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Systematic Review

Nursing Interventional Studies on High-Risk Neonates in Neonatal Intensive Care Units: A Systematic Review

Sun-Jung Park[1], Hye Jeong Choi[2*], Jung Min Lee[3]

1. College of Nursing, Samyuk Health University, Seoul, Korea
2. Hallym University Gangnam Sacred Heart Hospital, Seoul, Korea
3. School of Nursing, Hallym University, Chuncheon, Korea

ABSTRACT

Background: This study aimed to examine the effects of nursing interventions on high-risk neonates in neonatal intensive care units by systematic literature reviews.

Methods: Data were gathered in compliance with preferred reporting items for systematic reviews. The systematic review method proposed by Whittemore and Knafl guided this review of studies conducted from 2006 to 2020. The studies were identified in eight electronic databases and scholarly websites. Finally, 15 studies met the inclusion criteria.

Results: The results of a content analysis of the studies on nursing interventions for high-risk neonates led to the identification of the following nursing interventions: kangaroo care, massage therapy, Yakson, playing mother's voice, olfactory stimulation by breast milk, playing mother's heartbeat sound, playing mother's singing, sensory stimulation, and cycled lighting and auditory stimulation.

Conclusion: The findings suggested that these interventions were appropriate interventional methods to step up the growth and development of high-risk neonates in neonatal intensive care units.

Keywords: Hospitalization, Intensive care, Intervention, Neonate, Review

Introduction

Necessity of Research

According to the World Health Organization, neonates with high mortality and morbidity rates due to difficulty in postnatal adaptation are called high-risk neonates, and premature newborns constitute a large proportion of this rate. High-risk neonates include those born before 37 weeks of gestational age (premature neonate) or those born with a weight of 2,500 g (low birth weight [LBW] neonates) (1). High-risk neonates are more exposed to the possibility of postnatal severe diseases accompanied by higher death rates, compared to normal neonates, and have a high risk of developing permanent disorders, such as cerebral palsy or loss of sight. Premature and LBW neonates are the main patients in the neonatal intensive care unit (NICU), and the birth of high-risk neonates is the main reason for infant deaths worldwide. The criticality of infant deaths is emphasized due to the reason that it is closely related to infant mortality, which is one of the most important indicators of national health. Newborns die mostly of perinatal disease after birth, followed by congenital malformation (2).

In recent cases in Korea, the birth of high-risk neonates is rapidly increasing due to a rise in maternal infertility and average childbirth age. According to the Korean Statistical Information Service (KOSIS), there has been a 35% upward trend in the birth of premature babies with the birth of 7,200 premature neonates in the past 10 years since 2010 (3). In addition, the 2018 KOSIS birth statistics report shows how the birth of LBW neonates increased 1.8 times reaching 6.2% from 3.5% in 1998, and although there has been a consistent decrease in birthrate, it is necessary to pay attention to the growth in the survival rate of

* *Corresponding author*: Hye Jeong Choi, Hallym University Gangnam Sacred Heart Hospital, Seoul, Korea. Tel: +82269601225; Email: bun8973@naver.com

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these high-risk neonates, such as premature and LBW neonates (26).

Accordingly, the necessity of taking more systematic and scientific approaches toward the high-risk neonates is on the rise in Korea, considering the fact that the birth rate of high-risk neonates is increasing. The importance of early detection and treatment of high-risk neonates affects newborns after birth. The intervention of a medical team can minimize disorders in respiratory disease, jaundice, infection, congenital malformation, and metabolic abnormality (21).

Currently, there are inadequate studies on systematic consideration of precedent pieces of research on neonatal intensive care and treatment in Korea. Systematic review is a research method of combining the best available research results on a specific research topic, such as proposing strict and objective research procedures of systematic and inclusive search of reference, selecting references according to inclusion and exclusion criteria set prior to the study, and assessing the risk of the selected references (19). It is critical to study, analyze, and comprehend the attributes of studies that applied nursing interventions to high-risk neonates in Korea since successfully conducting evidence-based nursing of high-risk neonates can ultimately enhance the health of infant patients. This would lead to understanding the nursing of high-risk neonates in Korea and eventually establishing working strategies based on scientific evidence. Following this, the pursuit of infant patient's safety results in not only a positive result for his/her health but also considering the importance of the nurse's role in the NICU (4). Therefore, this study was conducted to identify the necessity of nursing research for the promotion of child patient's health and the significance of the role of future nursing intervention through a comprehensive study of pieces of research that provided nursing intervention and educational programs for NICU neonates. It would help fulfill the role of the NICU nurse.

Purpose of Research

The purpose of this study was to analyze and evaluate interventional studies conducted on high-risk neonate patients in domestic and abroad NICUs to seek effective and appropriate care interventions and study strategies for such patients in the future.

Methods

Research Plan

This study was a literature analysis employing the systematic literature reviews to examine the pieces of research based on domestic and abroad high-risk NICU patients.

