Original Article

Effect of Nesting on Bio-Physiological Parameters and Suckling Response among Low-Birth-Weight Infants

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Abstract:

Background: Nesting position is feasible to meet some of the unique care needs of low birth weight (LBW) infants during long-term hospitalization. Neonatal intensive care nurses must be provided with the best evidence regarding the importance of applying the nesting technique for LBW neonates in the neonatal intensive care units (NICUs) as a standard of developmentally supportive care. Nesting can be used as routine clinical practice. **The study aims** to evaluate the effect of nesting on bio-physiological parameters and suckling response among LBW infants. **Design:** A quasi-experimental research design was used. **Setting:** The study was conducted at the NICU of Abo hommos hospital for Children (Demesna) in El Beheira Governorate which is affiliated to the Ministry of Health and Population/Egypt. **Subjects:** A purposive sample of 60 LBW infants divided into two equal groups (30 LBW infants for the control group and 30 LBW infants for the study group) according to inclusion criteria**. Tools for data collection**: **Tool I:** Demographic and Health Data Structured Questionnaire about LBW Infants and Their Mothers**. Tool II:** Bio-Physiological Parameters Observational Checklist Sheet. **Tool III:** Early Feeding Skills Assessment Scale (EFS). **Results**: There was a substantial effect of nesting on LBW infants' suckling response of the study group with is a high statistically significant difference at a P value (≤0.0001) and there was a highly statistically significant association between the mean of LBW infants' respiratory rate, body temperature and O_2 sat at a P value (≤0.0001) among the study group. **Conclusion**: Nesting is an effective intervention to stabilize the bio-physiological parameters and to improve the suckling response among LBW infants. **Recommendations**: Enhance NICU nurses' knowledge and skills in developmental supportive positioning through structured educational programs and hands-on training sessions.

Keywords: Bio-Physiological Parameters, Low-birth-weight infants, Nesting, NICU, Nursing, Suckling.

Introduction:

According to the World Health Organization (WHO), LBW causes "substantial costs to the health sector and imposes a significant burden on society as a whole."[(1)] LBW infants, defined as those weighing less than 2500 grams at birth, face significant health challenges, including increased risks of mortality, developmental delays, feeding difficulties, and physiological instability, according to the WHO.[(2)] Globally in 2020, 19.8 million newborns, or an estimated 14.7 percent of all infants born that year, suffered from LBW. [(3)] In Egypt, 2020, LBW infants made up about 12.9% of all births, which is considered a high percentage.[(4)] Studies indicate that LBW infants have immature thermoregulatory mechanisms, leading to hypothermia, metabolic stress, and respiratory distress.[(5)] Additionally, these infants often exhibit poor suckling and swallowing coordination, resulting in feeding inefficiencies and prolonged hospital stays. Addressing these challenges requires targeted neonatal interventions, including developmental care strategies such as nesting.[(6, 7)]

Positioning support is an important nursing intervention to care for premature infants in the NICU. Currently, many hospitals offer a self-made "Traditional Nesting Device" to provide postural support for LBW infants receiving care in the units. Often, blankets or washcloths in roll form create this traditional nesting device, which is commonly used for infants under warmers or inside incubators to support their position. However, the structure and texture of the traditional nesting

PISSN: 2974-3281
EISSN: 2974-329x

device are often too soft to resist infants' body movements, especially since it cannot correctly prevent the abduction of the hip joint posture, leading to negative impacts on the infant's motor and neurodevelopment. [8]

Nesting is a therapeutic positioning technique designed to mimic the intrauterine environment by providing a contained, flexed posture. This method is widely used in NICUs to influence not only neuromotor and musculoskeletal development but also physiological functions and stability, skin integrity, thermal regulation, bone density, sleep facilitation, brain development, and feeding. One of the key areas and core skills of developmentally supportive care is optimal positioning, which should be considered from the point of delivery onward.[9, 10] Research suggests that nesting helps regulate physiological parameters, reduces stress-related responses, and enhances overall neonatal well-being.[11]

Effective suckling is essential for the nutritional and developmental progress of LBW infants. Research indicates that LBW infants often struggle with suck-swallow-breathe coordination, making breastfeeding a challenge.[12] Nesting has been proposed as a strategy to improve feeding efficiency by providing postural support that facilitates oro-motor control.[13] A study by Ahmed et al. (2024) observed that LBW neonates who are supported by nesting position exhibit organized behavioral readiness regarding their oral behavioral cues. Moreover they exhibit more feeding progression, weight gain and increases amount of consumed milk than those who do not.[14]

