

Effectiveness of Kangaroo Mother Care in the Management of Twin Low-Birth-Weight Neonates: A Non-Randomized, Open, Controlled Trial

Yaswanth Gonuguntla¹, Tanmaya Metgud^{1*}, N. S. Mahantshetti¹

1. Department of Pediatrics, Jawaharlal Nehru Medical College, Nehru Nagar, Belgaum Karnataka, India

ABSTRACT

Background: Twin low-birth-weight (LBW) neonates are exposed to the increased risk of mortality and morbidity due to poor prognosis. The present study aimed to evaluate the effectiveness of kangaroo mother care (KMC) in the management of twin LBW neonates.

Methods: This prospective, observational study was conducted on 150 neonates with the birth weight of <2,200 grams during one year. The neonates were divided into three groups of KMC I (receiving KMC; n=60), KMC II (singletons receiving KMC; n=30), and twins receiving conventional method of care (CMC; n=60). The neonates were assessed before and after the intervention in terms of thermoregulation, growth rate, breastfeeding, and self-confidence of the mothers managing the neonates based on a Likert scale. The subjects were followed-up until reaching the target weight of 2.5 kilograms. Data analysis was performed in SPSS software 20.0.

Results: Neonates in the KMC groups were eutermic. Mean weight gain increased in KMC I (13.48±1.76 g/kg/day) and KMC II (13.15±1.66 g/kg/day) compared to the CMC group (11.99±1.20 g/kg/day) (P=0.0014). Length (43.55±1.90, 43.86±1.34, and 43.40±1.94 cm, respectively) (P=0.567) and head circumference (31.13±0.77, 31.43±1.15, and 31.30±1.07 cm, respectively) (P=0.498) were comparable in the CMC, KMC I, and KMC II groups. Early initiation of breastfeeding was observed in KMC I (2.68±1.55 days) and KMC II (2.97±2.88 days) compared to the CMC group (5.17±2.65 days) (P<0.0006). In addition, the mothers' self-confidence to manage the LBW neonates was significantly higher in both the KMC groups compared to the CMC group (P<0.0001).

Conclusion: According to the results, KMC is a cost-effective, humane intervention, which could effectively alleviate the burden of managing twin and singleton LBW neonates in low-income countries.

Keywords: Kangaroo mother care, Low birth weight, Neonates, Singletons, Twins

Introduction

Low birth weight (LBW) is defined as the birth weight of less than 2,500 grams. It is a significant indicator of undernourished neonates that are exposed to the increased risk of mortality and morbidity. Each year, 20 million LBW preterm neonates are born across the world, and 96.5% are in developing countries (1). In India, 30% of the annual live births are reported to be LBW infants.

Twins are at the five-fold risk of fetal death, seven-fold risk of neonatal death, and five-fold risk of infant death compared to singletons (2-4). Twin pregnancies are associated with high-risk gestations, as well as elevated perinatal risks (5),

especially in developing countries; this largely contributes to the overall burden of perinatal mortality and morbidity (6). Furthermore, twins are at a higher risk of LBW, preterm birth, chronic disabilities, and morbidity and mortality compared to singletons. Hypothermia and infections (e.g., respiratory infections) are the major predisposing factors to the mortality of twins (2-4).

Management of twin LBW neonates requires incubators and open care systems (7). The standard care for these neonates is practiced worldwide although it is costly and complex and requires trained personnel and special equipment.

* Corresponding author: Tanmaya Metgud, Department of Pediatrics, Jawaharlal Nehru Medical College, Nehru Nagar, Belgaum, Karnataka, India. Tel: 09845395294; Email: tanmayametgud@gmail.com

Please cite this paper as:

Gonuguntla Y, Metgud T, Mahantshetti NS. Effectiveness of Kangaroo Mother Care in the Management of Twin Low-Birth-Weight Neonates: A Non-Randomized, Open, Controlled Trial. Iranian Journal of Neonatology. 2018 Sep; 9(3). DOI: 10.22038/ijn.2018.29036.1391

Kangaroo mother care (KMC) has been developed due to the unavailability of these facilities across the world and the increased morbidity and mortality caused by the conventional care of these infants (8, 9).

