Durations of Kangaroo Care and Premature Infants' Biophysiological Profile, Anthropometric Measurements and Stress of Maternal Role Attachment

Xiaojing Li¹, Min Wang¹, Liangjun Fang² & Rosalinda P. Salustiano¹

¹ Far Eastern University, Philippines
² Clinical College of Anhui Medical University, Anhui, China
Correspondence: Xiaojing Li, Far Eastern University, Philippines.

Abstract

In China, where more than 2 million premature infants are born each year, ranking second in the world estimates of preterm births, majority of hospitals have not conducted Kangaroo Care (KC) though it is now widely accepted to be beneficial for premature infants and mothers. The researcher's review of literature showed that no research focused on durations of KC and premature infants and their mothers. _Objective:_ This study aimed to determine the difference in effectiveness of various durations of KC on premature infants' biophysiological profile (heart rate/HR, respiratory rate/RR, oxygen/O2 saturation, and body temperature/BT), anthropometric measurements (body weight/BW, body length/BL, and head circumference/HC), and on stress level of maternal role attachment. _Methods:_ Quantitative method is used with a quasi-experimental, one group pretest-posttest design. A purposive sampling of 36 mother-infant pairs were selected based on inclusion criteria. Biophysiological Profile and Anthropometric Measurements Record was used to measure the premature infants' HR, RR, O2 saturation, and BT. Parental Role Alteration Questionnaire was used to score the stress level of maternal role attachment. Data were analyzed by statistical tools such as mean, median, independent t-Test, One-Way ANOVA, and Two-Way ANOVA and Tukey Test. _Results:_ Results showed for three-duration (2-, 4-, and 6-hour) comparation, HR, RR, BT, BW, HC, and stress level of maternal role among the three durations has a significant difference, but there is no significant difference in O2 saturation and BL. _Conclusion:_ The study found that long duration of KC has more effective impact on the stability of HR, RR, and BT, the growth of BW and HC in premature infants, and on stress level of maternal role attachment. Further studies are needed to study the durations of KC and O2 saturation and BL.

Keywords: kangaroo care, newborn biophysiological profile, newborn arthrometric measurement, stress level of maternal role, premature infants

1. Introduction

Kangaroo care (KC), as a formal infant care

technique, was developed by two Columbian pediatricians, Edgar Rey and Hector Martinez, in 1978 in response to low neonatal resources with few incubators or isolettes to contain infants with low body weight, which was later on recommended by the World Health Organization (WHO) as an ideal method to maintain warmth of neonates as early as 1993. Kangaroo Care or Skin-to-Skin Care (SSC) is the method of placing an infant dressed only in a hat and nappy between or on the mother's breasts so that the frontal contact of mother and baby is skin-to-skin and its essential component is the vertical position of the premature infant's body in relation to the mother's chest and abdomen (Qi, 2024).

Several studies including those of the WHO have shown that promoting skin-to-skin contact with infant establishes a positive effect in terms of sense stimulation on the growth and behavioral development of preterm infants, promoting better organization of motor and physiological systems, resulting in increased weight gain, body temperature maintenance, fewer infections and mortality, and behavioral effects that include shorter duration of crying and fewer signs of stress and pain. Not only on the premature infants, but kangaroo care also has a positive effect on the mother, that can prevent separation, reinforce the mother's role, and facilitate the interaction, thereby supporting the mother-infant relationship, infant's attachment, bonding to the mother, and maternal psychological well-being. Therefore, results show that kangaroo care can be effective for reducing the possible complications in preterm infants, that is a safe, effective, and feasible method for premature infant care and maternal care, and thus designated as an effective and comprehensive intervention in the NICU setting (Duanmu, 2024).

Therefore, in this study, the researcher would like to establish and determine the difference in the effectiveness of durations of kangaroo care on specific biophysiological profile such as heart rate (HR), respiratory rate (RR), oxygen saturation (O2 saturation), body temperature (BT), anthropometric measurements such as body weight (BW), body length (BL) and head circumference (HC), and on stress of maternal role attachment (Nie, 2024).