Research Procedure

We followed the 5-step guideline proposed by Whittemore and Knafl (2005): 1) Clarification of Research Question, 2) Reference Search and Selection, 3) Data Evaluation, 4) Data Analysis and Semantic Interpretation, and 5) Attribute Deduction through Data Integration [7, 27]. In addition, for data analysis, this study applied Gough's weight of evidence (2007; WOE) to evaluate the quality of each thesis.

1) Clarification of Research Question

In the guideline proposed by Whittemore and Knafl (2005), clarification of the research question is the first step to clarifying the phenomenon and the purpose of the research. For this study, we intended to present the research question of 'To what extent is the intervention research conducted on high-risk NICU patients, and what factors and elements are mainly examined?' (27).

2) Reference Search and Selection

The second step is the reference search process, and this process was recorded in detail to enhance the accuracy of the reference search and the credibility of this study (24, 27). The specific selection criteria and exclusion criteria were set as follows:

(1) Selection Criteria

- The studies that were related to nursing intervention for high-risk NICU neonates (24), and
- The studies that implemented the education of nursing intervention by a nurse or those that evaluated the effect of this education.

(2) Exclusion Criteria

- The master's/PhD degree study, editor's letter, and academic conference presentation studies that were impossible to obtain the original copy (24), and
- The studies that focused on nursing intervention and education by the guardian or other healthcare providers and the studies that omitted the report on the effects of such practice.

The reference search and analysis were conducted from May 1st to May 15th. We limited the publication period to studies published in the past 15 years (from 2006 to 2020) and searched

studies that conducted nursing intervention or nursing education by a nurse for high-risk NICU neonate patients in Korea and abroad. For the domestic search database, we used the Research Information Sharing Service, Korean Studies Information Service System, Korean Medical Database, and National Digital Science Library. The search process was performed using the following keywords 'High-risk neonate', 'Nursing', 'Nursing intervention', 'Nurse role', and 'Korea'. Regarding the foreign database, a detailed search was carried out on four search engines, including Cumulative Index of Nursing and Allied Health (CINAHL), PubMed, PsycINFO, Scopus using the following keywords: 'Neonatal intensive care unit', 'Nursing care or nursing interventions or nurse role' and 'Korea or Korean or South Korea'. The initial search results yielded 51 studies from CINAHL, PubMed, PsycINFO, and Scopus and 49 studies from Korean databases. Out of 100 studies, we excluded 28 overlapping studies, 9 studies published before 2005, and 37 irrelevant papers after reviewing their title and abstract. Through this process of reviewing the titles and abstracts of the remaining 26 studies, 11 studies that did not correspond to the respective criteria of the study were eliminated. Therefore, a total of 15 research papers were finalized as the subject of analysis for this study. Afterward, we proposed the diagram of the study search procedure employing Preferred Reporting Items for Systematic Reviews (Moher et al.) (Figure 1) (24).

3) Data Evaluation

According to Whittemore and Knafl (2005), there are no specific rules for evaluating literature, and literature review may vary depending on the structure of the collected studies. Therefore, if the study design of the studies selected for literature review is similar, it may be easier to evaluate them. However, systematic literature review studies should evaluate their thoroughness in both methodological and theoretical aspects. In this regard, 4 steps of Gough's WOE (2007) were used in this study, which is a quality evaluation method that satisfies 2 factors. It was evaluated whether the evidence and result derivation were objectively and appropriately described. Systematic literature review is the process of getting a clear answer on what we want to achieve through literature review

For an objective evaluation of the quality of the selected studies, we used Gough's WOE. According to Gough (2007), WOE is a useful tool to evaluate whether research purpose, research design, subject selection, and basis were used appropriately. Here, WOE is divided into 4 steps to discern the suitability of the proposed research, and the standard analysis is divided into 3 levels, including high, medium, and low (7, 24).

