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RESEARCH ARTICLE

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Effects of neonatal behavioral assessment scale on postnatal depressive symptoms in mothers of very low birth weight infants: a pilot randomized controlled trial

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ABSTRACT

Background: Mental support for mothers of low birth weight infants (LBWI) or preterm infants in neonatal intensive care unit (NICU) is a crucial issue as postpartum depressive symptoms are more prevalent among mothers of such infants in NICU compared to mothers of full-term infants.
Objective: In this pilot randomized controlled trial, we aimed to investigate the impact of psychological intervention through the neonatal behavioral assessment scale (NBAS) administration to very low birth weight infants, with or without mothers present, on the postnatal depressive symptoms experienced by mothers.
Methods: Mothers of LBWI were divided into two groups depending on their presence during NBAS assessment: Group M ($n=9$) with mothers present and Group non-M ($n=8$) without mothers present. Mothers in both groups answered the Edinburgh Postnatal Depression Scale (EPDS) before and after the NBAS assessment. The mothers in Group M received early intervention with their infants following assessment by the NBAS.
Results: No significant difference was observed in the EPDS score between the two groups in this study.
Conclusion: Early intervention using the NBAS with mothers present may yield no positive and negative effects on the mothers' depressive symptoms. Due to the small sample size of this pilot study, the results should be interpreted with caution, and there remains a need for further research about the effectiveness of the NBAS as early intervention.

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Preterm birth is defined as babies born alive before 37 weeks of pregnancy are completed and an estimated 11.1% were born preterm of all livebirths worldwide in 2010 [1]. The rate of preterm birth is increasing from 1990 to 2010 in most of the countries in the world and preventing preterm birth itself, preventing deaths and complications from preterm birth, and intervention for the care of preterm infants and their family are very important issue in World Health Organization [1,2].

Preterm birth and admission to the neonatal intensive care unit (NICU) poses unexpected and stressful challenges for parents. Postpartum depressive symptoms are more prevalent among mothers of very low birth weight (born less than 1500 g)/preterm infants (45.4%) compared to mothers of full-term infants (23.1%) [3]. Providing psychological support to hospitalized women with threatened preterm birth and parents of NICU infants is crucial for parental mental health and parent-infant bonding [3–5]. The Neonatal Behavioral Assessment Scale (NBAS), developed by Dr. Brazelton in 1973, is a standardized measure of newborn infants' behavioral competence and neurological status [6]. While traditionally used for infant neurobehavioral assessment without parental involvement, the NBAS has been gradually employed

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as an intervention to facilitate parent-infant relationships, allowing parents to observe and understand their infants' characteristics [7]. Some studies have reported positive effects of early intervention using the NBAS or other modified procedures on mother-child relationships and postpartum depressive symptoms [8,9], however others have found no significant effects on postnatal depression, mother-infant relationships, and infant development [10,11]. Most of these studies primarily focused on full-term infants, while some studies partially include preterm infants. Moreover, only one study conducted in Japan examined the effectiveness of the NBAS intervention on mothers' anxiety and caregiving confidence in low birth weight infants with cerebral injuries [12]. Thus, the effectiveness of psychological interventions using the NBAS with mother-infant dyads, especially for very low birth weight/preterm infants, remains controversial. Additionally, research on the effectiveness of the NBAS in Asian countries, including Japan, is limited. In this pilot randomized controlled trial, we aimed to investigate the impact of psychological intervention through NBAS administration to very low birth weight infants, with or without mothers present, on the postnatal depressive symptoms experienced by mothers in Japan.

Methods

Participants

This study adhered to the tenets of the Declaration of Helsinki, and the protocol was approved by the ethics committee at our hospital (IRB No. 20130226-12).

Very low birth weight infants (birth weight < 1500 g) born between April 2013 and March 2014 and admitted to the tertiary NICU in our hospital were eligible for this study. Infants with chromosomal abnormalities, severe motor impairments classified as Gross Motor Function Classification System level 3 [13], and those who died before or after discharge were excluded. Block-stratified randomization by weight and sex was performed to divide the participants into two groups. Written informed consent was obtained from the mothers to allow their infants' participation in the study.