Nesting has emerged as a crucial developmental care strategy in NICUs, offering significant benefits for LBW infants by enhancing physiological stability and improving suckling response. Existing literature supports its role in regulating bio-physiological parameters, promoting feeding efficiency, and reducing neonatal stress. However, further research is needed to explore its long-term impact and refine best practices for implementation in diverse neonatal care settings. By integrating nesting into standard neonatal care protocols, healthcare providers can contribute to improved outcomes for LBW infants, supporting their growth, development, and transition to exclusive breastfeeding.[11, 14, 15]

Nurses play a crucial role in optimizing the care of LBW infants by implementing evidence-based interventions such as nesting. Their expertise in monitoring bio-physiological parameters, assessing suckling responses, and providing individualized support ensures improved neonatal outcomes. Through continuous observation, education, and compassionate care, nurses contribute significantly to the overall growth, stability, and well-being of LBW infants, fostering their development and enhancing their transition to exclusive breastfeeding. [16, 17]

Significance of the study:

Several articles review reveal that pediatric nursing care including positioning and maintaining posture is an important aspect of the pediatric nurse's role in the development of LBW infants, since the incidence of physiological instability, distress, and developmental problems related to improper maintenance of posture is increased.[18-20] A few studies were carried out in Egypt about applying nesting and swaddling techniques for premature infants as a standard of developmentally supportive care in the NICUs.[21-23] This study holds significant importance in neonatal care as it explores the impact of nesting on bio-physiological parameters and suckling response among LBW infants.

Nesting, a developmental care intervention, has been shown to promote physiological stability, enhance neuromuscular development, and improve feeding outcomes in preterm and LBW infants. By assessing its effectiveness, this study provides valuable insights into evidence-based neonatal care practices that can enhance infant comfort, reduce stress, and support optimal growth and development. Furthermore, the findings of this study will contribute to the existing body of knowledge on neonatal nursing care, helping healthcare providers implement strategies that improve the overall well-being of LBW infants. It will also assist in guiding hospital policies and neonatal care protocols, ultimately leading to better clinical outcomes, shorter hospital stays, and improved breastfeeding success rates. Nurses, neonatologists, and other healthcare professionals can utilize the results to refine care practices and ensure holistic support for this vulnerable population.[24, 25]

Aim of the study

The present study aimed to evaluate the effect of nesting on bio-physiological parameters and suckling response among LBW infants.

PISSN: 2974-3281
EISSN: 2974-329x

Research hypotheses

1. LBW infants who receive nesting expected to have improvement in bio-physiological parameters (pulse, temperature, respiratory rate, and oxygen saturation) more than LBW infants who do not receive nesting.
2. LBW infants who receive nesting expected to have good suckling response more than the LBW infants who do not receive nesting

II. Materials and Methods

Research Design:

A quasi-experimental research design was used.

Setting:

The study was conducted in the NICU of Abo Hommos Hospital for Children (Demesna), located in El Beheira Governorate and affiliated to the Ministry of Health and Population/Egypt. The NICU is situated on the third floor and comprises 40 incubators distributed across three rooms (A, B, and C).

Subjects:

A purposive sample of 60 LBW infants was divided into two equal groups (30 LBW infants for the control group and 30 LBW infants for the study group) through serial numbers of cases; the LBW infants who had odd numbers were chosen in the study group (nesting technique), while the LBW infants who had even numbers were chosen in the control group (non-nesting technique) calculated by using the EPI-Info7 software program with a confidence level of 95%, margin of error is 5%, a population proportion of 50% from the pre-mentioned setting and who fulfilled the following **inclusion and exclusion criteria: -**

- Birth weight 1.0 < 2.5 kg
- Age is =< 7 days.
- Nutritive or non-nutritive feeding.

Exclusion criteria

- Neonates who were on CPAP or ventilator.
- Neonates are diagnosed with any severe medical or surgical illness.
- APGAR score was less than 7 in the first minute.

Tools for data collection:

Following an exhaustive review of the pertinent and recent literature, the researcher constructed three tools that were utilized to gather the data.[26-29]

Tool I: Demographic and Health Data Structured Questionnaire about LBW Infants and their Mothers

Part I: Demographic data of LBW infants' mothers, consisted of age, parity, risk during pregnancy, mode of delivery, and birth spacing.

