Volume 3 Issue 2, July 2026, p. 61-72

Journal of Nursing Periodic
http://journal.uds.ac.id/index.php/JNP
e-ISSN 3032-6761

ORIGINAL ARTICLE **Open Access**

Effectiveness of Developmental Care in Reducing Physiological Stress among Low-Birth Weight Infants

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Abstract

Introduction: Infants with low birth weight (LBW) are at high risk of experiencing physiological stress due to immaturity of organ systems and exposure to neonatal intensive care environments. Physiological stress can affect the stability of vital signs, sleep quality, and the baby's growth and development process. Developmental care is a treatment approach that focuses on providing stimulation according to the baby's developmental needs to minimize stress and increase physiological stability. This study aims to analyze the effectiveness of developmental care in reducing physiological stress in babies with low birth weight.
Methods: This study uses a pre-experiment design. The research population is LBW babies who are in the Perinatology room of dr. Soebandi Jember Hospital. The number of samples in this study was 37 LBW babies who were selected using the non-probability sampling technique using the purposive sampling method. The independent variable of the study is the application of Developmental Care in the form of an incubator cover. Meanwhile, the dependent variable is the baby's physiological stress level, which is assessed based on the baby's vital signs before and after the intervention. The research measurement tool was taken using a physiological scale observation sheet, which consisted of 4 indicators, namely HR, RR, SpO_2, and body temperature. Statistical analysis was carried out by means of the Friedman Test to find out the difference in the score of each indicator from day 1 to day 3 and the Kruskal-Wallis Test (non-parametric Anova) to find out the difference in total physiological stress scores between days.
Results: There was a significant decrease in the average score of Heart Rate (HR), Respiratory Rate (RR), SpO_2, and Body Temperature from day 1 to day 3 ($p = 0.000$ for each indicator). The total physiological stress score also showed a decrease from an average of 84.55 to 40.00 ($p = 0.000$).
Conclusions: Developmental care is effective in reducing physiological stress in babies with low birth weight. This approach can be applied as one of the neonatal nursing strategies to improve comfort, physiological stability, and support the growth and development process of LBW babies.

Keywords: developmental care, physiological stress, low birth weight babies, neonatal nursing.

Introduction

Health indicators are variables that can be used to measure public health status. One of the indicators that can be used to measure the degree of health is the infant mortality rate. Infant

Mortality Rate (AKB) is an indicator that can be calculated based on the number of babies who die before reaching the age of one year as expressed in 1000 live births in the same year. Currently, one of the factors for increasing the infant mortality rate is due to the condition of the baby Low Birth Weight (LBW) (Nurwati et al., 2023).

According to the World Health Organization (WHO), LBW is a baby born weighing less than 2500 grams (Care of Preterm or Low Birthweight Infants Group, 2023). In addition to judging from his weight, LBW can also be judged by his body length and head circumference. LBW poses various problems both in the short and long term. Therefore, this incident has become a global public health problem. In LBW, there is a risk of complications in the body system due to unstable body conditions. Complications can be hypothermia due to the baby's imperfect body temperature regulating center, relatively large body surface, limited production and heat storage capabilities (Rukiyah & Mulyati, 2022).

Physiological or biological stress is an organism's response to stressors such as environmental conditions. Stimuli that change the environment of an organism are responded to by various systems in the body (Ulrich-Lai and James 2009 in E-journal Atmajaya University Yogyakarta, 2024). Environmental conditions in the form of noise, lighting, odors, installation of tools for monitoring physiological parameters and procedures that can cause stress, pain and greatly contribute to morbidity. All of these actions can cause stress in the baby. The impact if the baby is stressed is changes in the baby's physiological function, such as hypothermia, the heart rate increases, the frequency of breathing will cause the occurrence of recurrent apnea, the percentage of hemoglobin bound by oxygen (SpO2) tends to decrease (Gitto 2012 dalam Alkatiry 2022).

A preliminary study conducted in the Perinatology room of dr. Soebandi Jember Hospital in the last 3 months (July, August, September 2024) obtained data on 128 babies born with LBW out of 336 total births. This means that 38% of the birth rate at dr. Soebandi Jember Hospital is LBW. This figure is very high when compared to the prevalence of LBW on a national scale. Until now, LBW ranks highest in infant deaths at dr Soebandi Jember Hospital. And Jember district is the first contributor to the newborn mortality rate in East Java, from the total number of LBW births it is estimated that there are around 60 babies who experience Physiological Stress.

One of the indicators of the quality of service in the Perinatology room at dr. Soebandi Jember Hospital is the success rate of LBW. This is in line with one of the national programs in the Millennium Development Goals (MDGs), which is to reduce infant mortality (AKB). The Sustainable Development Goals (SDGs) have determined that reducing the LBW rate is a

global focus that must be resolved immediately. A reduction in the LBW rate of up to 30% is targeted to be achieved by 2025. Therefore, it is expected that every year there will be a relative decrease in the LBW number by 30% in the period 2012-2025 or there will be a decrease in the LBW number from 20 million to 14 million (Abidanovanty et al., 2023).