2. Method

2.1 Research Design

This study used quantitative method, especially a quasi-experimental, one group pretest-posttest design. Quasi-experimental study designs are often described as nonrandomized, pre-post intervention studies. A single group is often studied but no comparison between an equivalent non-treatment group is made. One group pretest-posttest design is comparison between a group of subjects before and after experimental treatment.

2.2 Population and Sampling

In this study, there were two groups of subjects, premature infants and their mothers. For the mother, the researcher chose 36 mothers, and they were assigned to different durations groups (2 hours, 4 hours, 6 hours) by using purposive sampling. Purposive sampling (also known as judgment, selective or subjective sampling) is a sampling technique in which the researcher relies on his or her own judgment when choosing members of population to participate in the study (Wu, 2024). In this study, each duration group had 12 mothers. The following inclusion criteria are for the Chinese mothers: a. Age: 20-45 years old; b. Delivery type: Normal delivery/ Cesarean Section; c. Delivery frequency: Once/ Twice/ ≥Three times; d. Could understand and complete the questionnaire; and; e. Agree to participate in the research; f. Mothers who has given birth with premature infant; g. Mother without infectious disease, epileptic illness, skin disease, scars, or mental disorder.

For the premature infants, the researcher took into account the ethical considerations, whoever qualified to be the subject in this study as a mother, the researcher got the baby as the subject for the premature ones because they belonged to vulnerable groups. The researcher was extra careful in protecting their rights and in ensuring their maximum safety. The following inclusion criteria are for the premature infants: a. Boys or girls; b. Gestational age at birth: 28-32 weeks; c. Birth Weight: 1000-2500g; d. 5 mins of Apgar score: 8~10; e. Infant is stable in the first 72 hours; f. No any other health problems such as respiration distress syndrome, apnea, and infection. The exclusion criteria used were: a. The premature infant' age was less than 28 weeks or higher than 32 weeks. b. The premature baby was: 1) receiving respiration therapy with a ventilator and E-tube insertion; 2) receiving medicines that could influence sleeping patterns; 3) having a possible risk of infection and skin disease; and 4)

having a catheter inserted in the artery and veins or the umbilical cord.

c. Maternal age was less than 20 years old or higher than 45 years old. d. Mother who with infectious disease, epileptic illness, skin disease, scars, or mental disorder.

2.3 Research Locale

The study was conducted at Nanjing maternal and child health hospital, Nanjing city of Jiangsu province in China. Nanjing maternity and child health hospital is a licensed public tertiary grade hospital, which offers clinical training and health services. The researcher selected Neonatal Intensive Care Unit (NICU) as the study locale. The Neonatal Intensive Care Unit totally has eight rooms, three rooms of the infants are premature infants who are put into the incubator, 10 chairs in the whole units for the mother doing KC for their premature infants.

2.4 Research Instrument

Eight instruments were used in this study. Six instruments were used for the premature infants and two instruments were used for the mothers.

On the part of the premature infants, there are six instruments: The first instrument is demographic profile questionnaire. It was designed by the researcher, consisting of gestational age at birth, gender, birth weight, and 5 mins of Apgar score. This instrument was use to collect basic information about the premature infants in the first step of data collection. The second instrument is Biophysiological Profile and Anthropometric Measurements Record, was used to collect the data of premature infants' biophysiological profile and anthropometric measurements. The third and fourth instruments are cardiogram monitor and infrared ear thermometer, these two were used to measure the premature infants' biophysiological profile; the fifth and sixth instruments are weighing scale and tape measure, these two were used to measure the premature infants' anthropometric measurement (Dai, 2024).

1) Biophysiological profiles: HR, RR, O2 saturation, and BT.

a. Premature infants' HR was measured and recorded via a cardiogram monitor, using units "beeps per minutes". 15 mins before and 5 mins after different durations of KC. It was measured by the researcher with the assistance from the nurse.

b. Premature infants' RR was measured and recorded via a cardiogram monitor, using units "breaths per minute". 15 minutes before and 5 minutes after different durations of KC. It was measured by the researcher with the assistance from the nurse.

c. Premature infants' O2 saturation was measured and recorded via a cardiogram monitor, using units "%". 15 minutes before 5 minutes after different durations of KC. It was measured by the researcher with the assistance from the nurse.

d. Premature infants' BT was measured by infrared ear thermometer via ear route, using units "℃" 15 minutes before and 5 minutes after different durations of KC. It was measured by the researcher with the assistance from the nurse.