Part II: Health data of LBW infants included age in days, gender, and health history such as birth weight, gestational age, birth order, and mode of suckling (nutritive or non-nutritive feeding).

Tool II: Bio-Physiological Parameters Observational Checklist Sheet

It was developed by the researcher and used to measure temperature (Temp.), heart rate (HR), oxygen saturation (O_2 sat), and respiratory rate (RR).

Tool III: Early Feeding Skills Assessment Scale (EFS)

PISSN: 2974-3281
EISSN: 2974-329x

The tool was adapted from the Early Feeding Skills Assessment Scale that was developed by Thoyre, Shaker, and Pridham (2005) [30] and it comprises a 3-point scale consisting of 15 statements of suckling response, and the maximum score was 30 and the minimum 1.

The result was interpreted using a 3-point scale:
0 – No Response
1 – Fair Response
2 – Good Response

The maximum score was 2, and the minimum score was 0. The scores were interpreted as:

Score	Suckling response
21-30	Good Response
11-20	Fair Suckling Response
1-10	Poor Suckling Response
0	No suckling response

Methods:

- An official letter from the Faculty of Nursing at Damanhour University was directed to the representative of the Ministry of Health and Population in El Beheira Governorate/Egypt to obtain permission to conduct this study, after an explanation of the purpose of the study.

- Permission to conduct the study was obtained from the representative of the Ministry of Health and Population and the responsible authorities of the previously mentioned study settings after an explanation of the aim of the study.

Development of the study tools:

- **Tool III** was adapted by the researcher**.**

- The validity of **the tools (I & II)** in the study was tested by a jury consisting of five experts in pediatric nursing from the Faculty of Nursing at Alexandria University, who reviewed the contents of the tools for comprehensiveness, accuracy, clarity, and relevancy. Their opinions and suggestions were taken into consideration and modifications of tools were done accordingly such as demographic data of LBW infants' mothers.

- **Tool reliability, Tool III** was tested to determine the extent to which the tool items are related to each other. Cronbach's alpha model, which is a model of internal consistency was used to assess knowledge and practices assessment tool reliability (0.971 respectively). The statistical equation of Cronbach's alpha reliability coefficient normally ranges between 0 and 1. Higher values (more than 0.7) which denote acceptable reliability.

Pilot study

A pilot study was carried out by the researcher on six LBW infants (10% of the estimated sample) to test the clarity and feasibility of study tools (I, II, & III); consequently, necessary modifications were done. Those LBW infants were excluded later from the study.

Collection of the data:

i. Data Collection Process:

- Data were collected over a period of 7 months (from January to July 2023).

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EISSN: 2974-329x

- Implementation of the nesting technique passed into four phases (Assessment, Planning, Implementation and Evaluation) while the control group receiving routine care.

☒ **Assessment phase**

- A formal consent was obtained from the parents of LBW infants before inclusion in the study after an explanation of the aim of the study.
- Selecting the LBW infants in relation to inclusion and exclusion criteria and using a neonatal assessment sheet.
- The researcher introduced herself to the parents and nurses and explained the significance of the study as well as obtaining verbal agreement before applying the nesting.
- LBW infants in both groups were assessed at the beginning of the study for the following:
  - Demographic data of LBW infants. It was filled for both groups by the researcher from the patient's file (pretest).
  - Health data of the LBW infants.
  - Bio-Physiological Parameters such as vital signs (Temp., HR, and RR) and O2sat (as a Pre-test).

☒ **Planning phase:**

- The researcher was available during the evening shifts from 2 pm to 8 pm over three consecutive days weekly in the NICUs. The number of LBW infants who were assessed daily was 3-4. The researcher filled out the study tools by herself, and the time required for filling out each tool was around 5-10 minutes.
- All required nests were prepared from soft cotton linen with fiber and arranged by the researcher.

☒ **Implementation phase:**

- Nesting Technique (Study group):

The researcher prepared and arranged the necessary nests, placing the LBW infants in two positions: supine and side-lying. The researcher ensured that the nest size in both positions was suitable for each neonate's body, neither too loose nor too tight.

- Non-nesting technique (control group):

The LBW infant lies in two positions (supine and side-lying positions) without nesting and is assessed for applying different positions every two hours without nesting technique.