Instruments

NBAS

The NBAS comprises 28 behavioral and 18 elicited items, including primitive reflexes, and takes approximately 20 min to administer. Most items are scored on a nine-point scale, with higher scores indicating better performance. The NBAS yields seven predefined clusters: habituation to stimuli, orientation to stimuli, general motor tone and activity, behavioral state regulation, behavioral status range, autonomic stability, and reflexes [6]. In this study, the NBAS was used as both an assessment and intervention tool. The mothers of very low birth weight infants in Group M attended the NBAS administration, while in Group non-M the NBAS was used solely as an assessment tool without the mothers' presence.

Edinburgh postnatal depression scale (EPDS)

The EPDS is an internationally recognized self-report questionnaire designed to assess the depressive symptoms in postnatal mothers. It consists of 10 items scored on a four-point scale (0–3). The Japanese version of the EPDS was developed by Okano in 1996 [14]. In Japan, a threshold score of 9 is usually adopted to detect a probable diagnosis of depression.

Demographic data

Maternal age at childbirth, final academic background, marital status, job before childbirth, and childcare support were recorded to characterize the mothers. Gestational week, birth weight, multiple births, and birth order were considered as variables for the infants and were obtained from a questionnaire at 1 week after delivery or extracted from the medical records of the hospital.

Procedures

This study adhered to the tenets of the Declaration of Helsinki, and the protocol was approved by the ethics committee of the Japanese Red Cross Aichi Medical Center Nagoya Daini Hospital, Japan (IRB No.20130226-12). We registered this pilot randomized control trial in Japan Registry of Clinical Trial (No. jRCT1040230179).

This randomized controlled trial consisted of two groups: Group M, comprising infants assessed with the NBAS at approximately 40 weeks of postmenstrual age with their mothers' present ($n = 17$), and Group non-M, comprising infants assessed without their mothers' present ($n = 14$). As the calculated sample size of approximately 170 was not achievable in our situation due to limitations such as human resources and the annual number of LBWI born, we adhered to the precedent set by previous studies until 2013, which typically ranged from 20-30 participants [8,12]. In Group M, the examiner shared time and space with the mothers during the NBAS administration and after the

administration discussed their infants' behaviors, traits, and appropriate ways to interact with them. The NBAS was administered by a certified trainer (Y. N.) and an examiner (K. N.). Additionally, each mother was asked to answer the EPDS at five time points: 1 week, 1 month, corrected 1 month, 3 months, and 6 months after their infants' birth. Mothers whose EPDS scores before the NBAS administration were recorded within 1 week of childbirth were not included in the analysis due to the potential influence of maternity blues on the EPDS scores. The study included three infants from two pairs of twins in Group M. One pair consisted of an infant with a very low birth weight and another with a birth weight >1500 g, while the other pair comprised two infants with very low birth weight. Therefore, data from the two mothers and three infants were analyzed.

The primary outcome in this study is the difference in the EPDS scores before and after the administration of the NBAS.

Statistical analyses

The difference in scores of EPDS before and after the administration of the NBAS between Group M and Group non-M were analyzed using Mann-Whitney U test (SPSS 29, IBM Tokyo, Japan).

Results

A flowchart illustrating the participant selection process is presented in Figure 1. The final study cohort consisted of 10 infants (9 mothers) in Group M and 8 infants (8 mothers) in Group non-M. Tables 1 and 2 display the demographic characteristics of the infants and mothers, as well as the infants' NBAS scores and mothers' EPDS scores. The data of the dropouts ($n = 13$) were included in the Tables. All infants included in the study were born with very low birth weight (<1500 g) and were premature (<37 weeks of gestation). A higher difference in EPDS scores before and after the administration of the NBAS indicates a more favorable recovery from the postnatal depressive state of the mother. The difference in EPDS scores did not show a significant variation between the two

Table 1. Characteristics and results of NBAS of infants.

