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Massage intervention for preterm infants by their mothers: A randomized controlled trial

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Abstract

Objective: Studies of the impact of infant massage intervention on the growth of preterm infants have been conducted in neonatal intensive care units (NICUs) and have demonstrated positive effects; however, few data exist regarding the effects of massage interventions by mothers on the growth of infants in the NICU. The purpose of this randomized controlled trial was to examine the effects of a 2-week massage intervention conducted by mothers on their preterm infants.

Methods: Of 112 stable preterm infants born at a gestational age (GA) between 32 and 34 weeks and enrolled from an affiliated hospital, 54 were randomly allocated to an intervention group, and 58 were allocated to a control group. Mothers were trained to conduct a massage intervention in the intervention group, while the control group received standard care. For the infants in both groups, height (Ht), weight (Wt), and head circumference (HC) were measured at the onset of massage intervention, after one week, and after two weeks. Fifteen mothers were interviewed about their preparation for and completion of the massage intervention.

Results: Repeated-measures analysis of variance showed that weight, height and head circumference significantly increased in the intervention group. Preterm infants who underwent the two-week massage intervention had higher mean weight, height, and head circumference (F = 41.151, 6.621, 24.158, respectively; p < .001). This study developed modified massage intervention guidance to provide recommendations for optimal massage intervention by mothers in the NICU: (a) Adapt to the NICU atmosphere; (b) control the mother's strength; (c) slowly perform each period of the massage, that is (i) place in a prone position (5 + 5 min); (ii) place in supine position (5 min); (d) stay relaxed and watch the preterm infant's response.

Practice Implications: Trained mothers conducted massage interventions, which can improve the growth of preterm infants. We developed massage intervention guidance to provide recommendations for optimal massage intervention by mothers in the NICU. We recommend that mothers apply massage intervention for preterm infants in the NICU.

KEYWORDS
growth, massage intervention, premature, preterm infants

1 | INTRODUCTION

A total of 5–13% of all infants worldwide are born prematurely (Goldenberg, Culhane, Iams, & Romero, 2008). Fifteen million preterm infants are born each year (March of Dimes, 2012); this includes 1.5 million born in China, comprising one-tenth of preterm infants worldwide. This incidence is increasing. Preterm birth is one of the most significant health care challenges in developing countries, accounting for approximately 75% of neonatal morbidity cases and 70% of neonatal deaths. The problems facing this large group have severe medical and socioeconomic implications for their families, health care, and society as a whole (Petrou, Eddama, & Mangham, 2011). Poor growth puts surviving preterm infants at risk of limited growth into adulthood, neurocognitive defects, pulmonary dysfunction, ophthalmologic disorders (Saigal & Doyle, 2008), and metabolic and other neonatal complications (Goldenberg et al., 2008). Poor growth during the early stages of preterm infancy increases the risk of developing chronic diseases in later life, such as lung disease, diabetes, and myocardial infarction, all of which are major health problems worldwide (Sullivan, Hawes, Winchester, & Miller, 2008).

Sensations are involved in the correct growth of full-term infants, but preterm infants in the neonatal intensive care unit (NICU) have been deprived of the sensory stimuli from the amniotic fluid and the uterine walls by the skin (Mathai, Fernandez, Mondkar, & Kanbur, 2001). Infant massage provides a comforting and soothing touch, encouraging positive growth in preterm infants (Gorski, Huntington, & Lewkowicz, 1990). Somatic stimulation is the massage intervention most commonly applied to preterm infants, which uses various modalities to stimulate the somatosensory system through sensory receptors that cover the skin, skeletal muscles, bones, and joints. The definition of massage intervention is the manual application of a particular technique to the structures that lie within superficial soft-tissue of the skin, fascia, muscles, ligaments, blood vessels, and tendons, mainly by the mother's hands. This massage intervention involves a systematic external application, such as touching, stroking (effleurage), stretching, kneading, vibration, friction, percussion, compression, and active or passive flexion and extension movements within the normal range of physiologic motion. Tactile and kinesthetic stimulation are motions linked with the stimulation of social-emotional and neuromotor development in preterm infants (T. Field, Diego, & Hernandez-Reif, 2010).