- Bio-physiological parameters and suckling responses were assessed during the evening shift at four intervals: pre-intervention, one hour, three hours, and six hours' post-intervention.
- Low birth weight (LBW) infants were assessed following a stabilization period to minimize the impact of position changes. Each assessment lasted approximately 10 minutes during the designated intervals.
- All findings were accurately documented on the data-collecting sheet.

☒ **Evaluation phase:**

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EISSN: 2974-329x

The LBW infants in both groups were reassessed immediately after intervention for the following:

• Bio-physiological parameters such as vital signs (Temp., HR, and RR) and O_2sat (post-test).

• Suckling response (Post-test).

ii. Data processing and analysis:

Following data gathering, the obtained data was coded and converted into a format that was specifically created to be fed into a computer. Using the social science statistical program, data was entered and examined (IBM-SPSS version 25). Frequency analysis, 3-D clustered column, 3-D 100% stacked and cone chart, cross tabulation, and manual revision were used to review and examine the data after entering to find any entry errors.

Ethical considerations:

- Ethical approval was obtained from the research ethical committee of the Faculty of Nursing, Damanhour University.
- Permission was obtained to collect the data from the selected settings.
- Informed consent was obtained from the mothers of all participating LBW infants after providing a detailed explanation of the study's objectives and assuring them that the collected data will be used exclusively for research purposes.
- Confidentiality and privacy of all participants was maintained.
- Anonymity was assured during data collection by using code numbers instead of names.

Results:

Table (1) Shows demographic data of LBW infants' mothers

More than one-third (36.7%) of the study group mothers are aged between 25 < 30 years, and one-half (50%) of the control group mothers are aged between 20 < 25 years, with a mean age of 24.27±4.996 and 25.53±5.661 years for both groups, respectively. Approximately more than one-third (40%) of LBW infants' mothers were primigravida for each group, with a mean number of parities of 2.07±1.112 for the study group and 2.23±1.331 for the control group**.**

Additionally, over one-third (40%) of mothers in the study group and the majority (73.3%) of mothers in the control group of LBW infants experienced pregnancy-related risks, with a P value of 0.009. Among these risks, premature rupture of membranes (PROM) was the most prevalent, affecting 83.3% of the study group and over two-thirds (68.2%) of the control group**.**

Concerning mothers' type of delivery, the table indicated that nearly all mothers in both groups had delivered by C.S 93.3% - 90%, respectively**.**

Table (1) Distribution of the studied groups according to demographic data of LBW infants' mothers

Demographic data		Groups				Test of Significance
		Study (n=30)		Control (n=30)		
		No.	%	No.	%	
Mothers' Age (years)	<20	6	20.0	2	6.7	X^2= 7.380 P= 0.117
	20<25	8	26.7	15	50.0	
	25<30	11	36.7	5	16.7	
	30<35	3	10.0	6	20.0	
	35-40	2	6.7	2	6.7	
	(Mean ± SD)	24.27±4.996		25.53±5.661		t= 0.844 P= 0.362

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Parity	Primipara	12	40.0	12	40.0	X^2= NA
	Multipara	18	60.0	18	60.0	
Any risk during pregnancy	No	18	60.0	8	26.7	X^2= 6.787 P= 0.009*
	Yes	12	40.0	22	73.3	
Type of risk during pregnancy		N= 12		N= 22		
	Gestational diabetes	0	0.0	1	4.5	X^2= 2.473 P= 0.480
	Hypertension	0	0.0	3	13.6	
	Anemia	2	16.7	3	13.6	
	Others as premature rupture of membranes (PROM)	10	83.3	15	68.2	
Mode of delivery		N= 30		N= 30		
	Normal Vaginal Delivery (NVD)	3	10.0	2	6.7	X^2= 0.218 P= 0.640
	Cesarean Section (CS)	27	90.0	28	93.3	

X^2 Chi square test **t**= student t test NA= Not applicable * Significant p at ≤0.05

Table (2) represents the health data of LBW infants

Each group of LBW infant age groups was three days, with one-third (36.7%) belonging to the study group and one-fifth (23.3%) to the control group. The mean of LBW infants' age (days) was 3.43±1.431 and 3.80±2.024 for both groups, respectively.

Moreover, over fifty percent of participants in both groups are males, comprising 56.7% of them in the study group and 53.3% of them in the control group.