	Group M	Group non-M	Dropouts
Number	$n = 10$	$n = 8$	$n = 13$
Male	6 (60.0%)	5 (62.5%)	8 (61.5%)
Gestational age (weeks)	29.5 ± 3.1	29.8 ± 3.4	30.4 ± 3.8
Birth weight (g)	1082 ± 187	1088 ± 264	1072 ± 296
Age at NBAS administration (days)	71 ± 23	68 ± 25	72 ± 33
Postmenstrual age at NBAS administration (weeks)	39.8 ± 1.3	39.7 ± 0.9	40.3 ± 1.4
NBAS scores in seven clusters			
Habituation (1–9)	7.4 ± 1.0	8.0 ± 0.7	7.7 ± 0.9
Orientation (1–9)	5.8 ± 1.6	5.6 ± 1.2	5.7 ± 1.1
Motor (1–9)	4.6 ± 0.7	4.2 ± 1.3	4.7 ± 0.9
Range of state (1–9)	3.5 ± 0.7	4.1 ± 0.5	4.0 ± 0.5
Regulation of state (1–9)	4.2 ± 0.4	4.4 ± 1.0	4.3 ± 1.3
Autonomic stability (1–9)	5.3 ± 1.2	6.2 ± 0.4	5.9 ± 0.9
Reflex (number of abnormal reflexes)	1.4 ± 1.6	1.8 ± 1.8	1.9 ± 1.8

Values are shown as number (%) or mean ± standard deviation.
NBAS: Neonatal Behavioral Assessment Scale; Group M: NBAS with mothers; Group non-M: NBAS without mothers; EPDS: Edinburgh Postnatal Depression Scale.

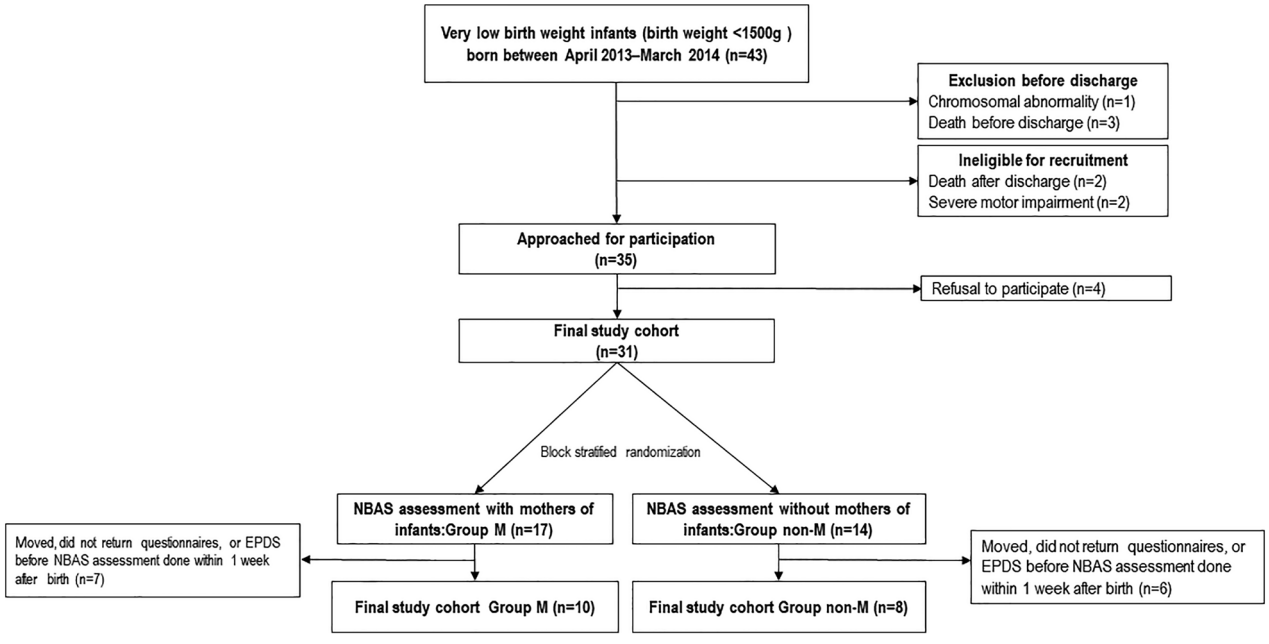

Figure 1. Study population. NBAS: Neonatal Behavioral Assessment Scale; Group M: NBAS with mothers; Group non-M: NBAS without mothers; EPDS: Edinburgh Postnatal Depression Scale.

Table 2. Characteristics and results of EPDS of mothers.