Compared with infants carried to term, preterm infants face challenges in their growth at the same postconception age (Ehrenkranz, 2000). A thorough literature review indicated that safe and relatively inexpensive massage intervention in the NICU improved growth and developmental activities in the preterm infants and did not reveal adverse effects (Alvarez et al., 2017). However, the beneficial effects of massage intervention by trained mothers need to be examined (Choi et al., 2016).

Research has also suggested that massage is an effective intervention that can decrease the levels of plasma cortisol, compared to control groups (Procianoy, Mendes, & Silveira, 2010). Massage intervention can be applied as a noninvasive and easily learned method, which improves the attachment bond between mothers and their infants, along with improving their well-being.

Studies have been conducted to evaluate the positive effect of massage intervention in hospitalized preterm infants(Alvarez et al., 2017; Choi et al., 2016), but the evidence from these studies has been too weak to directly support massage intervention by mothers in the NICU. Another aspect involves appropriate preparation and optimal completion of massage intervention by mothers. Thus, to address these aspects, this randomized controlled study provided insight into the potential effects of massage intervention for preterm infants conducted by their mothers on the weight (Wt), height (Ht), and head circumference (HC) of the infants. Additionally, this study attempted to develop recommendations for optimal massage intervention by mothers in the NICU.

2 | METHODS

2.1 | Design

This randomized controlled study investigated the potential effects of a massage intervention. Preterm infants were recruited and randomly assigned to an intervention and a control group. Preterm infants in the intervention group underwent a massage intervention by their mothers, while those in the control group received standard care. The study was single-blind; the two nurses, who were not involved in this randomized allocation, measured and recorded the growth of preterm infants in both groups, while the researcher assessed eligible preterm infants, conducted the randomization and analyzed the data. Randomization was performed using STATA 15.0 (STATA Corporation, College Station, TX) for windows the ratio of intervention to control was 1:1, and information concerning both groups was stored in sealed envelopes. Further specific aspects of the research design, including details of blinding and measuring, were also addressed.

2.2 | Sample

Between 1st March 2014 and 1st March 2015, preterm infants in the NICU in an affiliated hospital were recruited ($N = 181$), 69 were excluded, thus leaving a total of 112 preterm infants. The infants were randomly assigned to an intervention group ($n = 58$) and a control group ($n = 54$). Fifty-eight mothers in the intervention group were trained in massage, and 15 mothers were invited for interviews.

The inclusion criteria for the preterm infants were as follows:

1) Born at a gestational age (GA) between 30 and 34 weeks;
2) Medically stable (Ferreira and Bergamasco, 2010);
3) No birth or perinatal asphyxia and/or hypoxic insults or brain abnormalities (Guzzetta et al., 2009);
4) No skin diseases; and
5) Their parents signed the content form.

Exclusion criteria for preterm infants were as follows:

1) Changes of skin condition, muscle tension, heart rate, vomiting, apnea or dyspnea;
2) Medical instability.

The below formula was used to calculate the sample size (Sakpal, 2010); the calculated sample size was 52 in each group,

$$n = \left[\left(Z_{\alpha/2} + Z_{\beta} \right)^2 \times \{2(\acute{o})^2\} \right] (\mu1 - \mu2)^2$$

A clinically significant difference was $\mu_1 - \mu_2 = 0.65$, with a standard deviation $\acute{o} = 1.195$, $Z_{\alpha/2}$ = significance of 0.05 (1.96), and Z_{β} = power of 0.8 (0.84).

2.3 | Procedure

2.3.1 | Intervention

T. M. Field et al. (1986) developed a tactile and kinesthetic stimulation protocol, consisting of three 5-min phases (A-B-A). The first and third 5-min phases were tactile, and the second 5-min phase was kinesthetic. Trained mothers performed 15-min massage interventions twice a day for 2 weeks. Interactions between preterm infants and their mothers were encouraged.

(A) The tactile phase:The infant was placed with cupped hands in a prone position, and the mother stroked the infant with moderate pressure in a rhythmic motion (slight indentations on the skin).The massage intervention followed these steps, each for a one-min period:
  (i) From head to neck and back.
  (ii) From neck through the shoulders, then back to the neck.
  (iii) From upper-back to lower-waist, then returning to the upper back.
  (iv) From both thighs to the feet, then returning to the thighs.
  (v) From both shoulders to hands, then returning to the shoulders.
(B) The kinesthetic phase:

The infant was placed in the supine position, and flexions were performed on both the arms and legs; each flexion or extension motion lasted between 15 s and 1 min for every sequence.