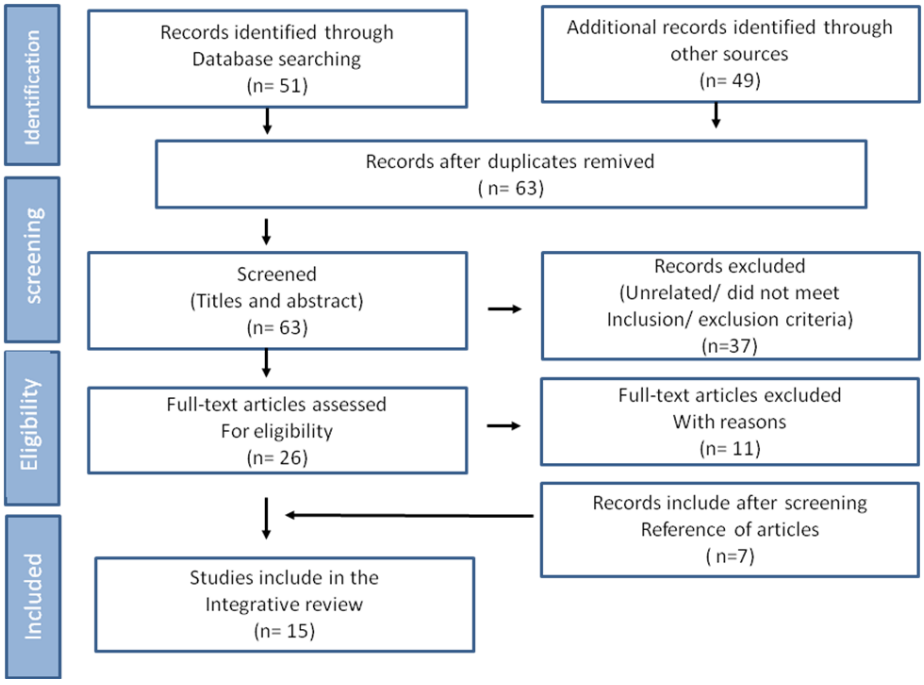

Figure 1. Flow diagram of Preferred Reporting Item for Systematic Reviews and Meta-Analyses

Therefore, in this study, WOE a focused on the context of the research using the researcher's concept to demonstrate the conformity with and integrity of the evidence and relativity was evaluated with an emphasis on how well the description of the research purpose was related to the research question(24). Weight of evidence b focused on whether an appropriate research plan was devised from the initial stage according to the purpose of the research or it was coincidentally recognized (24). Weight of evidence c evaluated the suitability of data collection and research analysis in accordance with the research question, and it was divided into example deduction, collection of data retrieving process, and data analysis for the methodological credibility (7). In addition, WOE d was the final evaluation based on WOE a, b, and c; in this regard, if two or more articles in WOE a, b, c were evaluated "high", it would be finalized as "high" level, and if two or more were evaluated as "medium", it would be at "medium" level (24). The two authors conducted such quality evaluation of each study and 15 research papers were finalized as "medium" or higher data (Table 1).

4) Data Analysis and Semantic Interpretation

We analyzed objective evaluation and

Table 1. List of reviewed articles (n=15)

No.	Authors (year)	Title	Journal	Gough's weight of evidence (a, b, c- d)
1	Ahn HY et al. (2010)	Kangaroo care on premature infant growth and maternal attachment and post-partum depression in South Korea	Journal of Tropical Pediatrics	H, H, H- H
2	Cho et al. (2016)	The effects of kangaroo care in the neonatal intensive care unit on the physiological functions of preterm infants, maternal-infant attachment, and maternal stress	Journal of Pediatric Nursing	H, H, H- H
3	Choi et al. (2016)	The effects of massage therapy on physical growth and gastrointestinal function in premature infants: A pilot study	Journal of Child Health Care	H, H, H- H
4	Im et al. (2009)	Acute effects of Yakson and gentle human touch on the behavioral state of preterm infants	Journal of Child Health Care	H, H, H- H
5	Im and Kim (2009)	Effect of Yakson and gentle human touch versus usual care on urine stress hormones and behaviors in preterm infants: A quasi-experimental study	International Journal of Nursing Studies	H, H, H- H
6	Kim and Bang (2017)	The effects of enteral feeding improvement massage on premature infants: A randomized controlled trial	Journal of Clinical Nursing	H, H, H- H
7	Lee and Bang (2011)	The effects of kangaroo care on maternal self-esteem and premature infants' physiological stability	Korean Journal of Women Health Nursing	H, H, H- H
8	Choi et al. (2014)	Effects of hearing recorded mother's voice on physiological reactions and behavioral state of sleep, weight of very low birth weight infants	Korean Academy of Child Health Nursing	H, H, H- H
9	Seo et al. (2016)	Effects of massage therapy on feeding intolerance and physical growth in premature infants	Korean Academy of Child Health Nursing	H, H, H- H
10	Lee (2019)	The effects of olfactory stimulation by breast milk on physiological responses, oral feeding progression and body weight in preterm infants	Korean Society of Nursing Science	H, H, H- H
11	Yeum et al. (2010)	The effects of maternal heart sound on the weight, physiologic responses and behavioral states of premature infants	Korean Academy of Child Health Nursing	H, H, H- H
12	Lee et al. (2010)	The effects of sensory stimulation on development of infants with low birth weight premature in NICU	Journal of the Korean Society of Physical Medicine	H, H, H- H
13	Jung and Chong (2007)	Effect of cycled lighting and auditory stimulation on body weight, physiological variables and behavioral states in low birth weight infants	Journal of the Korean Society of Neonatology	H, H, H- H
14	Park et al. (2013)	Effects of the 'intervention - mother's song' on physical response and behavioral state of low-birth weight infants in a neonatal intensive care unit	Korean Academy of Child Health Nursing	H, H, H- H
15	Jang (2009)	Effects of kangaroo care on growth in premature infants and on maternal attachment	Korean Academy of Child Health Nursing	H, H, H- H

synthesized the deduced significance using the selected data through the following quality evaluation. Each researcher independently created a diagram that included the authors, object of the study, purpose, major variable, result, and discussion of the 15 studies to analyze the data.

For simple and accurate interpretation for documentation, each researcher read and analyzed every paper, and then summarized and marked notes for discussion suitable for this study. The researchers of this study resided in different countries, which resulted in four intensive two-hour discussions every two weeks via online conference call to gather collective feedback. Apart from this conference call, there were constant e-mail checking and phone calls for sharing one's opinions and analyzing data (24).