2) Anthropometric measurements: BW, BL, and HC.

a. Premature infants' BW was measured every morning at a designated time by a weighing scale, using units' "grams" (g). It was measured by the nurse.

b. Premature infants' BL was measured every week at a designated time by a tape measure, using units' "centimeters" (cm). It was measured by the nurse.

c. Premature infants' HC was measured every week at a designated time by using a tape measure, units' "centimeters" (cm). It was measured by the nurse.

On the part of the mother, there are 2 instruments: The first instrument is demographic profile questionnaire. It was designed by the researcher, consisting of age, educational level, occupation, marital state, economic status, delivery type, and delivery frequency. This instrument was used to collect basic information about the mother in the first step of data collection. The second instrument is Parental Role Alteration Questionnaire (7 items), which is for rating the score of stress level of maternal role, and it is the second subscale of Parental Stress Scale: Neonatal Intensive Care Unit (PSS: NICU) questionnaire (Pu, 2024). PSS: NICU has 3 components, what the researcher used is just one component: Parental Role Alteration (7 items). The 7 items represent negative themes of parenthood. The PPS: NICU is a 5-point rating scale ranging from "not at all stressful" to "extremely stressful." 1 = Not at all

stressful, 5 = Extremely stressful. A low score to signify a low level of stress, and a high score to signify a high level of stress. Parental Role Alteration explained 6.03% of the variance. Cronbach's alpha was 0.92 (Zhang, 2024). The researcher has already contacted to the author of the scale and get the permission. The stress level of maternal role attachment was measured two times, 30 mins before first KC and 30 mins after last KC.

2.5 Statistical Treatment

The researcher used Microsoft Excel and SPSS in date analysis. Descriptive statistics and inferential statistics were used. The services of a professional statistician were sought to validate statistical analysis of findings.

3. Results

3.1 Sample Distribution

Table 1. Frequency and Percentage Distribution of Demographic Profile of Mothers in Different Durations

Frequency and Percentage Distribution of Demographic Profile of Mothers in Different Durations

Profile	2 hours Group		4 hours Group		6 hours Group	
	f	%	f	%	f	%
Age						
20-24	1	8.33	0	0	0	0
25-29	4	33.33	6	50	5	41.67
30-34	7	58.33	4	33.33	6	50
≥35	0	0	2	16.67	1	8.33
Education						
Middle School	1	8.33	2	16.67	1	8.33
High School	1	8.33	1	8.33	2	16.67
College	2	16.67	3	25	3	25
Bachelor	6	50	5	41.67	4	33.33
Master	2	16.67	1	8.33	2	16.67
Occupation						
Have	10	83.33	9	75	10	83.33
Have none	2	16.67	3	25	2	16.67
Economic status						
< 1000	3	25	3	25	2	16.67
1000-2999	2	16.67	1	8.33	2	16.67
3000-4999	4	33.33	5	41.67	4	33.33
≥5000	3	25	3	25	4	33.33
Delivery type						
Normal delivery	4	33.33	4	33.33	6	50
Cesarean Section	8	66.67	8	66.67	6	50
Delivery frequency						
Once	8	66.67	6	50	8	66.66
Twice	4	33.33	5	41.67	2	16.67
≥Three Times	0	0	1	8.33	2	16.67
Number of Fetus						
Single	9	75	10	83.33	10	83.33
Twins	3	25	2	16.67	2	16.67
Total	12	100.00	12	100.00	12*	100.00

*Note: One of the 12 mother 'baby got discharged early

Table 2.