Mothers were trained by one Chinese infant massage specialist. The training included three sections: Watching videos, watching lectures, and using a high-fidelity baby simulator to practice stimulation. The specialist ensured that the mothers were competent to perform the massage independently. The specialist guided the mothers in implementing the massages for the first several times until they could complete the massage unsupervised. The massage intervention was performed one hour before feeding and at least four hours after the previous massage.

2.4 | Data collection

The growth data of the preterm infants were assessed at three-time points: The onset of massage intervention, after one week, and after two weeks; Ht, Wt, and HC were measured by the same professional nurses in the hospital. GA was based on the last menstrual period and estimated by ultrasound measurements.

2.4.1 | Instruments

The Wt, Ht, and HC of all preterm infants were measured by standardized measuring devices. Preterm infants were weighed unclothed on digital scales with an accuracy of 0.1 g. Ht was measured in the supine position using a wooden stadiometer with a precision of 0.1 cm. HC was determined using a tape band with a precision of 0.1 cm. All measurements were repeated twice by different nurses, and the same results were recorded each time; if these results differed, a third measurement was taken.

2.4.2 | Interviews

Fifteen of the mothers were interviewed individually in a quiet office after two weeks of massage intervention. The semistructured interviews lasted between 30 and 70 min. All participants were asked two questions about how they optimally prepared for and completed massage intervention:

1) *How did you prepare to massage your child?*
2) *How did you complete massage for your child?*

2.4.3 | Ethical issues

Ethical approval was obtained from the research ethics committee in the **. The preterm infants' mothers were provided written informed consent documents with an instruction information sheet showing how to properly manage the massage intervention of their preterm infants, and all mothers signed a consent form at enrollment. The researcher reiterated throughout the identification, approach and recruitment processes that participants were free to quit the study without penalty.

2.5 | Data analysis

Statistical analyses of data were undertaken using Stata 15.0 (Stata Corporation, College Station, TX) for Windows. Continuous variables were summarized by their means and standard deviations; the means of independent samples between groups in Ht, Wt, and HC were compared using repeated-measures ANOVA. All *p* value tests given were based on two-tailed analyses. Statistical significance was set at $\alpha = 0.05$.

Interviews were validated by two researchers, and the initial coding, categorizing and storing of quotes were conducted using

NVivo11 software (QSR International). Thematic analysis was undertaken to identify consensus and contradiction extending across all of the interviews. The methods of thematic analysis were guided by Braun and Clarke (Braun & Clarke, 2014), and domains were established from the semistructured tool. Codes were generated and reviewed in a reflexive iterative manner (Braun & Clarke, 2006). Themes and subthemes were generated until new findings were not identified. The intention of the interviews was to obtain optimal massage intervention guidelines by mothers.

3 | RESULTS

3.1 | Homogeneity test between intervention and control groups

Before massage intervention, there were no significant differences between control and intervention groups in the demographic variables of gender, GA, Wt, Ht, and HC (Table 1): Male ($n = 32$), female ($n = 26$), GA 32.0 ($SD = 3.8$) weeks in the intervention group; male ($n = 26$), female ($n = 28$), GA 33.2 ($SD = 3.1$) weeks in the control group ($p > 0.05$) (Table 1).

3.2 | Effects of massage intervention on growth

There were significant impacts on the growth of preterm infants in the massage intervention group, as determined by repeated-measures ANOVA: Wt, $F = 41.151$, $p < .001$; Ht, $F = 6.621$, $p < .05$; HC, $F = 24.158$, $p < .001$. There were significantly higher means of Wt, Ht, and HC for preterm infants with massage intervention (Table 1).

The mean Wt of the intervention group, 1,750.5 ($SD = 267.2$) g, was significantly higher than that of the control group after one week of massage intervention, 1,606.4 ($SD = 230.4$) g ($F = 11.099$, $p = 0.001$); after two weeks, the mean Wt of intervention

group, 2,150.6 ($SD = 327.4$) g, was significantly higher than that of the control group, 1,747.8 ± 356.2 g ($F = 34.466$, $p < .01$; Table 1).