5) Attribute Deduction through Data Integration

According to Whittemore and Knafl (2005), the results of collective literary review support the study results and demonstrate logical trends when represented by a diagram or other visual form; this is because it is easy to compare and contrast studies (24, 27). Following this last procedure, this study created a list of selected studies (Table 2), provided information on major concepts on a diagram to facilitate readers' understanding (Table 1) (24), and included summaries of each research (Table 3).

Table 2. General characteristics of included studies (n=15)

Characteristic	Categories	n (%)	M±SD
Publication year	2006-2010	7 (46.7)	
	2011-2015	3 (20.0)	
	After 2016	5 (33.3)	
Published journal	Journal of the Nursing Society	12 (80.0)	
	Journal of Medical Society	2 (13.3)	
	Others	1 (6.7)	
Type of research design	True-experimental study	2 (13.3)	
	Quasi-experimental study	12 (80.0)	
	A pilot study	1 (6.7)	
Theoretical framework	Yes	0	
	No	15 (100)	
Intervention	Yakson	2 (13.3)	
	Kangaroo care	4 (26.7)	
	Massage therapy	3 (20.0)	
	Play mother's recorded voice	1 (6.7)	
	Olfactory stimulation by breast milk	1 (6.7)	
	Maternal heart sound	1 (6.7)	
	Sensory stimulation	1 (6.7)	
	Cycled lighting and auditory stimulation	1 (6.7)	
	Mother's Singing	1 (6.7)	
Participants	Preterm neonates with a gestational age of 26-34 weeks or less	1 (6.7)	
	Preterm neonates with a gestational age of ≥33 weeks	1 (6.7)	
	Premature neonates with a gestational age of ≤34 weeks	1 (6.7)	
	Premature neonates	7 (46.7)	
	Premature neonates with a gestational age of 30-34 weeks	1 (6.7)	
	Premature neonates with a gestational age of 28-32 weeks	1 (6.7)	
	Low birth weight neonates	2 (13.3)	
	Neonates with a weight of 1,000-2,000 g and more than 32 weeks	1 (6.7)	

Table 2. Continued

Study design	A nonequivalent comparison group	2 (13.3)	
	A pilot study	1 (6.7)	
	One group pretest-posttest	2 (13.3)	
	Pretest-posttest randomized control group	2 (13.3)	
	Nonequivalent pretest-posttest repeated design	1 (6.7)	
	Repeated measures design with nonequivalent control group	1 (6.7)	
	Nonequivalent pretest-posttest control group design	5 (33.3)	
	Nonequivalent control before-after design during similar experimental design	1 (6.7)	
Mean for sample size	Experimental group	282	20.80±10.05
	Control group	267	18.28±7.27

Table 3. Major contents of reviewed articles (n=15)

No.	First authors (year)	Nation	Intervention	Subject (sample size)	Purpose/research question	Main variable	Key findings	Implication
1	Ahn et al. (2010)	USA	Kangaroo care	E:10 E:10	This study was conducted to investigate the effects of KC on both premature neonates and their mothers.	Neonatal weight, height, and HC, and maternal attachment and depression	As a result, premature neonates in KC showed higher growth in height and HC than neonates in the control group. Maternal attachment scores were higher among the KC mothers.	The results supported the beneficial effects of KC on Korean premature newborns and their mothers.
2	Cho et al. (2016)	USA	Kangaroo care	E:20 E:20	This study was conducted to identify the effects of KC on the physiological functions of preterm neonates, maternal-infant attachment, and maternal stress.	Physiological functions, Maternal-infant attachment, and Maternal stress	After KC, the respiration rate significantly differed between the two groups (F=5.701, P=0.02). The experimental group had higher maternal-infant attachment scores (F=25.881, P=0.001) and lower maternal stress scores (F=47.320, P=0.001) than the control group after the test. In other words, KC showed significant positive effects on stabilizing neonatal physiological functions (e.g., respiration rate), increasing maternal-infant attachment, and reducing maternal stress.	Kangaroo care might be one of the most effective nursing interventions in the NICU for the care of preterm neonates and their mothers.
3	Choi et al. (2016)	USA	Massage therapy	E:10 E:10	The purpose of this study was to test the potential effects of massage therapy on increasing physical growth and promoting gastrointestinal function in premature infants.	Physical size and Gastrointestinal function	In the physical growth, height and chest circumference were significantly increased in the experimental group. In assessing gastrointestinal function, the frequency of pre-feed gastric residual was significantly decreased and the number of bowel movements was significantly increased in the experimental group.	The results of this study showed that massage therapy had the potential effects on increasing physical growth and gastrointestinal function in premature neonates.