Developmental care is care that facilitates the development of the baby through adequate environmental management that will increase physiological stabilization and reduce the baby's stress (Byers 2006 in Sofiyah and Fibriyani 2024). Rustina 2013 in Sofiyah and Fibriyani (2024) revealed that developmental care is the reduction of distractions and stimulation by caregivers to individuals in facilitating the growth and development of babies. Goldstein 2012 in Sofiyah and Fibriyani (2024) states that developmental care has the goal of creating a conducive environment, where nurses and other caregivers observe the behavior of premature babies to determine how to make their environment avoid stress, namely by maintaining sounds, dimming the lights, and minimizing painful procedures for the baby.

The benefits of implementing developmental care in LBW include prioritizing family-centered care and conditioning the environment to reduce stress on LBWs who are born in immature conditions both physically and psychologically Goldstein 2012 in Sofiyah and Fibriyani (2024), improving the competence of both parents in LBW care (Westrup 2005 in Sofiyah and Fibriyani 2024), shorter hospitalization times, growth benefits with daily weight gain in infants, and improved mental health of premature infants (Haumont, Vermeulen, and Dupuis 2013 in Sofiyah and Fibriyani 2024).

Early intervention is needed by LBW to optimize the growth and development of LBW. Interventions are carried out both to improve the environment and the baby itself including the relationship between parents and the baby, stimulation in the baby, LBW care education in the parents, in order to improve cognitive function, motor skills and reduce other disabilities. The results of the meta-analysis of early intervention in LBW improved cognitive function in infants and at preschool age (Irwanto et al. 2017 in Sofiyah and Fibriyani, 2024). The benefits of developmental care in the long term, including after developmental care interventions in children aged 3 years, have a positive impact on children's behavior and interactions between mother and child (Kleberg, Westrup dan Sternqvist, 2000 dalam Sofiyah and Fibriyani, 2024).

A nurse is someone who provides health services to individuals, families, groups or communities in the form of nursing care. The success of the implementation of Developmental Care is supported by the availability of human resources as professional care providers. Based on the description of the data above, the researcher is interested in conducting a study entitled

"The Effect of the Implementation of Developmental Care (Incubator Cover) on the Reduction of Physiological Stress in LBW in the Perinatology Room of dr. Soebandi Jember Hospital"

The purpose of the study was to determine the effect of the application *of developmental care* (incubator cover) on the reduction of physiological stress in LBW in the perinatology room of dr. Soebandi Jember Hospital.

Methods

This study employed a pre-experimental design to evaluate the effect of the independent variable on the dependent variable. The study population consisted of low birth weight (LBW) infants admitted to the Perinatology Unit of dr. Soebandi Hospital, Jember. The study sample comprised 37 LBW infants selected using a non-probability purposive sampling technique. Infants were included if they met the following inclusion criteria: (1) birth weight <2,500 g, (2) admitted to the Perinatology Unit during the study period, (3) clinically stable as determined by the attending neonatologist, and (4) parental or guardian informed consent was obtained. The exclusion criteria were: (1) infants with major congenital anomalies or chromosomal abnormalities, (2) infants requiring emergency surgical intervention or mechanical ventilation during the intervention period, (3) infants with severe clinical deterioration that prevented completion of the intervention, and (4) infants whose parents or guardians declined participation or withdrew consent during the study. A total of 37 infants who fulfilled these criteria were enrolled in the study.

The independent variable of the study is the application *of Developmental Care* in the form of an incubator cover. The intervention consisted of implementing Developmental Care through the use of an incubator cover for premature infants. The incubator cover was placed over the incubator to minimize excessive light and noise exposure, creating a low-stimulation environment that resembles the intrauterine condition. This intervention was performed throughout the study period while maintaining infant safety and allowing necessary clinical procedures. The aim of this intervention was to promote physiological stability and support neurodevelopmental outcomes in premature infants. Meanwhile, the dependent variable is the baby's physiological stress level, which is assessed through the indicators *of Heart Rate* (HR), *Respiratory Rate* (RR), Oxygen Saturation (SpO_2), and Body Temperature during 3 days of treatment. The research measurement tool was taken using a physiological scale observation sheet, which consisted of 4 indicators, namely HR, RR, SpO_2, and body temperature. Each indicator was assessed based on an ordinal scale score of 1–3 for three consecutive days.

Statistical analysis was carried out by means of the Friedman Test to find out the difference in the score of each indicator from day 1 to day 3 and the Kruskal-Wallis Test (non-parametric Anova) to find out the difference in total physiological stress scores between days. This research has received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Dr. Soebandi University Jember with the ethics letter number: 112/KEPK/FK-UDS/VI/2024. The researcher also obtained approval from the hospital and the consent of the baby's parents for the use of observation data.