After one week of massage intervention, the mean HC of the intervention group, 31.5 ($SD = 2.4$) cm, was significantly higher than that in the control group, 30.6 ($SD = 2.1$) g ($F = 4.547$, $p = 0.035$); after two weeks, the mean HC of the intervention groups, 32.5 ($SD = 2.5$) g, was significantly higher than that in the control group, 31.0 ($SD = 2.4$) g ($F = 23.535$, $p < .001$; Table 1).

The mean Ht of the intervention group, 44.1 ($SD = 2.2$) cm, was significantly higher than that in the control group, 43.0 ($SD = 2.7$) g, after one week of massage intervention ($F = 5.084$, $p = 0.026$); after two weeks, the mean Ht of the intervention group; 46.9 ($SD = 2.3$) g, was significantly higher than that in the control group, 450 ($SD = 2.4$) g ($F = 16.308$, $p < .001$; Table 1).

3.3 | Modified massage intervention guideline for mothers

Qualitative data were gathered to determine guidelines for optimal massage intervention by mothers.

The first subtheme was "Adapt to the NICU atmosphere." Some mothers stated that they needed several visits to adapt to the NICU environment, because the first several times they forgot massage, although they had mastered it during practice sessions. After watching massage videos, the mothers watched the NICU environment video; furthermore, before entering the NICU, nurses communicated with the mothers to understand their problems and to ensure that they were mentally prepared. A large proportion of the mothers were concerned about the NICU atmosphere before starting massage—they never had experienced a medical environment, particularly the NICU. For instance, when she entered the NICU for the first time, one of the mothers expressed,

TABLE 1 The effects of massage intervention on the growth of preterm infants.

		n	Onset Mean (SD)	1 Week Mean (SD)	2 weeks Mean (SD)	F	p-value
Wt g	Intervention group	58	1635.4 (244.3)	1750.5 (267.2)*	2150.6 (327.4)**	41.151	<.001
	Control group	54	1569.7 (226.9)	1606.4 (230.4)	1747.8 (356.2)		
	F		1.978	11.099	33.466		
	p		.162	.001	<.001		
Ht, cm	Intervention group	58	43.6 (2.4)	44.1(2.2)*	46.9 (2.3) **	6.621	<.05
	Control group	54	42.7 (2.1)	43.0 (2.7)	45.0 (2.4)		
	F		.104	5.084	16.308		
	p		.748	.026	<.001		
HC, cm	Intervention group	58	30.8 (2.8)	31.5 (2.4)*	32.5 (2.5)**	24.158	<.001
	Control group	54	30.2 (2.5)	30.6 (2.1)	31.0 (2.4)		
	F		3.934	4.547	23.535		
	p		.050	.035	<.001		

Abbreviations: SD, standard deviation; Wt, weight; Ht, height; HC, head circumference.
**Correlation is significant at the 0.01 level (two-tailed).
*Correlation is significant at the 0.05 level (two-tailed).

I did not realize she was my baby when I first entered the NICU room, and I was a little scared to touch her. I forgot the whole massage procedure. (id 10)

I thought I had prepared myself enough, but when I entered the NICU, I realized it was not enough; I could only touch my baby, I couldn't do anything. (id 8)

The second subtheme was "Control the strength of mothers". A large proportion of the mothers expressed that although they had practiced the massage technique regularly, they were nervous to perform it at first. Some mothers stated that although they practiced massage using a high-fidelity baby simulator, when they massaged their own children, they could not control the strength of the massage. We noted that several mothers had long fingernails and that they did not realize that they might scratch the skin of their infants, or that their nails were not clean, which risked infection.

I didn't understand how to touch my baby; it was very different compared with my practice, the baby simulator. (id 7)

I could not control my hands, soft or hard; my baby was soft, very different from the simulator. (id 6)

The third subtheme was "Slowly perform each period of the massage." Some mothers indicated that they often forgot the 5 steps of massage in the NICU environment, which influenced the effects of massage intervention. The researcher realized that pictures were needed to remember and simplify the massage procedure. One of the mothers stated,

I can't remember the whole massage procedure; my memory has grown worse after the birth. (id 5)

The nurse told that I could not stay in the NICU for a long time, so my massage steps were reversed. (id 2)

A little bit hard to remember all massage steps; I was distracted by *my children.* (id 9)