Table 3. Continued

4	Im et al. (2009)	USA	Yakson and GHT	E:40	This study evaluated the acute impact of both interventions on the sleeping state during and immediately after touch.	Anderson Behavioral State Scale	A significantly greater sleeping state was identified in both groups after touch. This effect was significantly stronger with Yakson than GHT. During touch, about half the Yakson neonates showed an arousal effect, while the GHT newborns showed little change.	Both interventions left the babies calmer after touch. This calming effect was consistent with the previously observed effect on stress hormones and should be beneficial in terms of growth and development.
5	Im and Kim (2009)	USA	Yakson and GHT	E:20 E:20 C:19	The goal of this study was to test the effect of Yakson and GHT on preterm neonate's stress and behaviors, compared to usual nursing care.	Stress hormones and behavioral state	Following the intervention period, preterm neonates in the Yakson and GHT groups had significantly lower stress hormone levels, compared to the control group. No significant difference was found in stress hormone levels between Yakson and GHT groups. After Yakson or GHT, the neonates exhibited an increased percentage of sleep states and a decreased percentage of awake and fussy states.	The results suggested that Yakson was another touching method that was not aversive or stressful to preterm newborns and may provide several positive effects on preterm neonates.
6	Kim and Bang (2017)	USA	Massage	E:26 C:29	This study aimed to prove the effects of an enteral feeding improvement massage on premature neonates with regard to their feeding, growing, and superior mesentery artery blood flow aspect by a randomized controlled trial.	Feeding parameters, including feeding intolerance days, pregavage residuals, abdominal circumference, stooling, bowel sounds, calorie intake, the postnatal age of full feeding, and mesenteric blood flow, and the growth parameters, including weight, height, and HC.	The experimental group reached the day of full enteral feeding significantly faster. The experimental group had a higher superior mesentery artery peak velocity and a lower resistant index. The experimental group of the feeding-intolerant subgroup had a higher superior mesentery artery peak velocity maximum velocity, and minimum velocity. The experimental group had a higher weight and bigger HC after 14 days.	Neonatal nurses in the NICU can apply enteral feeding improvement massage for feeding-intolerant neonates.
7	Lee and Bang (2011)	Korea	Kangaroo care	E:17 C:17	This paper identified the effects of KC on maternal self-esteem and the growth and physiological stability of premature neonates hospitalized in the NICU.	Bodyweight, physiological response, and maternal self-esteem	The experimental group showed a significant increase in maternal self-esteem. Moreover, KC was effective in the physiological stabilization of preterm neonates.	The findings of this study suggested that KC could be provided in clinical settings more widely in Korea as one of the nursing interventions aimed at promoting maternal self-esteem and newborn's physiological stabilization.

Table 3. Continued

8	Choi et al. (2014)	Korea	Playing mother's recorded voice	E:11 C:11	The purpose of this study was to identify whether hearing a recording of the mother's voice affected physiological reactions, behavioral state related to sleep, and weight of VLBW neonates.	Physiological response, sleep behavior condition, and weight	For physiological responses (e.g., heart rate, respiration rate, and oxygen saturation), there were statistically significant differences between the experimental and control groups. Behavioral state during sleep was more in the very quiet and quiet states in the experimental group. In the daily weight change, there was no significant difference between the experimental and control groups.	The findings suggested that, for VLBW neonates, the intervention of hearing a recording of the mother's voice had some significance as a nursing intervention having a positive impact. Such interventions can help pediatric nurses to stabilize the physiological response, maintain more the very quiet sleep states, and improve the growth of VLBW neonates.
9	Seo et al. (2016)	Korea	Massage therapy	E:30 C:30	This study aimed to identify the effects of massage therapy on feeding intolerance and physical growth among premature neonates.	Non-feeding resistance and physical growth	After the intervention, the number of fecal excretions and weight gain was significantly higher in the experimental group than in the control group. Furthermore, the number of gastric residuals in the experimental group was lower than that in the control group.	Massage therapy laid the basis for nursing intervention to promote feeding tolerance and physical growth in premature neonates.
10	Lee (2019)	Korea	Olfactory stimulation by breast milk	E:12 C:16	This study was conducted to evaluate the effect of breast milk olfactory stimulation on physiological responses, oral feeding progression, and body weight in preterm neonates.	Physiological reaction, oral lactation, and progressive weight	The gastric residual volume of the experimental group was significantly less than that of the control group. The heart rate, oxygen saturation, respiration rate, transition time to oral feeding, and body weight were not significantly different between the two groups.	These findings indicated that olfactory stimulation by breast milk reduced gastric residual volume and improved digestive function in preterm neonates without inducing distress.
11	Yeum et al. (2010)	Korea	Maternal heart sound	E:18 C:17	The study was performed to measure the effects of maternal heart sound on body weight, physiologic reactions (heart rate and cortisol), and behavioral states of preterm neonates.	Weight and physiological reaction behavior	There were differences in the variations in daily weights (F=3.431, P=0.011) and cortisol (t=3.184, P=0.006) between groups; however, no difference was observed in the variations of daily heartbeat (F=0.331, P=0.933) and behavioral states (F=1.842, P=0.323).	The findings supported the safety of continuous maternal heart sound as no changes occurred in the heartbeat and behavioral states, while it showed its efficacy as the weight increased and cortisol decreased.