	Group M	Group non-M	Dropouts	P-values
Number	$n=9$	$n=8$	$n=13$	
Married (%)	9 (100%)	8 (100%)	13 (100%)	
Multiple birth (%)	2 (22.2%)	0 (0%)	0 (0%)	
Primipara (%)	3 (33.3%)	3 (37.5%)	6 (46%)	
Maternal age at childbirth (years)	33.2 ± 3.2	35.9 ± 3.8	31.5 ± 5.5	
Final academic background (high school, professional training college, university, graduate school)	1, 2, 6, 0	0, 3, 4, 1	6, 6, 1*,0	
Job before childbirth (full-time, part-time, self-employed, housewife)	1, 1, 2, 5	3, 1, 0, 4	5, 0, 1, 6	
Childcare support at 1 week after childbirth (%)	9 (100%)	8 (100%)	12 (92%)	
EPDS score at 1 week after childbirth (rate of score≧9, %)	11.7 ± 8.3 (44%) $n=9$	13.2 ± 6.7 (83%) $n=7$	8.6 ± 7.0 (38%) $n=13$	
EPDS score at 1 month after childbirth (rate of score≧9, %)	5.1 ± 4.9 (11%) $n=9$	6.3 ± 5.2 (43%) $n=7$	3.3 ± 3.3 (14%) $n=7$	
Difference of EPDS scores (score in pre-NBAS minus score in post-NBAS)	0.22 ± 2.5	−1.6 ± 3.2		0.208
Days between two EPDSs (pre-NBAS and post-NBAS)	55 ± 11	73 ± 22		

Values are shown as number (%) or mean ± standard deviation, and intergroup comparisons were performed using the Mann-Whitney test.
NBAS: Neonatal Behavioral Assessment Scale; Group M: NBAS with mothers; Group non-M: NBAS without mothers; EPDS: Edinburgh Postnatal Depression Scale. * Significant differences were detected by Bonferroni correction.

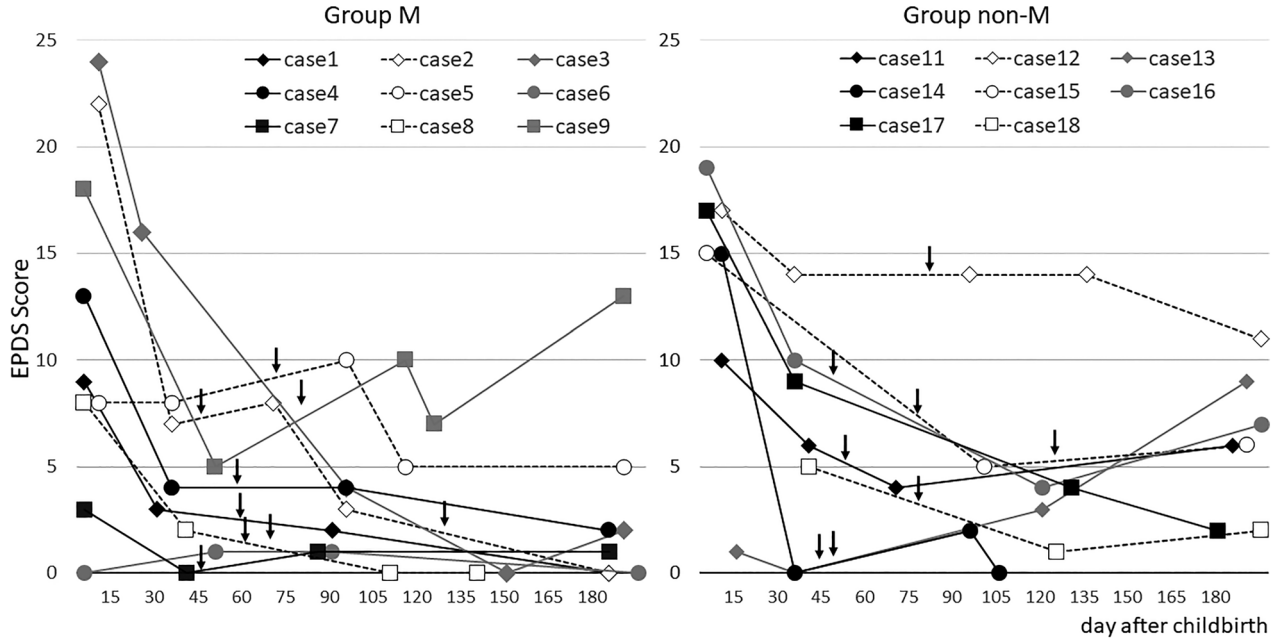

Figure 2. Trajectories of EPDS scores of mothers in group M and group non-M. Arrows indicate the day from birth of NBAS administration. Group M: NBAS with mothers; Group non-M: NBAS without mothers; EPDS: Edinburgh Postnatal Depression Scale; NBAS: Neonatal Behavioral Assessment Scale.