Profile	2-hour Duration				4-hour Duration				6-hour Duration			
	15 Minutes Before KC		5 Minutes After KC		15 Minutes Before KC		5 Minutes After KC		15 Minutes Before KC		5 Minutes After KC	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
HR (beats/min)	159.21	8.31	153.27	7.62	156.33	7.77	147.10	6.67	154.11	5.30	145.24	4.61
RR (breaths/min)	53.51	1.88	50.33	1.69	52.10	1.88	46.66	1.59	51.50	2.16	45.49	1.40
O2 Saturation (%)	92.2	1.68	96.3	0.7	91.47	1.35	96.63	0.52	93.13	1.03	96.59	0.61
BT (℃)	36.02	0.11	36.39	0.09	36.10	0.08	36.71	0.07	36.15	0.10	36.77	0.07

For 2-hour duration of KC, fifteen minutes before KC, the HR mean score was 159.21 (SD=8.31); the RR mean score was 53.52 (SD=1.88); the O2 saturation mean score was 92.20 (SD=1.68); the BT mean score was 36.02 (SD=0.11). Five mins after KC, the HR mean score was decreased to a level of 153.27 (SD=7.62); the RR mean score was also decreased to 50.33 (SD=1.69); the O2 saturation mean score was increased to 96.30 (SD=0.70); the BT mean score was also increased to 36.39 (SD=0.09).

For 4-hour duration of KC, fifteen minutes before KC, the HR mean score was 156.33 (SD=7.77); the RR mean score was 52.10 (SD=1.88); the O2 saturation mean score was 91.47 (SD=1.35); the BT mean score was 36.10 (SD= 0.08). Five mins after KC, HR mean score was decreased to a level of 147.10 (SD=6.67); the RR mean score was also decreased to 46.66 (SD=1.59); the O2 saturation mean score was increased to 96.63 (SD=0.52); the BT mean score was also increased to 36.71 (SD=0.07).

For 6-hour duration of KC, fifteen minutes before KC, the HR mean score was 154.11 (SD=5.30); the RR mean score was 51.50 (SD=2.16); the O2 saturation mean score was 93.13 (SD=1.03); the BT mean score was 36.15 (SD=0.10). 5 minutes after KC, the HR mean score was decreased to a level of 145.24 (SD=4.61); the RR mean score was also decreased to 45.49 (SD=1.40); the O2 saturation mean score was increased to 96.59 (SD=0.61); the BT mean score was also increased to 36.77 (SD=0.07). The statistical data presented in Table 2 suggest decreased levels of HR and RR, while the O2 saturation and the BT were increased in the premature infants after receiving the kangaroo care. The premature infants' four biophysiological profile are all in the normal range and the trends we tend to be more stable because of the decreased standard deviation after KC. What's more, the changes of HR, RR, and BT in 4-hour and 6-hour duration of KC groups are greater than 2-hour duration of KC group, the changes of O2 saturation in 4-hour duration of KC group are greater.

While kangaroo care has been in practice in the world since 1978 in Columbian, in China, kangaroo care has only been developed in recently years. Even now, many hospitals have not started KC. There is a growing belief among some Chinese neonatal nurses that the newborn is weak and has low resistant, immunocompromised and should be exposed to as little as possible. Parents are not allowed to go to the inpatient ward to visit the baby, only when they were discharged from the hospital, parents were allowed to take them home, which was considered to reduce the incidence of infection. Furthermore, medical equipment is sufficient in some developed city, such as incubators, which can maintain the good condition of premature baby, thereby parents do not need to go to the hospital to participate in care, which will bring the risk of infection to the ward baby, and will increase the workload of the nurse because the nurse needs to guide the mother to do kangaroo care and also need to observe the changes of infants' condition at any time. What's more, medical disputes are easy to occur in China. Once an infant has an accident in the process of receiving kangaroo care, the hospital will face medical disputes, even if the

accident is not caused by kangaroo care. While with the change of the concept of nursing staff and the improvement of people's quality, and more and more literature were established the benefits of KC, kangaroo care is developing in Chinese hospital. Majority of hospital of NICU in China conducted KC less than 2 hours a time. Furthermore, KC can easily let the infants fell asleep or in a state of clam to reduce some involuntary action.

In terms of HR, the mean score decreased by around 6 bpm in 2-hour duration of KC group, by around 9 bmp in 4- and 6-hour duration of KC group. The decreased level of HR was probably because skin to skin contact with mother's chest, the premature infants felt security and comfortable in this stable position, which can easily let the infants fell asleep or in a state of clam. And there is also a study showed an upright, prone position can promote cardiorespiratory stabilization (Zhang, 2024). The result of the study was consistent with the research, which reported after 10 times of KC (30-min duration/time) in the experimental group, the post-test mean score of HR was decreased compared to the pre-test, even though there is no significant difference in the heart rate.