KMC, also known as skin-to-skin contact, is an alternative to conventional neonatal care (10). In the KMC method, the infant is vertically placed between the mother's breasts and firmly attached to her bare chest. KMC results in frequent, exclusive breastfeeding and early discharge from the hospital. In this method, mothers act as an "incubator" to stabilize the body temperature of LBW neonates and are the main source of nutrition. LBW neonates are nurtured via KMC until they acquire adequate immunity (as that of term neonates) in order to survive in the extra-uterine environment. KMC was developed to overcome the lack of incubators and high rates of nosocomial infections in local hospitals (11).

The appropriate care of twin LBW neonates involves exclusive feeding, temperature control, skin care, early detection and treatment of complications, and reduction of mortality rate. There is limited literature regarding KMC and its efficacy in the monitoring of twin LBW neonates. The present study aimed to evaluate the effectiveness of KMC in the management of twin LBW neonates.

Methods

Study Design and Data Collection

This prospective, interventional study was conducted at the neonatal intensive care unit (NICU) of the Department of Pediatrics at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre in Belagavi, India. In total, 150 LBW neonates with the birth weight of <2,000 grams, including twins and singletons, were enrolled in the study.

Exclusion criteria of the study were as follows: 1) critically ill neonates requiring ventilation, oxygen, orogastric aspiration, and ionotropic support; 2) critically ill mothers who were not able to nurse the neonates; 3) neonates with congenital anomalies (e.g., cleft palate) and 4) mothers with multiple pregnancies (more than two neonates). The neonates of the mothers who were unwilling to participate in the study were assigned to the control group receiving conventional method of care (CMC). The selected LBW neonates were divided into three groups of twins with KMC (KMC I; n=60), twins without KMC (CMC; n=60), and singletons with KMC (KMC

II; n=30).

Prior to the study, ethical clearance was obtained from the Institutional Ethical Committee for Human Subjects' Research. After explaining the objectives of the study, written informed consent was obtained from all the mothers before data collection. Data were recorded in a predesigned and pretested proforma.

Intervention

The effectiveness of KMC was assessed based on the neonates' temperature regulation, growth rate, exclusive breastfeeding, bonding, and self-confidence of the mother in the care of the infants. The study groups were also compared in terms of these parameters.

KMC was explained to the mothers and family members of the subjects in the KMC I (LBW twins) and KMC II groups (LBW singletons). Both groups were counseled regarding basic hygiene principles, the importance of temperature maintenance, and skills and benefits related to breastfeeding and expressing breast milk.

KMC was initiated when the neonates were stable. Skin-to-skin care was provided by the mothers by placing the neonates in a kangaroo bag in an upright kangaroo position. The mothers were encouraged to provide skin-to-skin care for a minimum of 13-14 hours. Conventional maternal care was pursued in the twins in the CMC group. Once stable, the neonates were wrapped appropriately and placed next to the mother. The mothers were trained on the importance of temperature maintenance, breastfeeding and expressing the breast milk, and basic hygiene standards.

The study groups were monitored in terms of body temperature, weight, length, head circumference, vital signs, and random blood sugar. Furthermore, the behavioral effects of KMC on the mothers were analyzed through promoting breastfeeding by considering the day of initiating direct breastfeeding and the number of feedings per day. Duration of KMC per day was assessed and marked on a KMC chart by the mothers and nurses at home and in the hospital, respectively.

Oral calcium, vitamin, zinc and iron supplements were administered in accordance with the guidelines of the National Neonatology Forum of India (12). After initiating KMC, the acceptability and effectiveness of KMC were evaluated by comparing the responses of the mothers regarding their bonding and self-confidence in the care of the LBW neonates.

The level of maternal self-confidence in the management of the infants was measured based on a Likert scale on days two and seven.

Discharge and Follow-up

The neonates were discharged when they met the discharge criteria, as follows: 1) weight gain of 15-20 g/kg/day for three consecutive days; 2) successful breastfeeding or expressed breast milk feeding; 3) maintenance of body temperature; 4) no evidence of disease and 5) self-confidence of the mothers in the care of the units. The neonates were followed-up weekly until reaching 2.5 kilograms of weight, and the adaptation of KMC at home was assessed using a questionnaire during follow-up. The follow-up questionnaire consisted of items on the weight gain, length, and head circumference of the neonates.