Table 3. Continued

12	Lee et al. (2010)	Korea	Sensory stimulation	E:10 C:14	The purpose of this study was to investigate the effect of sensory stimulation on the development of premature LBW neonates.	Test of Infant Motor Performance	Over time, the number of observed items presented a significant difference among test periods, and elicited total score and total raw score were significant (P=0.00). There was no significant value, meaning that sensory stimulation affected the development of premature LBW neonates.	Sensory stimulation affected the development of premature low weight birth neonates.
13	Jung and Chong (2007)	Korea	Cycled lighting and auditory stimulation	E:10 E:10 C:10	This study aimed at finding the effects of cycled lighting and auditory stimulation on body weight, physiological variables, and the behavioral state of LBW neonates in the NICU.	Weight, physiological variables, and behavior status	It was demonstrated that the application of cycled lighting and auditory stimulation resulted in increased body weight, decreased heart rate, and stabilization of the behavioral states among LBW neonates. However, there was no effect on the increase of O_2 saturation and the decrease of respiration rate.	The application of cycled lighting and auditory stimulation would have positive effects on the growth and development of LBW neonates.
14	Park et al. (2013)	Korea	Intervention-mother's singing	E:24 C:24	This study was conducted to identify the effectiveness of the 'intervention-mother's recorded singing' on LBW neonates in the NICU.	Physiological response and state of action	For physical response according to vital signs, there were no significant statistical differences in heart rate, respiration rate, and pulse oximetry saturation between the experimental and control groups. For behavioral state, there was a significant statistical difference between the experimental and control groups.	The study results indicated that the intervention using the mother's singing had some significance as a nursing intervention with positive impacts. Such an intervention can help pediatric nurses improve the stabilization of neonates' vital signs and behavioral states.
15	Jang (2009)	Korea	Kangaroo care	E:24 C:29	This study, using a pretest-posttest nonequivalent groups design, was conducted to determine the effects of KC on the premature neonate's growth and maternal attachment	Premature growth (weight, kidneys, and head)	The KC group had a higher weight (t=2.565, P=0.013), height (t=2.182, P=0.034) and HC (t=2.468, P=0.017) than the control group. Compared to the control group, the KC had significantly higher scores in Maternal attachment (t=2.026, P=0.048).	The results of this study suggested that the practice of KC in the nursing environment, as one of the most efficient nursing interventions, could actively promote attachment between mother and neonate and accelerate the growth of premature neonates.

GHT: Gentle Human Touch; KC: Kangaroo care; HC: Head circumference; NICU: Neonatal intensive care unit; VLBW: Very low birth weight; LBW: Low birth weight

Results

1. Attributes of Subject of Research

The attributes of 15 research papers evaluated in the current study were nursing interventional studies published in Korea and abroad on premature and LBW neonates

hospitalized in NICU (Table 1).

These 15 published academic journals were mainly composed of experimental studies rather than descriptive research studies. In addition, arranging studies according to the publication year after 2006, it was revealed that 7 studies were published in 2006-2010, 3 studies in 2011-2015, and 5 studies after 2016; therefore, 2006-2010 was the duration containing most studies (n=7). Most studies were published in nursing academic journals (12 studies), followed by medical academic journals (2 studies) and other journals (1 study). Among these, it was confirmed
that 2 studies were pure experimental studies, 14 were quasi-experimental studies, and 1 was a pilot study. In the 15 pieces of research, a total of 549 neonates were premature and LBW neonates hospitalized in the NICU, of which, 282 and 267 newborns were included in the experimental and control groups, respectively.

2. Methodological quality evaluation result and content analysis of studies on the nursing intervention of high-risk neonates hospitalized in NICU

As a result of methodological quality evaluation of studies on the nursing intervention of premature and LBW neonates hospitalized in NICU, 5 of the 15 studies were conducted based on a nonequivalent pretest control group design. For the methodological quality evaluation, 15 out of 15 (100%) studies were properly evaluated according to a clear purpose statement, compliance with object selection, suitable result of research purpose, proper follow-up period, and appropriate statistical analysis.

According to the content analysis of nursing intervention studies, 1 study was performed on extremely LBW neonates, another study on premature neonates over 33 weeks of gestational age, 5 studies on premature neonates over 26 and below 34 weeks of gestational age, and 7 and 1 studies on premature and LBW neonates, respectively.

As a result of analyzing studies on the nursing intervention of premature and LBW neonates, 4 studies were on kangaroo care applied intervention, 3 studies were on massage therapy applied intervention, 2 studies on Yakson applied intervention, 1 study on maternal attachment promotion intervention (including playing mother's recorded voice, olfactory sense stimulation with breast milk, and playing mother's heartbeat and singing), and another study on sense stimulation intervention (including sensory-motor stimulation, and blocking night light and auditory sense stimulation) (Table 2).

1) Massage & Sensory stimulation intervention

Based on the results, 4 studies applied massage & sensory stimulation intervention. The total number of subjects was 159 individuals. The subjects of this study were 3 premature neonates and 1 low birth weight newborn. There were 3 studies conducted based on an inequality control group before and after design and 1 single group control group was confirmed as a pre-post study (Table 3).