groups (mean ± standard deviation [SD]: Group M 0.22 ± 2.5, Group non-M −1.6 ± 3.2, $p=0.208$). The trajectory of EPDS scores for each mother is presented in Figure 2, and Figure 3 displays a close-up of the differences in scores before and after the NBAS administration in the two groups. Our data suggests that the presence of mothers during the NBAS administration may not necessarily improve or exacerbate mothers' depressive symptoms. Some mothers exhibited persistently high EPDS scores or an increase indicating a high-risk level (≥9) following the NBAS administration. In cases 2 and 9, the mothers were exhausted from taking care of twins without assistance. In case 8, the mother felt anxious and alone after 4 months because her husband was on a long business trip. In case 12, the mother suffered from a sense of guilt regarding her preterm delivery and expressed having a bad relationship with her family.

Discussion

The aim of this study was to examine the impact of early intervention with the NBAS, on mothers of low birth weight infants in the NICU. Concerns were raised

regarding potential adverse effects on mothers, who are at high risk of mental vulnerability [3]. It is suggested that the mothers' presence during the NBAS might have had no adverse effects on their depressive symptoms, although the result cannot be considered important statistically. Stern (1999) emphasized the importance of clinicians providing emotional care and support to anxious and vulnerable mothers of infants in the NICU, particularly before an assessment with the NBAS [15]. Therefore, we need to focus on building a strong relationship both before and after the NBAS administration, as this can enhance the impact of the intervention on mothers' depressive states.

McManus et al. [9] demonstrated the effectiveness of early intervention with the Newborn Behavioral Observation (NBO) system [16] developed based on the NBAS in reducing mothers' depressive symptoms and enhancing infants' abilities in high-risk populations, including low birth weight infants and low-income families. Their intervention was conducted once a week for up to 12 weeks after birth. Høifødt et al. and Cooper et al. reported no significant differences in mother-infant relationships, mothers' depressive symptoms, and parental stress following early intervention with the NBAS and the NBO [10,11]. Høifødt et al. studied healthy families, while Cooper et al. focused on high-risk mothers for postnatal depression. Their interventions consisted of three sessions up to four weeks from birth and 11 sessions from antenatally up to 16 weeks from birth, respectively. The participants were healthy family in the research by Høifødt et al. and high-risk mothers for postnatal depression in the research by Cooper et al. Their interventions were done three sessions up to four weeks from birth and 11 sessions from antenatally up to 16 weeks from birth respectively.

In our study, a single session without pre-intervention of the NBAS has influenced the non-favorable result. Future studies should explore most cost-effective and beneficial interventions for parents, infants, and their relationships.

Super and Harkness [17] highlighted cultural differences in the perceived organization of newborn behaviors between Kenya and the U.S. While a previous study in Japan demonstrated favorable results of early intervention with the NBAS for high-risk infants and their mothers [12], further research involving low birth weight infants and their mothers from different cultural backgrounds is necessary.

Although the trajectory of EPDS scores was not the primary outcome in this study, the data in Figure 2 may have indicated the existence of maternity blues and the need for early intervention for depressive symptoms