In terms of RR, the mean score decreased by about 3 per minute in 2-hour duration group, 5 per minute in 4-hour duration group, 6 per minute in 6-hour duration group. The decreased level of RR may be because of the premature infants in a stable embracing position on the mother's soft and warm chest, induce the premature infants to a deep sleep, and the study by Bi. (2023) also showed that prone position has a positive effect on the respiratory rate. The result of the study was the same with the research, which reported after 10 times of KC (30-min duration/time) in the experimental group, the post-test mean RR was decreased compared to the pre-test.

For BT, the mean score rose by $0.37℃$ after 2-hour duration of KC, by around $0.6℃$ after 4-hour and 6-hour durations of KC. The increased body temperature may be due to contact with the mothers' warm skin, which helped the premature infants save energy and maintain their BT (Qin, 2024). Furthermore, the premature infants have less brown fat, lower basal metabolism, less heat production, and relatively larger body surface area, less subcutaneous fat, easy to dissipate heat, and the body temperature regulation center is not perfect, so the body temperature regulation is difficult and unstable, and it is easy to follow the ambient temperature.

Table 3.

Pairwise Comparison	p-Value	Decision
2 hours vs 4 hours	.061	There is no significant difference.
2 hours vs 6 hours	.006	There is a significant difference.
4 hours vs 6 hours	.625	There is no significant difference.

The post-hoc test results are presented in Table 3. The comparison between 2 hours of KC and 4 hours of KC yielded a p-value less than 0.05. This means that there is a significant difference between the two groups. In particular, the weight in 2 hours KC is less than the weight in 4 hours KC. On the other hand, the comparison between 2 hours and 6 hours KC yielded a p value less than 0.05. This means that there is a significant difference between the two groups. In particular, the weight in 2 hours KC is less than the weight in 6 hours KC. Finally, the comparison between 4 hours and 6 hours KC yielded a p-value 0.074, which is greater than 0.05. Thus, there is no significant difference between the weights in 4-hr KC group and 6-hr KC group. This is maybe because the researcher just measured the weight in premature infants in this study for 30 days to see the difference of different durations of kangaroo care. The 30 days is not enough to see the difference in weight gain between the two groups.

Table 4.

Source of Variation		Mean	F Value	p-Value	Decision
Duration	2 hours	40.528	.630	.534	Fail to reject
	4 hours	40.765			Ho2; differences are significant;
	6 hours	40.533			post-hoc is needed
Period (Weeks)	Week 0	38.306	66.065	.000	Reject Ho2;
	Week 1	39.485			differences are significant;
	Week 2	40.614			post-hoc is needed
	Week 3	41.751			
Duration* Period	Week 4	42.888	0.813	.592	There is no interaction effect between duration and period of treatment.

Table 4 presents the length among the premature infants are compared in terms of duration (2 hours, 4 hours, 6 hours) and period (Weeks 0-4) of KC. In terms of duration, the p-value is the p-value 0.534, which is greater than 0.05. Thus, the null hypothesis is not rejected and thus, there is no significant difference among the duration groups. That's possibly because the researcher just measured the 30 days of length in premature infants in this study, which is not enough to see the difference under different durations of KC group. And the duration of the study was not long enough to effect a major change in the infant's body length. In addition, the growth of length in 30 days is very small. So, the effect of different durations of KC in longer periods of time can be experimented in future studies. However, since the p-value is 0.592, greater than 0.05, thus, there is no interaction effect between duration and period.

In terms of comparison between periods, the p-value is found to be less than 0.05. Thus, the lengths among the periods have significant differences. Post-hoc test is required to determine which pairs of periods are significantly different. The result is supported by the study of QIN (2024), there is a significant difference in the weekly length gain between the KC group and the control group. That may be because as the duration of KC increases, the time of premature infant deep sleep also increases, which can save energy for infant growth. In addition, with the duration increasing, the time of skin-to-skin contact also increases, which can increase the hormone for growth.

Table 5.