Statistical Analysis

Data analysis was performed in SPSS version 20.0. Temperature regulation and growth rate of the neonates were assessed using student unpaired t-test, and breastfeeding performance was analyzed using Mann-Whitney U test. In addition, bonding and self-confidence were assessed using Wilcoxon signed-rank test. Assessment of KMC adaptation at home was carried out using Chi-square. The study parameters were compared between the groups, including the body temperature, weight, length, head circumference, vital signs, random blood sugar, day of initiating direct breastfeeding, and

number of the feedings per day. In all the statistical analyses, $P \leq 0.05$ was considered significant.

Results

The majority of the mothers were within the age range of 20-24 years with 1-3 parities. In addition, the majority were housewives and had academic education. In the CMC (18) and KMC I groups (21), the mode of delivery was natural vaginal, while in the KMC II group, low-segment cesarean section was common. Sociodemographic characteristics of the patients are presented in Table 1.

In the CMC (33) and KMC I groups (32), the majority of the neonates were female, while most of the neonates were male in the KMC II group ($n=19$). Birth weight was 1.8-2.2 kilograms in the CMC (19), KMC I (18), and KMC II groups (18). The number of moderately preterm neonates was high in the CMC (18), KMC I (23), and KMC II groups (26). Demographic characteristics of the neonates are shown in Table 2.

Effect of KMC on Temperature Maintenance

The axillary temperature of the neonates was compared before and after the completion of KMC. Before the intervention, hypothermia was observed in the CMC (3) and KMC I groups (2) and none of the neonates in the KMC II group. Cold stress ($36-36.5^\circ\text{C}$) was identified in the majority of the neonates in the KMC I group compared to the CMC ($P=0.062$) and KMC II groups ($P=0.065$).

Table 1. Sociodemographic Characteristics of Mothers

Variable	Group			P-value	
	CMC N (%)	KMC I N (%)	KMC II N (%)	CMC-KMC I	KMC I- KMC II
Age (year)					
20-24	15 (50)	22 (73.3)	15 (50)		
25-29	15 (50)	7 (23.3)	12 (40)	0.0731	0.162
≥ 30	0	1 (3.3)	3 (10)		
Parity					
Primiparous	12 (40)	12 (40)	14 (46.6)		
1-3	18 (60)	18 (60)	15 (50)	0.0796	0.4747
>3	0	0	1 (3.33)		
Education Level					
Illiterate	0	0	3		
Non-graduate	29	28	27	0.1065	0.2542
Graduate	1	2	0		
Occupation Status					
Housewife	29 (96.7)	28 (93.3)	30 (100)	1.0	1.0
Employed	1 (3.3)	2 (6.7)	0		
Socioeconomic Status					
840-1399 (Class III)	5 (16.67)	4 (13.33)	5 (16.7)		
420-839 (Class IV)	12 (40)	16 (53.33)	13 (43.33)	0.58	0.74
<420 (Class V)	13 (43.33)	10 (33.33)	12 (41)		
Mode of Delivery					
NVD	18 (60)	21 (70)	10 (33.3)	0.4172	0.0040
LSCS	12 (40)	9 (30)	20 (66.7)		

*CMC: conventional method of care; KMC: kangaroo mother care; NVD: normal vaginal delivery; LSCS: low segment cesarean section

Table 2. Demographic Characteristics of Neonates

Variable	Group			P-value	
	CMC N (%)	KMC I N (%)	KMC II N (%)	CMC-KMC I	KMC I-KMC II
Gender					
Male	27 (45)	28 (46.6)	19 (63.3)	0.8552	0.1362
Female	33 (55)	32 (53.34)	11 (36.7)		
Birth Weight (kg)					
<1.5	0	4 (13.3)	3 (10)	0.0997	0.1411
1.5-1.8	11 (36.7)	8 (26.7)	9 (30)		
1.8-2.2	19 (62.3)	18 (60)	18 (60)		
Gestational Age (week)					
<32	2 (6.67)	0	0	0.2082	0.3172
33-36	18 (60)	23 (76.67)	26 (86.7)		
≥37	10 (33.33)	7 (23.33)	4 (13.3)		