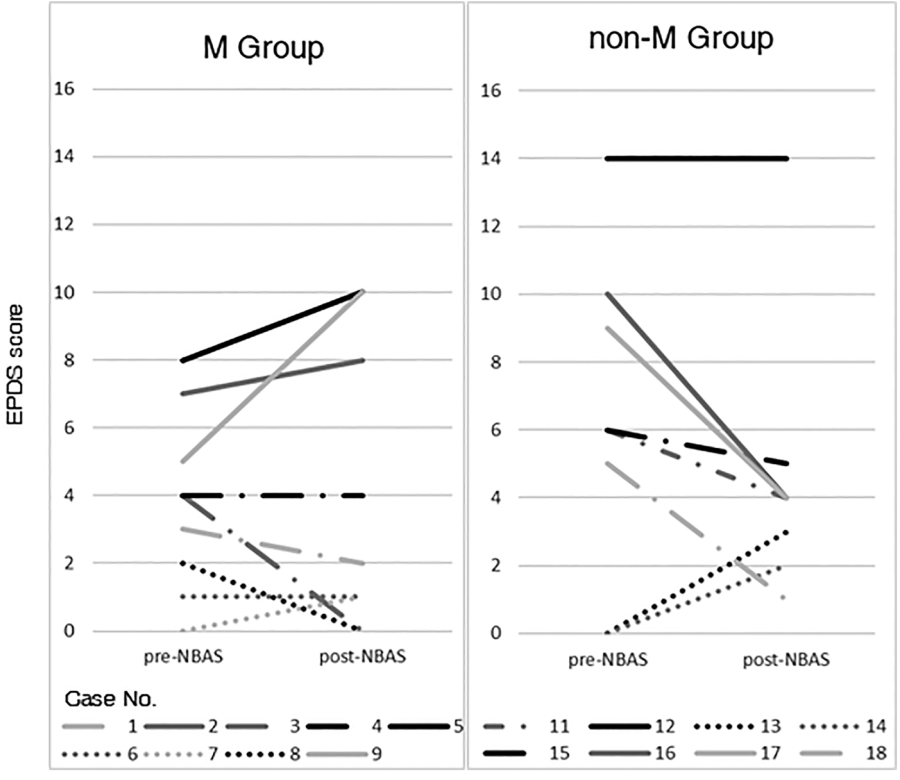

Figure 3. Trajectories of the score on EPDS between pre-NBAS and post-NBAS. Group M: NBAS with mothers; Group non-M: NBAS without mothers; EPDS: Edinburgh Postnatal Depression Scale; NBAS: Neonatal Behavioral Assessment Scale.

approximately 1 month after childbirth, consistent with previous research [18]. The trend of a second increase in EPDS scores at approximately 6 months is consistent with the findings of a meta-analysis of healthy mothers of full-term infants [19]. Continuous high-risk EPDS scores observed in some mothers of low birth weight infants in this study emphasize the importance of early intervention and monitoring programs.

Our study had several limitations. Firstly, to make a randomized controlled trial as reliable as possible, a third party should monitor the allocation table. In our study, owing to a lack of funds, we attempted to allocate each case using a pre-made allocation table. Future studies should strictly monitor this procedure using a central management center. Secondly, the time spans of two EPDSs in the two groups were different, which made it difficult to interpret the results. In the future a shorter and comparable time span should be set for obtaining the EPDSs before and after NBAS intervention. Finally, the sample size was small. In addition to insufficient numbers of the enrollment in this study, the high dropout rate resulted in fewer participants, diminishing the reliability of our results. The administration of the questionnaire survey five times after delivery may pose a burden to mothers. When we compared the characteristics of mother-infant dyads who dropped out in Tables 1 and 2, there appears to be a trend of lower academic background that we should take into consideration in future research. Based on this pilot study, studies with large sample sizes involving multiple centers are required to elucidate the effectiveness of early intervention using the NBAS for mothers of low birth weight/preterm infants.

Conclusions

This pilot randomized controlled trial, found no significant positive or negative effects on mothers' depressive symptoms when they were present during the administration of the NBAS to their very low birth weight infants in the NICU in Japan. While early intervention using the NBAS may not exacerbate mothers' depressive symptoms, it is important to interpret the findings cautiously due to the small sample size. Given the scarcity of research on the effectiveness of the NBAS for low birth weight/premature infants and their parents, further studies with large sample sizes investigating the optimal interval, duration, and frequency of NBAS-based early interventions in the NICU, taking into account different cultural contexts, are urgently needed.

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Authors contributions

All authors planned and conducted the study. Kayo Nomura registered the data, designed the study, and critically revised the manuscript. Yukiyo Nagai rechecked and analyzed the data and wrote the first draft of the manuscript. All authors have approved the final version of the manuscript before submission.

Consent to participate

Written informed consent was obtained from the mothers to allow their infants' participation in the study.

Disclosure statement

All the authors hereby certify that there is not conflict of interest.

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Data availability statement

Authors agree to make data and materials supporting the results or analyses presented in this paper available upon reasonable request.

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