The fourth subtheme was "Stay relaxed and watch the response of the preterm infants." A large proportion of the mothers indicated that they felt guilty that they could not accompany their children, for mothers with separation anxiety, massage intervention helped them to build relationships and relaxation with their infants, with some saying,

I am very distressed; I do not want to leave my baby alone in the hospital. (id 14)

I would like to stay with my baby, but my hands might be too strong, so my baby did not enjoy it . (id 1)

4 | DISCUSSION

Preterm infants are prone to weight and growth retardation after birth, making it important to monitor their growth (Thureen & Heird, 2005). Massage for preterm infants by mothers is recommended as an effective intervention both to provide environmental enrichment (Cioni, D'Acunto, & Guzzetta, 2011) and to improve mother-preterm infant attachment (Kim & Bang, 2018). This randomized controlled study of massage intervention by mothers recorded anthropometric measurements for two weeks to demonstrate the effects of massage

on the growth of preterm infants. This study provided supporting evidence to improve optimal massage intervention by mothers in the NICU, which might improve their health outcomes.

The findings from this study supported the positive effects of massage intervention in Wt, Ht, and HC; these findings were inconsistent with those of previous studies (Diego, Field, & Hernandez-Reif, 2014; Lee, 2006; Vickers, Ohlsson, Lacy, & Horsley, 2000), which showed that massage intervention solely improved weight gain in preterm infants. In this study, weight gain was significantly larger in the massage intervention group than in the control group (T. Field et al., 2010), consistent with reports in the Cochrane database and as obtained in other studies (Kim & Bang, 2018). Poor growth of HC and Ht is related to delays in neurologic developmental (Peterson, Taylor, Minich, Klein, & Hack, 2006), although the indexes of Ht and HC are also sensitive to long-term nutritional status and need additional follow-up time. In this study, after 2 weeks of massage intervention, the growth of preterm infants was improved.

There were significant increases in the growth of preterm infants whose mothers performed massage intervention. One driving mechanism could be that massage intervention provided stimulation in tactile and kinesthetic phases, which improved the secretion of growth hormones and stimulated the release of insulin from the sympathetic nervous system (Beachy, 2003). Another mechanism could be that massage intervention improves gastrointestinal motility, promoting absorption, and digestion (Diego, Field, & Hernandez-Reif, 2005). Comforting massage touch involving flexion and extension motion by moderate pressure increases the mineral density and development of bones (Diego et al., 2014). Massage intervention might also improve the growth of preterm infants by accelerating blood flow, helping sleep, affecting hormonal release, and promoting the mother-preterm infant relationship (Vickers et al., 2000).

In this study, massage intervention by mothers in the NICU promoted the growth of preterm infants in Wt, Ht, and HC (Vickers et al., 2000), with no negative effects observed; massage intervention was also found to be easily applicable (Diego et al., 2005). The qualitative data provided in-depth understanding of massage intervention by mothers, with a large proportion of mothers reporting difficulty in compliance with the massage guidelines. Based on the findings from the interviews, we consulted some Chinese massage specialists and developed modified (easy-to-remember) massage intervention guidance.

(i) Adapt to the NICU atmosphere: Before performing the massage intervention, watch NICU environment videos and practice massage regularly. Stand comfortably in front of the incubators and position the preterm infant on the small bed in front of them, on their back so that they can maintain eye communication with mothers.

(ii) Control the mother's strength: For the first few sessions, a massage specialist guides mothers until they are relaxed, familiar, and confident with the massage technique, using a firm
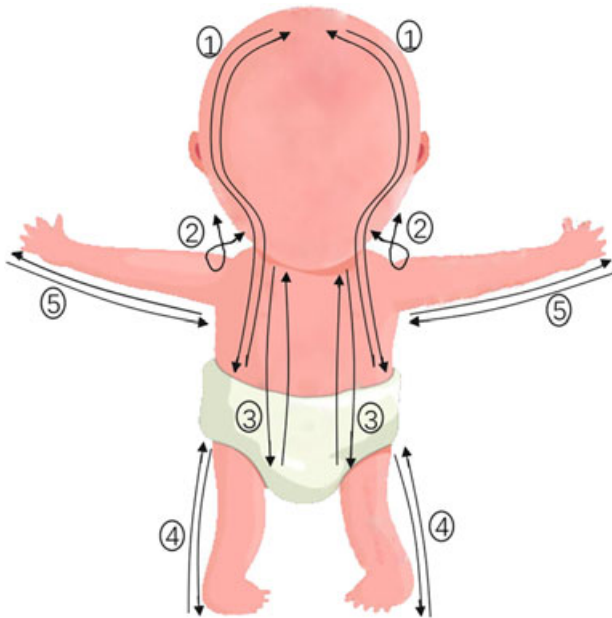
FIGURE 1 Massage intervention in prone position

touch to control and engage in massage. If convenient, mothers could practice massage on real people, such as their husbands. Cut and smooth mothers' nails to avoid tickling the skin of the preterm infants.