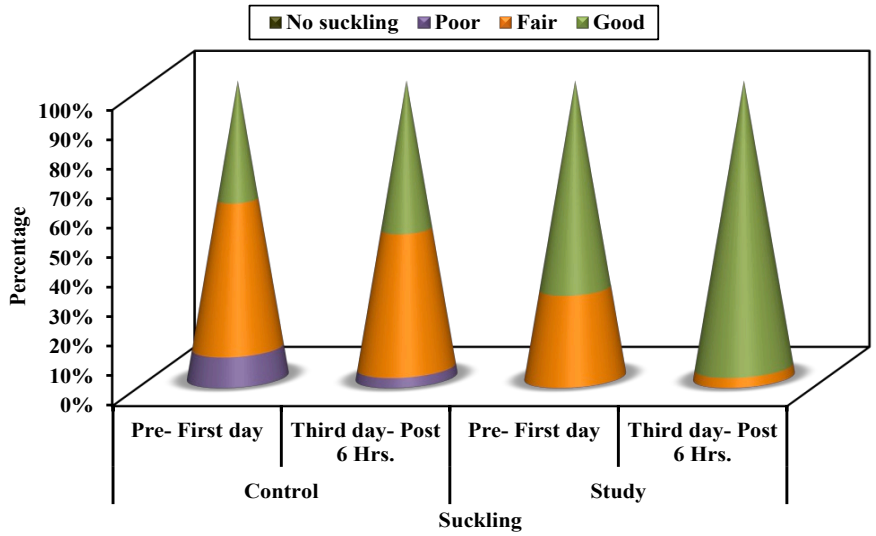
One-third of LBW infants in study and the control groups (36.7% and 40%, respectively) fall within the gestational age range of 36 to 37 weeks **.**

Based on the observations, it was noted that more than half of participants in both the study group (56.7%) and the control group (60%) utilized the same non-nutritive sucking approach**.**

Table (2) Distribution of the studied groups according to health data of LBW infants

Demographic data		**Groups**				**Test of Significance**
		Study (n=30)		**Control (n=30)**		
		No.	**%**	**No.**	**%**	
Infants' Age (days)	One	1	3.3	4	13.3	X^2= 7.133 P= 0.309
	Two	7	23.3	5	16.7	
	Three	11	36.7	7	23.3	
	Four	5	16.7	4	13.3	
	Five	1	3.3	1	3.3	
	Six	5	16.7	5	16.7	
	Seven	0	0.0	4	13.3	
	(Mean ± SD)	3.43±1.431		3.80±2.024		t= 0.657 P= 0.421
Gender	Boys	17	56.7	16	53.3	X^2= 0.067 P= 0.795
	Girls	13	43.3	14	46.7	
Gestational age at birth	34	6	20.0	3	10.0	X^2= 1.325 P= 0.723
	35	3	10.0	4	13.3	
	36	10	33.3	12	40.0	

PISSN: 2974-3281
EISSN: 2974-329x



	37	11	36.7	11	36.7	
	(Mean ± SD)	35.87±1.137		36.03±0.964		t= 0.375 P= 0.543
Mode of suckling	Nutritive	13	43.3	12	40.0	X^2= 0.069 P= 0.793
	Non-nutritive	17	56.7	18	60.0	

X^2 Chi square test **t**= student t test NA= Not applicable * Significant p at ≤0.05

Figure (1) portrays the correlation between pretest and posttest suckling responses among the LBW infants in both groups. It was obvious from the table that there was a substantial effect of nesting on LBW infants' suckling response of the study group at r =0.885 that increased the percentage of good suckling response from less than three-quarters of them (70%) in the pre-first day (baseline) to almost all of them (96.7%) in the third day post 6 with a mean score 10.60±4.680, 24.23±1.924, respectively and there is a high statistically significant difference at a P value (≤0.0001) compared to the control group had a slight increasing in the percentage of good suckling response from one third (40%) in the pre-first day (baseline) to half of them (50%) in the third day post 6 hours with a mean score 12.40±6.196, 20.27±5.126, respectively with a high statistically significant difference at a P value (≤0.0001).

Figure (1): Correlation of Pretest and Posttests suckling response among the LBW infants in both groups

Table (3) clarifies the correlation between pre-test and post-test bio-physiological parameters among the LBW infants in both groups.