Results

Table 1. Characteristics of LBW babies (n=37)

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	23	62,2
Female	14	37,8
Infant Age		
1 day	24	64,9
2 day	7	18,9
3 day	6	16,2
Length of Treatment		
1 day	2	5,4
2 day	11	29,7
3 day	24	64,9
Weight (grams)		
1000–1590	6	16,2
1600–2090	20	54,1
2100–2490	11	29,7

This study involved 37 babies with Low Birth Weight (LBW) who received Developmental Care interventions during the treatment period. Respondents' characteristics included gender, infant age, length of treatment, and birth weight. Table 1 shows that most of the LBW babies were male as many as 23 babies (62.2%), while female babies were 14 babies (37.8%). Based on the age of the babies at the time of the study, the majority of babies were 1 day old, namely 24 babies (64.9%), followed by 2-day-old 7 babies (18.9%) and 3-day-old 6 babies (16.2%). Based on the length of treatment, most of the babies underwent treatment for 3 days, namely 24 babies (64.9%), while 11 babies (29.7%) were treated for 2 days and 2 babies (5.4%) for 1 day. No babies were found with a treatment duration of more than 3 days. The weight distribution showed that most babies weighed between 1600–2090 grams, namely 20 babies (54.1%), then 11 babies (29.7%) were in the weight range of 2100–2490 grams, and 6 babies (16.2%) weighed 1000–1590 grams.

Table 2. Friedman Test Results of LBW Infant Physiological Parameters (n=37)

Parameter	Day-1 Mean Rank	Day-2 Mean Rank	Day-3 Mean Rank	Chi-Square	p-value
Heart Rate	2,82	1,65	1,53	58,563	0,000
Respiratory Rate	2,68	1,70	1,62	48,308	0,000
SpO_2	2,70	1,73	1,57	44,387	0,000
Suhu	2,74	1,76	1,50	50,191	0,000

Analysis of changes in physiological parameters of Low Birth Weight (LBW) infants after Developmental Care was carried out using the Friedman test because measurements were taken repeatedly during three days of treatment. The results of the study showed significant changes in all physiological parameters of LBW infants. In the Heart Rate (HR) parameter, there was a decrease in the mean rank value from 2.82 on the first day to 1.53 on the third day with the results of the Friedman test showing a Chi-Square value of 58.563 and $p = 0.000$ ($p < 0.05$). The Respiratory Rate (RR) parameter also decreased the mean rank from 2.68 to 1.62 with a Chi-Square value of 48.308 and $p = 0.000$. Furthermore, the oxygen saturation parameter (SpO_2) showed a decrease in the mean rank from 2.70 on the first day to 1.57 on the third day with a Chi-Square value of 44.387 and $p = 0.000$. In the body temperature parameters, there was a change in the mean rank from 2.74 to 1.50 with a Chi-Square value of 50.191 and $p = 0.000$. These results show that the administration of Developmental Care has a significant influence on changes and stabilization of the physiological parameters of LBW infants during the treatment period.

Table 3. Results of the Kruskal–Wallis Test

Length of Treatment Day	Frequency	*Mean Rank*	Kruskal-Wallis H	df	Asymp. Sig.
Hari ke-1	37	84,55			
Hari ke-2	37	43,45	49,932	2	0,000
Hari ke-3	37	40,00			
Total	111				

Follow-up analysis using the Kruskal-Wallis test showed that there was a difference in the physiological score of LBW infants during three days of treatment. The mean rank value decreased from the first day by 84.55 to 40.00 on the third day. The results of the statistical test

showed a value of H = 49.932 with a p-value = 0.000 ($p < 0.05$). These results show that the administration of Developmental Care is effective in helping to reduce the physiological stress response and improve the stability of LBW infants during the treatment period.

Discussion

The results of the statistical test showed significant (Sig. = 0.000), indicating that *Development Care interventions* have the potential to be effective in reducing the physiological response to stress in LBW infants in the Perinatology room of dr. Soebandi Jember Hospital. The findings suggest that environmental intervention through the incubator cover can serve as protection against excessive external stimuli (light, sound), thus helping to maintain the physiological stability of premature babies. This is in line with the findings of studies by Als, Lawhon, and Duffy (2003) and White-Traut and Nelson (2004), which show that the Developmentally Supportive Care strategy can modulate infants' physiological responses, including lowering *heart rate*, increasing oxygen saturation, and improving sleep patterns. A local study by Wulandari (2019) also showed that the use of incubator cover fabrics contributed to a decrease in the stress score of premature infants in the Perinatology room.