(iii) Slowly perform each period of massage:Place the preterm infant in the prone position (2 × 5 min) (see Figure 1): ① Head, neck, back, top head (1 min); ② Neck, shoulders, neck (1 min); ③ Upper-back, waist, upper-back (1 min); ④ Thighs, feet, thighs (1 min); ⑤ Shoulders, hands, both shoulders (1 min).Place the preterm infant in the supine position (5 min) (see Figure 2):
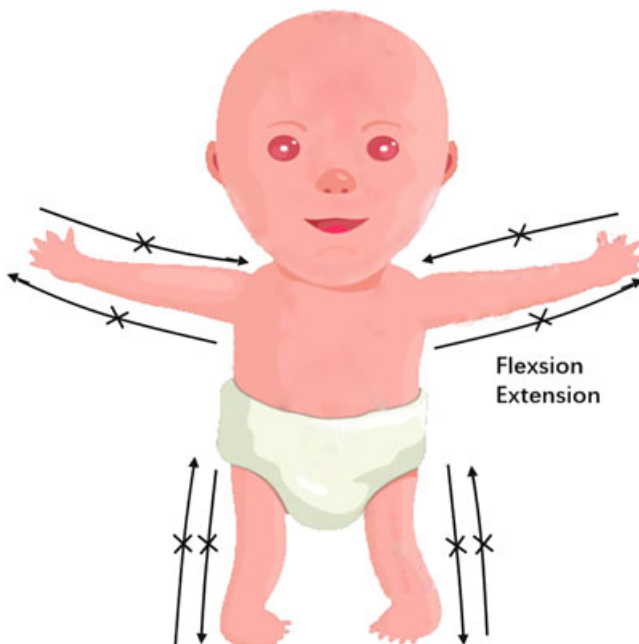
FIGURE 2 Massage intervention in supine position

① Both arms to both legs (5 s for each of 9 repetitions); ② Both legs (flexed 10 s for 6 repetitions and extended 10 s for 6 repetitions).

(iv) Stay relaxed and watch the preterm infant's response: Smile to the infant throughout the massage to help the infant release tension.

If the preterm infants were happy and enjoyed the massage touch, mothers could continue the process of massage intervention. If the preterm infants showed a desire to sleep, such as through yawning, or if the preterm infants expressed signs of distress cues, such as crying, hiccups, gagging, grimacing, an arched back, or any medical conditions (Beachy, 2003), mothers stopped and did not attempt the massage again.

4.1 | Limitations

This study has some limitations. The participants were recruited from one hospital, and the sample size was not large, thus reducing the ability to generalize these findings. Thus, growth improvement through massage intervention needs to be proven by a larger, multicenter study. Although this study provided scientific evidence for the advantages of massage intervention by mothers in the NICU, more research is necessary.

5 | CONCLUSIONS

Massage intervention is safe and has a long history in traditional Chinese medicine; moreover, no study has demonstrated adverse effects when massage is conducted in the NICU. In this study, we trained mothers to deliver a massage intervention to their preterm infants in the NICU for two weeks, which improved the growth of Wt, Ht, and HC of these preterm infants. This study developed modified massage intervention guidance, thus providing recommendations for optimal massage intervention by mothers in the NICU. We recommend the application of a massage intervention for preterm infants by mothers in the NICU.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analysed during the current study are not publicly available due to original consent, but are available from the corresponding author on reasonable request.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS

Xiaoning Zhang and Jun Wang designed the study and collected the data. All authors contributed to interpretation of results and prepared the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Human participant approval was obtained from Xuzhou Medical University. All mothers provided signed consent.

CONSENT FOR PUBLICATION

Informed written consent for publication was obtained from mothers.

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