It is revealed from this table that there was a minor effect of nesting on LBW infants' heart and respiratory rates at (r=0.089, 0.439), respectively in the study group with a mean heart rate of LBW infants (137.90±8.479 b/m & 137.77±12.08 b/m) in the control group at third-day post 6 hours **.**

On the other hand, there was a highly statistically significant association between the mean of LBW infants' respiratory rate 51.13±1.978 c/m in the study group compared to 52.57±3.875 c/m in the control group at the third-day post 6 hours, at a P value (≤0.0001) in the study group **.**

Additionally, It is clear from table (3) that there was a medium effect of nesting on LBW infants' oxygen saturation and body temperature at r=0.700, 0.481 in the study group, with a high statistically significant difference at a P value (≤0.0001) for both variables with a mean oxygen saturation of LBW infants 98.57±1.040% in the study group compared to 95.73±2.970% in the control group in the third day post 6 hours, and the mean of LBW infants' body temperature 36.80±0.228 C° in the study group compared to 36.63±0.307 C° in the control group post 6 hours at the third day.

PISSN: 2974-3281
EISSN: 2974-329x

Table (3) The correlation between pre-test and post-test bio-physiological parameters among the LBW infants in both groups.

Items	Time of assessment	Study (n=30)	Control (n=30)
Heart rate	**Pre- First day**	135.53 ±16.65	136.87 ±14.30
	Third day- Post 6 Hours	137.90 ±8.479	137.77 ±12.08
	Test of significance	t= 0.695 P= 0.490	t= 0.263 P= 0.793
	Effect Size Coefficient (r)	r = 0.089	r = - 0.034
Respiratory rate	**Pre- First day**	57.37 ±8.806	55.50 ±7.417
	Third day- Post 6 Hours	51.13 ±1.978	52.57 ±3.875
	Test of significance	t= 3.787 P= 0.000*	t= 1.918 P= 0.060
	Effect Size Coefficient (r)	r = 0.439	r = 0.240
Oxygen saturation	**Pre- First day**	95.03 ±2.327	96.07 ±2.149
	Third day- Post 6 Hours	98.57 ±1.040	95.73 ±2.970
	Test of significance	t= 7.607 P= 0.000*	t= 0.313 P= 0.755
	Effect Size Coefficient (r)	r = 0.700	r = 0.065
Body temperature	**Pre- First day**	36.31 ±0.589	36.59 ±0.559
	Third day- Post 6 Hours	36.80 ±0.228	36.63 ±0.307
	Test of significance	t= 4.249 P= 0.000*	t= 0.344 P= 0.732
	Effect Size Coefficient (r)	r = 0.481	r = - 0.044

T= Paired t test χ^2 = Chi square test * Statistically significant at P ≤0.05 *Effect Size Coefficient (r) <0.5 small effect, 0.5-0.7 medium effect, ≥ 0.8large effect*

Discussion:

Comprehending **the demographic data of LBW infants' mothers** is crucial to identifying their risk factors. Maternal age is considered a key factor for the healthy outcome of pregnancy. [31] More than a third of the mothers in the study group (36.7%) were between the ages of 25 <30 years, while half of the mothers in the control group (50%) of them were between the ages of 20 <25 years. The findings show that the mothers fall into the age range associated with fewer pregnancy complications. The results align with the literature, which suggests that optimal outcomes are associated with maternal ages between 20 < 30 years. These results were also similar to those of a study by Suprihatin et al. (2023) [32], which looked at how nesting and lighting affected the bodies of infants in Sidoarjo who were born with LBW. They found that 28% of the 17 mothers were between the ages of 20 and 35.

First-time mothers may lack experience in managing pregnancy, which could contribute to inadequate prenatal care, suboptimal nutritional practices, or higher levels of stress and anxiety, all of which are risk factors for LBW. The findings of the present study reaffirm this, as approximately 40% of mothers in both groups in the current study were primigravida. This finding was in accord with studies performed by Rupashree (2022)[33] and Moradi et al. (2021)[34]; they reported that there was a higher percentage (59.38% & 39.34%) of mothers who were first-time mothers, respectively.

Premature rupture of membranes (PROM) was identified as the most common risk factor in this study, with a significantly higher prevalence in the study group (83.3%) compared to the control group (68.2%). This highlights PROM as a critical contributor to the risk of delivering LBW infants. The results are similar to those found by Huanga et al. (2023)[35], who found that mothers who had bad perinatal outcomes, such as PROM, had a 2–8 times higher risk of LBW. This strengthens the evidence linking PROM to LBW and emphasizes the need for universal strategies to manage and mitigate its effects.