2) Kangaroo care intervention

A total of 4 studies applied kangaroo care intervention to 147 premature neonates and mothers, and all 4 studies were based on premature neonates and mothers. It was found that 2 studies were conducted with a nonequivalent control study design and the other 2 ones with a pretest-posttest nonequivalent control groups design. The 4 interventional studies applied skin contact, and it was demonstrated that it had moderating effects.

3) Yakson therapy intervention

Totally, 2 studies were conducted based on massage intervention on 135 subjects, which were interventional studies based on premature neonates in anticipating premature neonates' physical development and enteral formula promotion. The applied intervention study designs included 1 pilot study and 1 randomized experimental pretest-posttest control group. All 2 studies applied the skin contact method, which was demonstrated to have moderating effects.

4) Mother-child interaction promotion intervention

There were 5 studies of mother-child interaction promotion intervention. The intervention study that applied the intervention of playing the mother's recorded voice, olfactory stimulation by breast milk, and playing the mother's heartbeat and singing performed the role of mediating mother-child interaction. The study participants consisted of 133 cases, and the moderating effect on premature neonates confirmed the physical growth, physical response, starting oral breastfeeding, and change in sleep behavior.

Discussion

This study was designed to identify the

interventional studies based on high-risk neonates hospitalized in NICUs in Korea and abroad since 2005 and confirm the results of such studies. The systematic literature review analysis resulted in selecting 15 studies (including 9 domestic and 6 abroad) that met the inclusion criteria for this study.

Recently, the birth rate has been decreasing in Korea, while on the other hand, maternal aging and medical development for infertility treatment are causing an increase in the birth rate of premature neonates (15, 23).

The development of neonatology and medical treatment have contributed tremendously to the survival and death rate reduction of premature neonates, and such phenomenon highlights the necessity to induce optimal growth and development of neonates and emphasizes the importance of active nursing intervention to bring forth the positive growth of premature neonates (23). Out of the 15 studies conducted in Korea and abroad, we found various realistic limitations, such as recruiting participants, intervention period, and investment of time and resources. Considering such difficulties, it is necessary to have more studies to draw real elements from high-risk neonatal nursing interventions.

This study mostly utilized the data collection method of physiological measurement, state of action, weight, and girth of the head in case of applying experimental research, which appears to be due to the easy measurement of physiological variables and physical conditions, such as heart rate or oxygen saturation of the subject participants while they are hospitalized, and also because, in this type of methodology, it is possible to acquire critical information of high-risk neonates' growth (17). In order to apply recent interventional studies, we added an objective biochemical diagram, considering the fact that studies that demonstrated the effects of intervention in a more scientific and objective ways were emphasized, and therefore, for future reference, it would be highly significant in raising the quality of nursing if high-risk neonate-based interventional studies are coupled with evidence-based clinical research (2).

This study also confirmed that random allocation and double-blind methods were not accurately arranged in most studies. The studies conducted by Choi and other researchers proposed that it was necessary to obtain the research participants' consent and improve researchers' blindfolding to form high-quality evidence. In the case of proceeding with quasi-experimental studies with nonrandom allocation, it was difficult to confirm the definite effect of an intervention (7), and we identified a decrease in internal validity. For future studies, random allocation and double-blind methods must be conducted, and such studies can be compared as randomized control trials required for systematic review or meta-analysis.

This study reviewed 15 interventional studies after searching studies with keywords of 'Premature infants', 'High-risk neonates', 'Low birth weight infants', and 'Nursing intervention'. Among the 15 studies, 10 studies applied the skin contact method (e.g., kangaroo care, massage therapy, and Yakson therapy) and 5 studies applied olfactory, optic, and auditory senses.

The social interest in high-risk neonates is growing, and the government holds direct influence on the establishment of a high-risk neonate treatment system; in this regard, it is very essential to apply confirmed interventions in this study to achieve the optimal growth of high-risk neonates.

The subjects of the interventions included premature neonates, LBW neonates, and both LBW and premature neonates. This emphasizes the important role of nursing intervention in high-risk neonates in NICU as more high-risk neonates are born as the outcome of medical development and their birth rate is much higher than the death rate. The attributes of mediating subject require a higher level of intellectual judgment, compared to other nursing interventions for general neonates, and it is highlighted that this nursing intervention requires more comprehensive and skilled nursing.

All 15 studies applied in this study were also sensory stimulation interventional studies; however, this research was studied as a nursing interventional study in nursing science, in comparison to other studies, and it confirmed that nursing interventional studies were applied with sensory stimulation for the growth of high-risk NICU hospitalized neonates. This will be the basis for improving the health of high-risk neonates by providing systematic sensory stimulation intervention.