Table 3. Comparison of Pre-intervention and Post-intervention Body Temperature of Neonates

Test	Group	Temperature (°C) N (%)				P-value	
		<36	36-36.5	36.5-37.5	>37.5	CMC-KMC I	KMC I-KMC II
Pre-intervention	CMC	3 (10)	6 (20)	21 (70)	0	0.062	0.065
	KMC I	2 (6.67)	15 (50)	13 (43.33)	0		
	KMC II	0	8 (26.67)	22 (73.33)	0		
Post-intervention	CMC	0	1 (3.33)	26 (86.67)	3 (10)	0.112	1.000
	KMC I	0	0	30 (100)	0		
	KMC II	0	0	30 (100)	0		

Table 4. Comparison of Growth Parameters between Study Groups at Birth, upon Discharge, and after Reaching 2.5 Kilograms of Target Weight

Test	Growth Parameters Mean±SD	Group Mean±SD			P-value
		CMC	KMC I	KMC II	
At Birth	Weight (kg)	1.79±0.25	1.83±0.13	1.75±0.22	0.353
	Length (cm)	43.55±1.90	43.86±1.34	43.40±1.94	0.567
	Head Circumference (cm)	31.13±0.77	31.43±1.15	31.30±1.07	0.498
Upon Discharge	Weight (kg)	1.80±0.24	1.74±0.14	1.67±0.17	0.0647
	Length (cm)	44.41±1.50	44.19±1.32	43.93±1.80	0.498
	Head Circumference (cm)	31.74±0.67	31.68±1.07	31.67±0.95	0.945
After Reaching Target Weight	Length (cm)	46.80±1.02	47.22±1.34	47.33±1.82	0.319
	Head Circumference (cm)	33.33±0.67	33.73±0.67	33.68±0.88	0.074

Furthermore, euthermia was common in the neonates of the CMC (21) and KMC II groups (22) compared to the KMC I group (13). However, most of the neonates were euthermic in the present study (56), and none of the neonates had hyperthermia. Postintervention, cold stress (1), and hyperthermia (3) were observed in the CMC group, while the neonates in the KMC I and II groups were euthermic (Table 3).

Effect of KMC on Growth Rate

Comparison of growth parameters between the study groups was performed at birth and upon discharge from the hospital. At birth, the differences in weight ($P=0.353$), length ($P=0.567$), and head circumference ($P=0.498$) were comparable in the study groups. However, after the intervention and upon discharge, the differences in this regard were insignificant and comparable with the CMC ($P=0.0647$), KMC I ($P=0.498$), and KMC II groups ($P=0.945$). After reaching the target body weight of 2.5

kilograms, the mean length ($P=0.319$) and head circumference of the neonates ($P=0.074$) were significant in the study groups (Table 4). The time required to reach the target weight was less in the KMC I group than the CMC and KMC II groups ($P=0.4118$). In addition, weight gain was comparatively higher in the KMC I group compared to the CMC and KMC II groups ($P=0.0014$) (Table 5).

Effect of KMC on Breastfeeding and Its Acceptability

Breastfeeding was initiated earlier in the KMC I and KMC II groups compared to the CMC group ($P=0.0006$). Eventually, the frequency of breastfeeding per day was also higher in the KMC I and KMC II groups compared to the CMC group ($P=0.0003$) (Table 5).

After initiating KMC, the acceptability and effectiveness of KMC were assessed on days two and seven. A Likert scale was used to compare the responses of the mothers regarding bonding and

Table 5. Comparison of Time Required for Neonates to Reach Target Weight (2.5 kg) and Breastfeeding Performance of Mothers in Study Groups

Variables	Group Mean±SD			P-value
	CMC	KMC I	KMC II	
Time to reach Target Weight (week)	6.38±2.16	5.66±1.27	6.00±2.11	0.4118
Weight Gain (g/kg/day)	11.99±1.20	13.48±1.76	13.15±1.66	0.0014
Daily Frequency of Breastfeeding	6.67±2.55	9.27±1.49	8.57±2.64	0.0003
Day of Initiation	5.17±2.65	2.68±1.55	2.97±2.88	0.0006