Pairs	p-Value	Decision
Week 0 vs Week 1	.000	There is a significant difference.
Week 0 vs Week 2	.000	There is a significant difference.
Week 0 vs Week 3	.000	There is a significant difference.
Week 0 vs Week 4	.000	There is a significant difference.
Week 1 vs Week 2	.000	There is a significant difference.
Week 1 vs Week 3	.000	There is a significant difference.
Week 1 vs Week 4	.000	There is a significant difference.
Week 2 vs Week 3	.000	There is a significant difference.
Week 2 vs Week 4	.000	There is a significant difference.

Week 3 vs Week 4	.000	There is a significant difference.

The post-hoc test results in terms of period are presented in Table 5. Note that the p-values in all the pairs were found to be less than 0.05. This means that there is a significant difference in the mean length when the periods are compared pairwise. Furthermore, it can be said that the weights of the premature infants increase significantly over time when KC is used. The results are supported by Qin (2024), that kangaroo care can promote the growth of length in premature infants.

Table 6.

Source of Variation		Mean	F value	p-Value	Decision
Duration	2 hours	3.500	1.087	.343	Fail to reject
	4 hours	3.292			Ho3; differences are significant;
	6 hours	2.273			post-hoc is needed
Period	Before	4.495	263.455	.000	Reject Ho3;
	After	2.215			differences are significant; post-hoc is needed
Duration* Period			0.826	.404	There is no interaction effect between duration and period of treatment.

In Table 6, the results on the comparison on level of maternal role in terms of duration and period among the respondents ("Not having time alone with my baby") are presented. In terms of duration, the p-value of 0.343 is greater than 0.05. Thus, the duration groups do not have a significant difference.

On the other hand, Table 6 shows that p-value for the comparison between periods yielded a p-value less than 0.05 so the null hypothesis is rejected. Thus, there is a significant difference between the stress level of maternal role attachment in relation before KC and after KC in all the duration groups. In particular, the mean level of maternal role in relation before KC (Mean=4.495) is higher compared to after KC (Mean=2.215).

However, since the p-value is 0.404, greater than 0.05, thus, there is no interaction effect between duration and period. The statistical data shown in Table 6 suggests that with the duration time increasing, the mean score of stress level of maternal in relation to slightly decreased even though there is no significant difference. That's maybe because KC was conducted 3 times a week in this study, and the mother can be alone with her baby just 3 times a week. The time was not enough for them to accompany her baby even though for different durations/times. And after KC, the mean score has an evident decrease than before. Because after the mother delivery, the premature infants are put into NICU, and the mother is not allowed to go to the inpatient ward to visit her baby, so the stress ("Not having time alone with my baby") was high. On the other hand, by doing KC, the mother can go inside the units and be alone with her baby for a period of time. There she can hold her baby, touch her baby, and speak some words or sing songs for her baby; these activities can reduce the stress.

The findings of this quasi-experimental investigation on the outcome of different durations (2 hour, 4 hours, and 6 hours) of kangaroo care on premature infants' biophysiological profile (heart rate, respiratory rate, oxygen saturation, and body temperature), anthropometric measurements (body weight, body length, and head circumference), and stress level of maternal role attachment can provide additional evidence on the value of long duration of Kangaroo care implementation which seems to have more effective impact on the stability of premature infants' biophysiological profile, and growth of BW and HC. As for the mother, there is evidence that Kangaroo care affects the reduction in the level of stress brought about by maternal role

attainment among Chinese mothers (Bi, 2023).

4. Conclusion

This study investigated the effect of 2-, 4-, and 6-hour durations of KC on premature infants' biophysiological profile (heart rate, respiratory rate, oxygen saturation, and body temperature), and anthropometric measurements (body weight, body length, and head circumference), and the mothers' level of stress of maternal role attainment, and identified the significant differences among the three durations of KC. Kangaroo care has positive effects on the Chinese mother-premature infant dyad. The long duration of Kangaroo care implementation seems to have more effective impact on the stability of premature infants' heart rate, respiratory rate, body temperature, and growth of body weight and head circumference. As for the mother, there is evidence that Kangaroo care affects the reduction in the level of stress brought about by maternal role attainment among Chinese mothers.

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