It was identified that every participant in the 15 nursing interventional studies witnessed a positive influence. In 10 studies, the skin contact method was applied as the intervention. In the interventional studies by Ahn (2010), Cho (2016), Lee and Bang (2011), and Jang (2009), kangaroo care of skin contact was applied, where newborns wearing only diapers and hats were held directly

in parents' bare chests. In another study by Choi et al. (2016), massage therapy was employed as the intervention method, where the participants supported the neonate's back with one hand and massaged the abdominal area in a circle. Im and Kim (2009) also applied one kind of massage therapy called the Yakson therapy and another sensory stimulation method. In 5 other studies, mother-child interactive interventions were employed as playing the mother's recorded voice and sound of heartbeats and blocking light to stimulate auditory, olfactory, and optic senses (Choi et al., 2014; Leeee, 2019; Yeum et al., 2019, Jung, 2007; Park, 2013). The respective studies promoted interaction between the mother and the high-risk neonate and brought emotional stability for mothers who were stressed and suffering from separation anxieties with the neonates hospitalized in NICU. In addition, the nursing intervention applying the mother-child interaction enhanced the mother's sensitivity and aided the formation of a positive mother-child relationship.

Kangaroo care was applied in 4 interventional studies (Ahn et al., 2010; Cho et al., 2016; Lee and Bang, 2011; Jang, 2009), accounting for 26.7% of the 15 studies. The intervention participants included in this study were premature newborns and their mothers. Considering the conditions of premature neonates, it is difficult to form a mother-child relationship and the mothers experience both anxiety and sorriness towards premature and high-risk neonates. The nurturing of newborns and interest in children are the interventions required during the absence of lingual communication; this is one of the most effective methods to mitigate the participant's anxiety and give stability (1, 3, 11, 16). Massage therapy was employed in 3 nursing interventional studies, taking up 20% of the skin contact intervention. Massage therapy intervention is accomplished by direct skin contact and has been demonstrated to have a positive influence on height/cerebral/physical growth as the most effective mother-child interactive nursing intervention (Choi et al., 2016). The analysis of massage therapy interventional studies in this research revealed that this direct skin contact method assisted the stability promotion of participants, and it has been shown as effective basic data for enhancing parent-child interactive relationships when it is conducted by parents themselves. In the other 2 interventional studies, Yakson therapy was employed as a kind of massage therapy, accounting for 13.3% of the 15 interventional studies. The Yakson interventional study is a sensory stimulation study that has been demonstrated to increase the participant's weight. Im and Kim (2009) confirmed the safety and positive effect of Yakson therapy. Further studies are needed to be performed in this regard since this skin contact method of mother's Yakson intervention has been shown to have a promotional effect on mother-child interaction and attachment (8).

A total of 5 interventional studies were conducted on mother-child interaction promotion, responsible for 33.3% of the 15 studies. These studies consisted of playing the mother's voice, olfactory stimulation by breast milk, and playing the mother's heartbeat and singing. As a result, Choi et al., (2014) it has been identified that these interventional studies were effective in playing the mother's voice since they decreased unnecessary energy consumption for extremely low weight neonates while inducing stable conditions (3). The olfactory sense stimulation intervention using breast milk aided the digestion of premature newborns, thereby decreasing residual amount and preventing gastrointestinal complications, and in the long run, this method has been shown to have a positive impact on the neonate's growth (5). The mother's heartbeat kept the newborn's stable condition by stimulating the auditory sense (29).

In 1 interventional study, the sensory stimulation was applied as the intervention, accounting for 6.7% of the 15 studies (14). The sensory-motor stimulation intervention was arranged for a 15-minute practice for 4 weeks; when premature neonates turned 40 weeks old and the sensory-motor stimulation enhanced the growth of premature neonates, the effectiveness of the sensory-motor stimulation program was demonstrated (14).

The limitations identified in this study were the low number of a random selection of participants and the lack of applying the double-blind method. In addition, the limited number of experimental and control groups confirmed the limitations of the methodology. In future studies, an appropriate sample size should be selected to be able to generalize the participants, and random allocation and double-blind method need to be incorporated.

As it was confirmed through the interventional studies based on high-risk neonates hospitalized in NICU, the competence of nurses is the utmost critical element to decrease the number of high-risk neonates in Korea. It is recommended that further studies be performed regarding the nursing intervention of high-risk neonates in NICU

to heighten the quality of nursing for such neonates. Therefore, various interventional programs not only promote the healthy growth of neonates but also will be the foundation for evidence-based clinical research.

Conclusion

This study analyzed and evaluated the nursing interventional studies on high-risk neonates hospitalized in the NICUs in Korea and abroad to seek appropriate nursing interventions and effective research strategies for neonates and mothers. The results of the research showed the positive influence and potential effect of kangaroo care, massage therapy, Yakson therapy, playing mother's voice, and olfactory stimulation by breast milk on the development of high-risk neonates hospitalized in NICU. Considering interventional studies based on high-risk NICU hospitalized neonates, this study can be utilized as initial data in designing suitable interventions to enhance neonate's growth. Furthermore, this study can be employed as baseline data to accurately understand various nursing interventions for high-risk neonates in the clinical research stage and ultimately take a closer approach toward evidence-based practice.

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Conflicts of interest

The authors declared that there is no conflict of interest.

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