Table 6. Comparison of Responses of Mothers Regarding Bonding and Self-confidence in Care of Low-Birth-Weight Neonates on Days Two and Seven

Options	Day 2			P-value	Day 7			P-value
	CMC	KMC I	KMC II		CMC	KMC I	KMC II	
Are you happy and comfortable with the infant being in the NICU?								
1	0	0	0		19	30	30	
2	0	25	25		11	0	0	
3	27	5	5	<0.001	0	0	0	<0.001
4	3	0	0		0	0	0	
5	0	0	0		0	0	0	
Are you self-confident in handling the infant?								
1	5	5	5		0	0	0	
2	16	21	22		1	0	0	
3	9	4	3	<0.295	21	0	0	<0.001
4	0	0	0		8	5	5	
5	0	0	0		0	25	25	
Are you self-confident in looking after the infant at home?								
1	10	0	0		0	0	0	
2	20	11	11		0	0	0	
3	0	19	19	<0.001	17	0	0	<0.001
4	0	0	0		13	6	6	
5	0	0	0		0	24	24	
Do you feel free to do routine work?								
1	3	7	7		0	0	0	
2	8	23	23		0	0	0	
3	10	0	0	<0.001	5	0	0	<0.001
4	9	0	0		5	20	20	
5	0	0	0		20	10	10	

1: Not at All; 2: No; 3: Not Sure; 4: Yes; 5: Very Much
NICU: neonatal intensive care unit

self-confidence in the care of their LBW neonates. In all the study groups, the majority of the mothers were dissatisfied with the management of the neonates admitted in the NICU on days two ($P<0.001$) and seven ($P<0.001$). On day two, most of the mothers in the study groups were not confident in the care of the neonates ($P<0.295$), whereas on day seven, most of the mothers in the KMC I and KMC II groups were confident in the management of the neonates compared to the mothers in the CMC group ($P<0.001$).

According to the results, the majority of the mothers were not confident in the care of the neonates at home when interviewed on day two ($P<0.001$). However, on day seven, most of the mothers in the KMC I and KMC II groups were confident in the care of the neonates at home compared to only a few of the mothers in the CMC group ($P<0.001$). On day two, the results of post KMC indicated that only a few mothers in the CMC

group were capable of performing routine neonatal care ($P<0.001$). On day seven, most of the mothers in the KMC I, KMC II, and CMC groups could perform routine care ($P<0.001$). However, five mothers in the CMC group were unable to carry out routine neonatal care on day seven (Table 6).

Discussion

The present study aimed to evaluate the efficacy of KMC in the care of 150 LBW neonates, including twins and singletons. According to the findings, KMC was an effective method to promote and increase maternal bonding and self-confidence in the management of LBW neonates. It is notable that the study groups were homogenous in terms of sociodemographic parameters.

In the current research, body temperature maintenance was better in the neonates who

received KMC compared to the CMC group. After the intervention, the neonates in the KMC I and KMC II groups were eutermic, while they experienced hypothermia and cold stress in the CMC group. In general, thermoregulation is well maintained in neonates; however, the thermal process gradually deteriorates. In neonates, energy is used for basic metabolism, regulation of the body temperature, and growth. Due to increased heat exchange in LBW neonates compared to adults, they are at an increased risk of hypothermia or hyperthermia. KMC reduces the energy expenditure in metabolism and thermoregulation, which in turn causes energy to directly accentuate the growth of neonates (13). In the present study, KMC could improve thermoregulation in the neonates. Similarly, Ibe et al. (14) compared KMC and CMC groups to determine thermoregulation in LBW neonates. According to the mentioned study, the risk of hyperthermia reduced by 90% in the neonates through the implementation of KMC compared to CMC. Moreover, Acolet et al. (15) reported enhanced thermoregulation in infants as a result of skin-to-skin contact at room temperature (26-29°C).

In KMC, the skin-to-skin contact between the mother and neonate reduces the energy utilization by the neonate and improves the growth and multisensory stimulation (16). In addition, it enhances the physiological processes in infants; such examples are increasing quiet sleep and stabilizing thermoregulation, heart rate, respiratory rate, and oxygen saturation (17). Therefore, KMC could stabilize the body temperature and enhance the growth of LBW neonates.