Based on the mode of delivery, this study reveals a significantly high proportion of mothers in both groups delivered by Cesarean section (C.S.), with rates of 93.3% and 90%, respectively. This could be related to mothers preferring C.S. over vaginal delivery to avoid pain and long labor hours; in addition, some obstetricians may also favor C.S. for its predictability and convenience, particularly in high-risk pregnancies,

PISSN: 2974-3281
EISSN: 2974-329x

such as those involving LBW or preterm infants. This result aligned with studies conducted by Unnikrishnan and Aneesha (2023)[11], who examined the "Effect of nesting on physiological parameters among preterm babies admitted in NICU" which found that the majority 55% of preterm infants studied underwent cesarean section.

Regarding **health data of LBW infants**, the current study found that, LBW infants were around three days old (mean ages of 3.43±1.431 and 3.80±2.024) days for the study and control groups, respectively. These findings were in alignment with Suprihatin et al. (2023)[32], who also observed a predominance of neonates aged three days, supports the results of this study.

In relation to gender, more than half were boys in both groups, with 56.7% in the study group and 53.3% in the control group in this study. These results were in coincidence with those of studies by Suprihatin et al. (2023)[32] and Rupashree (2022)[33], which also found that 50% of the neonates were boys.

Regarding gestational age at birth**,** more than one-third of infants in both groups (36.7% & 40%) fall into the gestational age range of 36 to 37 weeks, respectively. These results agree with those of Khazaei et al. (2021)[36], who found that the risk of LBW was four times higher for pregnancies shorter than 37 weeks. This supports the well-established link between preterm birth and LBW due to inadequate in-utero growth time.

Concerning the mode of suckling, both the study and control groups predominantly utilized the non-nutritive suckling method, with 56.7% in the study group and 60% in the control group. This highlights the widespread use of non-nutritive suckling among LBW infants in this setting. These findings align with Das et al. (2020)[37], where the majority of preterm infants (83.3%) in both experimental and control groups used non-nutritive suckling. This suggests that non-nutritive suckling is a common practice for preterm infants, likely due to their underdeveloped feeding reflexes or inability to handle nutritive feeding effectively. While Unnikrishnan and Aneesha (2023)[11] reported that 80% of preterm babies were breastfed (nutritive feeding), which contrasts with the predominant use of non-nutritive suckling in the current study.

Compared to routine procedures, nesting significantly improved body temperature regulation in LBW infants, ensuring stability and normalcy. The present study showed that there was a high statistically significant difference in the temperature range of LBW infants between the study and control groups throughout the observation period ($P \leq 0.0001$). The findings suggest that nesting provides a thermoregulated environment that supports LBW infants' physiological needs, minimizing temperature fluctuations.

This result matched what Reddy and Solomon (2023)[38] examined: the effectiveness of nesting and swaddling techniques on bio-physiological parameters, neuro-behavioral activity, and sucking response among sick neonates of selected pediatric units of Navi Mumbai, as evidenced by significant differences in skin temperature ($P<0.05$). However, Unnikrishnan and Aneesha (2023)[11] found no significant results in stabilizing body temperature with nesting. This suggests that results may vary depending on things like the method used, the characteristics of the sample, or the care protocols.

Heart rate is a critical indicator of neonatal well-being. The lack of a statistically significant difference in heart rate between the study group (137.90±8.479 bpm) and the control group (137.77±12.08 bpm) indicates that nesting did not have a measurable impact on heart rate regulation by the third day post-6 hours. These results are consistent with Damayanti et al. (2024) [28], who found no significant changes in heart rate ($\alpha > 0.05$) after applying nesting and murottal Al-Qur'an interventions.

Ismail et al. (2024)[39], who examined the impact of nesting care on heart rate, oxygen saturation, and discomfort in preterm infants inside Saudi Arabian neonatal intensive care units, reported findings contrary to those of this study. They found that heart rate was significantly lower in the nesting group than the non-nesting group at baseline and after procedures (136b/m and 139b/m vs. 144b/m and 148b/m, $P \leq 0.05$). These differences may arise due to interruptions during the intervention period.

