection rate (6.9% vs. 23.2% $p=0.014$), than babies who received KMC (19). Palencia et al. (2009) in 115 LBW infants who were followed up until 13 months, showed that the growth in height for age was higher within the percentiles of weight for age ($p=0.0001$). Male gender had a higher weight than females ($p=0.031$) (34). This study was similar to the study in Indonesia reported previously. In that study, we showed that only the last measured weight, the difference in the initial and the last weight, and the weight gain velocity were higher in the KMC group than the conventional group. No differences were found in the length and head circumferences. Haksari (2004) and Rahmayanti (21) in Indonesia also found that there was no difference between weight/age, length/age, head circumference/age in LBW infant treated with KMC and conventional therapy. On the other hand, Rao et al. (20) showed that infants treated in incubators had a higher weight gain, head circumference (0.49 vs 0.75 cm, $p = 0:02$), and body length (0.99 vs. 0.7 cm, $p=0.008$) compared with infants who received KMC.

It had been observed that weight gain should approximate an intrauterine growth rate of 16.8 to 30.7 g/day (32). In this study, the accurate weight gain velocity was 5.098 ± 2.155 g/day and the estimated weight gain velocity was 5.112 ± 2.168 g/day. These were still far below the recommended growth rate. The Z-score of weight was still below the expected average. Newborns were still categorized as small for gestational age at the end of the study.

The parameters of weight and length were not affected by maternal age, parity, maternal education, mode of delivery, fetal sex, and the initial Apgar score. Newborns

Table 2: Difference accurate weight gain velocity, estimated weight gain velocity, mean differences of initial and last weight, length, and had circumference between subgroups of maternal and fetal characteristics

Characteristics	Accurate weight gain velocity	Estimated weight gain velocity	Absolute difference percentage	Mean differences of initial and last weight	Mean differences of initial and last length	Mean differences of initial and last head circumference
Maternal characteristics						
Maternal age (years old)	r 0.309 p 0.186	r 0.309 p 0.185	r -0.325 p 0.163	r 0.155 p 0.515	r -0.325 p 0.163	r 0.155 p 0.515
Parity (n)	r 0.134 p 0.574	r 0.134 p 0.572	r -0.417 p 0.068	r 0.350 p 0.130	r -0.417 p 0.068	r 0.350 p 0.130
Gestational age						
<37 weeks	5.793 ± 1.898	5.810 ± 1.913	0.258 ± 0.156	338.57 ± 137.165	1.286 ± 0.474	-0.314 ± 3.746
>37 weeks	4.680 ± 2.289	4.691 ± 2.304	0.189 ± 0.168	283.85 ± 158.248	1.192 ± 0.236	1.415 ± 1.064
p value	0.810	0.812	0.980	0.815	0.271	0.035*
Maternal education						
Non educated	3.819 ± 1.223	3.824 ± 1.229	0.111 ± 0.078	208.33 ± 79.352	1.050 ± 0.197	1.600 ± 1.580
Educated	5.604 ± 2.309	5.622 ± 2.324	0.257 ± 0.173	343.57 ± 156.579	1.300 ± 0.351	0.471 ± 2.683
p value	0.061	0.08	0.015	0.074	0.487	0.774
Mode of delivery						
Vaginal delivery	4.773 ± 1.541	4.782 ± 1.552	0.175 ± 0.1257	281.25 ± 114.697	1.300 ± 0.417	-0.025 ± 3.471
Caesarean section	5.267 ± 2.565	5.283 ± 2.581	0.238 ± 0.186	317.50 ± 172.844	1.175 ± 0.263	1.517 ± 1.048
p value	0.059	0.059	0.85	0.346	0.723	0.073
Fetal characteristics						
Fetal sex						
Male	5.408 ± 2.535	5.426 ± 2.549	0.248 ± 0.170	315.27 ± 169.534	1.063 ± 0.1912	1.482 ± 1.155
Female	4.654 ± 1.699	4.664 ± 1.713	0.171 ± 0.153	285.56 ± 129.722	1.422 ± 0.3632	-0.011 ± 3.298
P value	0.069	0.07	0.271	0.142	0.266	0.142
Initial Apgar score	r -0.041 p 0.864	r -0.041 p 0.865	r 0.064 p 0.788	r -0.141 p 0.554	r 0.292 p 0.211	r 0.018 p 0.938

*Significant difference

at birth who were <37 weeks of gestational age, had delayed the growth of head circumference. KMC had been proved to increase cerebral blood flow, acting as nutritional support, mainly to the brain. Korraa et al. (2014) found that newborns who received KMC had a lower cerebral blood flow resistive index ($p < 0.05$), indicating an improved cerebral blood flow (35). The influence of immature organ in preterm babies need to be considered, and this would require further research (36).

The strength of this study is the detailed follow-up parameters which are better than those reported in other studies. The better follow-up rate in the KMC group could be due to the active involvement of the mother in the care of her LBW baby. The limitations of this study are the small sample size conducted in two institutions only. Further research is needed to confirm these findings.

Conclusion

There were no maternal and fetal differences in the growth parameters of the two groups of the study, except for the delayed growth of head circumferences in preterm infants.

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Conflict of interest

The author declared no conflict of interest in this study.

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