A decrease in physiological stress in LBW has the potential to reduce the length of treatment, risk of complications, and treatment costs. It can be applied in training for health workers and as a hospital policy recommendation for *family-centered care* and *neuroprotective intervention* (Lewis et al., 2024). Stress in babies treated in the perinatology room, usually stems from noise, excessive lighting, invasive procedures, and lack of touch interaction. With the use of incubator covers, excessive environmental stimuli are reduced so that the baby's body is not constantly in a *fight-or-flight* condition (Raghu & Vatsa, 2022). These results suggest that a simple intervention can stabilize the baby's autonomic system and promote optimal physiological calm during recovery (Hastuti & Zubaidah, 2026).

LBW has a limited energy capacity to maintain the basic functions of the body. By reducing stress and providing a calmer environment, *Developmental Care* allows babies to allocate energy not to survive stimuli, but to speed up the healing process (Pineda et al., 2023). A decrease in respiratory frequency and heart rate means that the need for oxygen and metabolism decreases, so that the baby's body is in an ideal condition to repair tissues, maintain body temperature, and promote organ maturation. This effect also supports the reduction in length of care shown in literature studies and local findings (Lewis et al., 2024).

Optimal growth requires a balance between nutrient intake, sleep quality, and a stress-free environment. The reduction in physiological stress that has been shown in studies

contributes directly to improved metabolic stability, sleep regulation, and daily weight gain. This is in line with the results of a study by Rodovanski et al., (2023) which linked *Developmental Care* to increased weight and health status of premature infants. These interventions not only stabilize, but also stimulate growth through reduced invasive interventions and increased comfort.

A calm and controlled environment can also provide space for babies to display behaviors according to their neurological maturity stages, such as expressions of comfort, directed motor reactions, and more stable sleep-wake rhythms. Without excessive stress exposure, babies are better able to react to gentle touch and show early social engagement. *Developmental Care* helps to dampen the activation of the limbic system and allows for healthy neuro-motor reflex engagement. This study shows that simple interventions such as incubator closures can be a means to support the sensory and motor development of babies in the long term (Zhang et al., 2024).

With the implementation of *Developmental Care*, families, especially parents, are actively involved in the process of caring for babies. This increases belonging, competence, and emotional bond with the baby. As the incubator environment becomes friendlier, parents feel safer to approach and care for their babies, accelerating the bonding process that is important for the baby's emotional growth and development (Hounsome et al., 2026). Although parental psychological outcomes were not directly measured in this study, previous evidence suggests that improvements in infant physiological stability through Developmental Care can enhance parental confidence, reduce anxiety, and strengthen parent–infant bonding during hospitalization (Franck et al., 2020).

When preterm or low birth weight infants demonstrate clinical stability and reduced physiological stress responses, parents often experience improved emotional well-being and greater confidence in participating in their infant’s care. Hospitalization in the perinatology or neonatal intensive care environment can be a highly stressful experience for families, contributing to increased parental anxiety, psychological distress, and depressive symptoms due to uncertainty regarding the infant’s condition and prolonged separation (Barbancho- & Sanduvete-, 2024). Developmental Care offers a supportive approach by involving parents in caregiving activities, enhancing parent–infant bonding, and strengthening family resilience throughout the hospitalization process (Hastuti & Zubaidah, 2026). Interventions aimed at reducing excessive sensory stimulation and promoting infant comfort not only improve neonatal physiological stability but also create a more compassionate, empowering, and family-

centered care experience, facilitating a transition from parental trauma and fear toward collaborative healing and adaptation (Pineda et al., 2023).

The difference between this study and other studies is that there is no control group (without intervention), so the absolute effect of Development Care is difficult to distinguish from other factors. Consistently, your research reinforces the evidence that modification of the incubator environment with a Development Care approach consistently has a positive impact on the homeostasis of high-risk infants.

Conclusion

Based on the results of the study, it can be concluded that the provision of Developmental Care has an effect on the physiological stability of babies with Low Birth Weight (LBW) during the treatment period. The developmental care intervention showed significant changes in physiological parameters including Heart Rate (HR), Respiratory Rate (RR), oxygen saturation (SpO_2), and body temperature during three days of treatment with the results of the Friedman and Kruskal-Wallis tests showing a value of $p = 0.000$ ($p < 0.05$). This shows that Developmental Care is effective in helping to reduce the physiological stress response and improve the stability of LBW babies' condition, so that it can be one of the neonatal nursing interventions in supporting the baby's adaptation and recovery process during treatment.

Acknowledgment

The author expresses his gratitude to all parties who have supported the implementation of this research, especially the perinatology team of dr. Soebandi Jember Hospital for their permission, support, and cooperation during the research process, as well as nurses and midwives who play a role in the implementation of Developmental Care and data collection. Appreciation was also expressed to the parents of LBW babies for their participation and trust, and dr Soebandi University for facilitating the implementation of research professionally.

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