The study revealed a highly statistically significant difference in respiratory rates (RR) between the study group (51.13±1.978 c/m) and the control group (52.57±3.875 c/m) on the third day post-6 hours ($P \leq$

PISSN: 2974-3281
EISSN: 2974-329x

0.0001). The decrease in mean respiratory rate in the study group suggests that nesting has a positive effect on respiratory stability by creating a calming environment.

These results corresponded with those reported by a study conducted by Shamkhi and Shawq (2024)[40], which reported significant improvements in cardiorespiratory parameters (including RR) after the nesting technique with different positioning, confirming the current study's results. These findings reinforce the effectiveness of nesting in stabilizing respiratory function. While conflicting with this result, the study done by Damayanti et al. (2024)[28] found that respiratory rate did not show significant results ($\alpha>0.05$) after the intervention.

The present study showed that there was a statistically significant difference between the study groups throughout the study days, with the study group's mean score being 98.57±1.040% and the control group's score being 95.73±2.970% on the third day after 6 hours. This could be because nesting simulates the environment inside the uterus, providing support and containment that helps the baby stay in a flexed position. Also, the comfort and safety of nesting lowers stress and promotes relaxation, which slows the breathing rate and makes oxygen exchange more effective. This result was similar to those reported by a study done by Damayanti et al. (2024)[28], who found significant changes in oxygen saturation levels ($\alpha=0.006$) after using nesting.

The study highlights the positive impact of nesting on the suckling response in LBW infants. Specifically, as the percentage of LBW infants with a good suckling response increased dramatically from 70% at baseline (pre-first day) to 96.7% after the intervention, there was a high statistically significant difference at P value (≤ 0.0001). Mean suckling response scores also rose significantly from 10.60±4.680 to 24.23±1.924, indicating substantial improvement in feeding ability and coordination. The findings align with those of Sharma et al. (2024) [41], who observed a similar improvement in the suckling response among LBW infants following nesting interventions. This strengthens the evidence base for nesting as an effective technique.

The study strongly supports nesting as an effective way to improve LBW infants' suckling responses, which will improve their ability to feed, their physical stability, and their development. From the ongoing discussion, it can be noted that nesting position to routine care is considered a nursing priority for LBW infants to enhance their bio-physiological parameters and suckling response. Dependence on only routine care for LBW infants is associated with prolonged treatment regimens and hospital stays. Therefore, nurses in NICU have a more meaningful and active role in tailoring as well as implementing the developmental supportive care practices including nesting position for LBW infants' plan of care.

Conclusion:

Based upon the results of the current study, it could be concluded that:

This study highlights the positive impact of nesting on the bio-physiological parameters (temperature, heart rate, oxygen saturation, and respiratory rate) and suckling response of LBW infants and supports the research hypothesis. The findings suggest that nesting promotes physiological stability, reduces stress, and enhances feeding efficiency, contributing to overall neonatal well-being.

Recommendations:

A. Based on the results of the current research, the following recommendations are suggested:

1. Enhance NICU nurses' knowledge and skills in developmental supportive positioning through structured educational programs and hands-on training sessions.

2. Identify key factors influencing bio-physiological parameters and suckling response in LBW infants to guide targeted neonatal care strategies.

B. Recommendations for further studies

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1. Conduct large-scale studies to validate the effectiveness of nesting interventions with a broader sample size.
2. Evaluate the long-term impact of nesting on neurodevelopmental outcomes and overall growth through longitudinal research.
3. Conduct prospective studies on long-term outcomes in LBW infants with poor suckling response, including their developmental progress and feeding abilities.

Limitation of the study:

- **Small Sample Size:** The study was conducted on a limited number of LBW infants, which may affect the generalizability of the results to a larger population.
- **Single-Center Study:** The research was conducted in a single NICU, limiting its applicability to different healthcare settings with varying protocols and resources.
- **Short Follow-Up Duration:** The study primarily focused on the immediate effects of nesting, without long-term follow-up to assess its impact on neurodevelopmental outcomes and overall growth.
- **Exclusion of Certain Neonatal Populations:** The study did not include LBW infants on respiratory support (e.g., CPAP or mechanical ventilation), limiting its findings to more stable neonates.

Acknowledgments

The researchers would like to offer their sincere thanks to the nurses who helped them in this study and the colleagues for their help throughout this study.

Financial Disclosure: The authors declared that this study received no financial support.

Competing interests and disclosures

All of the authors do not have any commercial or other association that might pose a conflict of interest.

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PISSN: 2974-3281
EISSN: 2974-329x