In the present study, various growth outcomes were evaluated in the LBW neonates. Before the initiation of KMC, the differences in the mean weight, length, and head circumference of the study groups were comparable. However, after reaching the target weight of 2.5 kilograms, the mean length and head circumference of the neonates in the KMC I and KMC II groups was higher compared to the CMC group, while the difference was not considered significant.

The mean weight gain and time required by the neonates to reach the target weight of 2.5 kilograms enhanced in the KMC I and KMC II groups compared to the CMC group. Similarly, Samra et al. (18) reported that the neonates in the KMC group regained weight faster than the neonates in the control group (15.7 and 24.6 days, respectively ($P < 0.001$)). In addition, the daily

weight gain in the KMC groups was twice higher than the control group (22.1 and 10.4 grams, respectively ($P < 0.001$)). Rao et al. (19) also observed improved weight gain in the neonates of the KMC group compared to those receiving conventional methods of care. In the mentioned research, the mean daily weight gain in the KMC and control groups was 23.99 and 15.88 grams, respectively.

KMC is an effective and economical method to reduce the risk of nosocomial infections and mortality and morbidity in newborns. KMC substantially improves the weight of LBW neonates and is associated with early discharge from the hospital (20). In the current research, the initiation of breastfeeding was earlier, and the frequency of breastfeeding was higher in the KMC I and KMC II groups compared to the CMC group. Therefore, it could be concluded that KMC promotes early and enhanced breastfeeding in twins and singletons.

According to the results obtained by Ramanathan et al. (21), the mothers who nursed their neonates by the KMC method could breastfeed for a longer period, and the frequency of breastfeeding also enhanced in these subjects compared to the CMC group. In another research, Udani et al. (22) reported increased breastfeeding in the KMC group compared to the CMC group. During KMC, the intense and continuous skin-to-skin contact between the mother and neonate increases the responsiveness of the mother to the neonate's hunger. Increased breastfeeding in KMC is due to the release of oxytocin, which enhances the self-confidence of the mother (22).

According to the present study, the mothers who used KMC expressed high levels of satisfaction and comfort, and their self-confidence in the management of their LBW infants significantly increased compared to the CMC group. The majority of the mothers in the KMC I and KMC II groups, who preferred their neonate to be next to them rather than in the NICU, were more confident in the handling of the neonate even at home and reported that KMC did not hinder their daily routine.

The introduction of KMC has increased the self-confidence of mothers in the care of LBW neonates owing to the stimulation of oxytocin and C-afferent nerves. During KMC, the chest, shoulders, and forearms are the foremost regions of the mother that are in close contact with the neonate. The skin-to-skin contact stimulates the C-afferent nerves in these regions, thereby enhancing oxytocin release in the brain and

diminishing maternal and neonatal stress. Therefore, this multimodal stimulation increases the bonding and confidence between the mother and infant (22).

In the present study, KMC proved beneficial in thermoregulation, improving weight gain, promotion of breastfeeding, and enhancing the self-confidence of the mothers in the management of twin and singleton LBW neonates. The limitations of the study were the small sample size and short follow-up.

Conclusion

According to the results, KMC is equally effective in the management of twin and singleton LBW neonates. This cost-effective, humane intervention could remarkably alleviate the burden imposed by the care of twin LBW neonates, especially in low-income countries. It is recommended that further longitudinal investigations be conducted on larger sample sizes in order to evaluate the efficacy of KMC in the care of neonates.

Acknowledgments

Hereby, we extend our gratitude to Dr. V.D. Patil (Registrar, KAHER, Belagavi) and Dr. N.S. Mahantashetti (Principal, J. N. Medical College and CEO & MD, KLE Hospital and MRC) for assisting us in this research project. We would also like to thank the professors, head of the pediatric department, the faculty in-charge of the NICU, and all the physicians and nurses. We greatly appreciate the cooperation of the mothers and newborns during the study period.

Conflicts of interests

None declared.

References

- World Health Organization. Care of the preterm and/or low-birth-weight newborn. Geneva, Switzerland: World Health Organization; 2016.
- Scher AI, Petterson B, Blair E, Ellenberg JH, Grether JK, Haan E, et al. The risk of mortality or cerebral palsy in twins: a collaborative population-based study. *Pediatr Res*. 2002; 52(5):671-81.
- Misra DP, Ananth CV. Infant mortality among singletons and twins in the United States during 2 decades: effects of maternal age. *Pediatrics*. 2002; 110(6):1163-8.
- Tan H, Wen SW, Walker M, Demissie K. The effect of parental race on fetal and infant mortality in twin gestations. *J Natl Med Assoc*. 2004; 96(10):1337-43.
- Gielen M, Lindsey PJ, Derom C, Loos RJ, Souren NY, Paulussen AD, et al. Twin-specific intrauterine 'growth' charts based on cross-sectional birthweight data. *Twin Res Hum Genet*. 2008; 11(2):224-35.
- Ananth CV, Chauhan SP. Epidemiology of twinning in developed countries. *Semin Perinatol*. 2012; 36(3):156-61.
- Gebremedhin D, Berhe H, Gebrekirstos K. Risk factors for neonatal sepsis in public hospitals of Mekelle City, North Ethiopia, 2015: unmatched case control study. *PLoS One*. 2016; 11(5):e0154798.
- Unicef. Undernourishment in the womb can lead to diminished potential and predispose infants to early death. UNICEF Data: Monitoring the Situation of Children and Women; 2016.
- Mew A, Holditch-Davis D, Belyea M, Miles MS, Fishel A. Correlates of depressive symptoms in mothers of preterm infants. *Neonatal Netw*. 2003; 22(5):51-60.
- Conde-Agudelo A, Belizán JM, Diaz-Rossello J. Cochrane review: Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. *Evid Based Child Health Cochrane Rev J*. 2012; 7(2):760-876.
- Conde-Agudelo A, Díaz-Rossello JL. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. *Cochrane Database Syst Rev*. 2016; 8:CD002771.
- Hirsh J, Kenneth F, Bauer A, Maria M, Donati B, Gould M, et al. Evidence-based clinical practice guidelines. *Chest*. 2008; 133(6):141S-59S.
- Tourneux P, Libert J, Ghyselen L, Leke A, Delanaud S, Dégrugilliers L, et al. Heat exchanges and thermoregulation in the neonate. *Arch Pediatr*. 2009; 16(7):1057-62.
- Ibe O, Austin T, Sullivan K, Fabanwo O, Disu E, Costello AM. A comparison of kangaroo mother care and conventional incubator care for thermal regulation of infants < 2000 g in Nigeria using continuous ambulatory temperature monitoring. *Ann Trop Paediatr*. 2004; 24(3):245-51.
- Acolet D, Sleath K, Whitelaw A. Oxygenation, heart rate and temperature in very low birthweight infants during skin-to-skin contact with their mothers. *Acta Paediatr Scand*. 1989; 78(2):189-93.
- Cong X, Ludington-Hoe SM, McCain G, Fu P. Kangaroo care modifies preterm infant heart rate variability in response to heel stick pain: pilot study. *Early Hum Dev*. 2009; 85(9):561-7.
- Chiu SH, Anderson GC. Effect of early skin-to-skin contact on mother-preterm infant interaction through 18 months: randomized controlled trial. *Int J Nurs Stud*. 2009; 46(9):1168-80.
- Samra NM, Taweel AE, Cadwell K. Effect of intermittent kangaroo mother care on weight gain of low birth weight neonates with delayed weight gain. *J Perinat Educ*. 2013; 22(4):194.
- Suman Rao PN, Udani R, Nanavati R. Kangaroo mother care for low birth weight infants: a randomized controlled trial. *Indian Pediatr*. 2008; 45(1):17.
- Rasaily R, Ganguly KK, Roy M, Vani SN, Kharood N, Kulkarni R, et al. Community based kangaroo mother care for low birth weight babies: a pilot study. *Indian J Med Res*. 2017; 145(1):51-7.

21. Ramanathan KP, Paul VK, Deorari AK, Taneja UK, George G. Kangaroo mother care in very low birth weight infants. *Indian J Pediatr.* 2001; 68(11): 1019-23.
22. Udani RH, Hinduja AR, Kabra NS. Role of Kangaroo mother care in preventing neonatal morbidity in the hospital and community: a review article. *J Neonatol.* 2014; 28(4):29.