Effect of Oral Sensory Stimulation Program with Expressed Breast Milk on Breastfeeding Outcomes of Preterm Newborns

Bothayna N. Sadek[1], Amira Elrefaee[2], Tanazor Hemdan Abdelhamed [3]

[1]Assistant professor of Pediatric Nursing, Faculty of Nursing, Ain Shams University, Egypt.
email: Bouthinan@nursing.asu.edu.eg
[2]Lecturer of Pediatric and Neonatal Medicine, Faculty of Medicine, Cairo University, Egypt.
email:amiraelrefaee@kasralainy.edu.eg
[3]Lecturer of Pediatric Nursing, Faculty of Nursing, Modern University, Egypt.
e-mail : abdelrahman_habiba@yahoo.com

Abstract

Preterm newborns develop a coordinated sucking and swallowing depending upon their gestational age and maturation of their respiratory, digestive and neurological systems. However, criteria to determine the best time for initiation of breastfeeding is an important challenge for physicians, nurses, and parents. **Aim:** the study aimed to investigate the effect of oral sensory stimulation program with expressed breast milk on breastfeeding outcomes of preterm newborns **Design:** a quasi-experimental study design was utilized. **Setting:** The study was conducted at neonatal intensive care unit of Cairo University Children Hospital, Cairo, Egypt. **Sample:** The study sample composed of 80 preterm newborns with gestational ages ranging between 32 and 36 weeks. Preterm newborns were selected for the research based on inclusion criteria and were allocated randomly to one of two equal groups (control group 40 and intervention group 40). **Study Tools**: Included, (1) The newborn's medical record (2) feeding assessment sheet (3) preterm infant breastfeeding behavioral scale. The preterm newborn in the study group received an oral sensory stimulation program with expressed breast milk and the control group received only routine hospital care. **Results:** There was statistically significant difference between preterm newborns in control and intervention groups regarding to transition time from gavage feeding to full breastfeeding, weight gain and length of hospital stays. There was statistically significant difference between the preterm newborns in control and intervention groups in all six items of preterm infant breastfeeding behavioral scale in the first attempt of breastfeeding, second day and before discharge. There were no statistically significant differences between the control and intervention groups regarding respiratory rate and oxygen saturation before the beginning of the study, after 5 days and on discharge. **Conclusion:** Providing an oral sensory stimulation program with expressed breast milk had a highly statistically significant effect on breastfeeding outcomes of preterm newborns including, enhancing breastfeeding readiness behavior, decreasing the transition time from gavage to full breastfeeding, increasing weight gain, and subsequently reducing length of hospital stays. **Recommendation:** Set an oral sensory stimulation program with expressed breast milk as a part of routine nursing care for preterm newborns in neonatal intensive care units.

Keywords: Preterm newborns, oral sensory stimulation, breastfeeding outcomes, expressed breast milk, breastfeeding readiness behavior.

Introduction:

Preterm newborns have usually experienced breastfeeding difficulties due to their lack of suck-swallow-breath coordination ***(Younesian and Soleimani, 2015)***. The majority of them are unable to complete their oral feeding, which impairs their ability to breastfeed ***(Medeiros et al., 2018)***. Therefore, feeding difficulties are frequent in premature newborns and may result in a delay in achieving complete oral feeds, prolonging the requirement for intravenous nourishment and increasing the duration of hospital stay ***(Muelbert et al., 2019).***

Breastfeeding is the preferred feeding strategy for preterm newborns because of the critical nutritional, immunological,

psychological, and emotional advantages, as well as the fact that it promotes mother-child attachment ***(Fujinaga et al., 2012)***. Safe and effective breastfeeding is one of the requirements of hospital discharge and an ultimate objective of preterm newborns' nutrition. Thus, improving preterm oral skills helps them with their breastfeeding readiness ***(Younesian and Soleimani, 2015 & Jadcherla et al., 2016).***

Oral sensory stimulation was established to improve not only the physiological function of the oral structures but also, the development of neurological maturation ***(Diego et al., 2014 & Altimier and Phillips, 2016)***. Oral sensory stimulation is defined as stroking pressure apply to peri-and intra-oral structures including the cheeks, lips, jaw, tongue, palate, and gums, as well as the non-nutritive sucking of a pacifier. Therefore, it enhances oral motor performance, increases feeding progress, and lowers the number of days required to transition to full oral feeding. ***(Gonzalez et al., 2021)***.

Expressed breast milk in combination with oral sensory stimulation activates physiological pre-absorptive processes that contribute to feeding digestion and absorption ***(Osman et al., 2019).*** During tube feedings, breast milk bypasses the nasal and oral canals, limiting exposure to the smell and taste of milk. The provision of the smell and taste of expressed breast milk is a non-invasive and cheap method that accelerates the transition from tube feeding to full oral feeding and, subsequently, to full breastfeeding ***(Muelbert et al., 2019)***.

The Beckman Oral Motor Intervention [BOMI] and the Premature Infant Oral Motor Intervention [PIOMI] were designed to stimulate the oral skills of preterm newborns who were more than or less than 30 weeks gestational, respectively. Beckman's procedure is 15 minutes in length and seeks responses to a variety of stimuli through mechanically non-cognitively mediated muscle reactions. Different stresses, motions, ranges of motion, forces, and controls are provided to the lips, cheeks, jaw, and tongue ***(Fucile et al., 2002)***. However, PIOMI is a 5-minute oral motor intervention that provides supported oral movements against resistance ***(Lau, 2007)***.

Nurses working in neonatal intensive care units (NICUs) should be aware of preterm newborns' feeding difficulties and be knowledgeable about encouraging safe and effective breastfeeding skills, which require the coordinated action of a variety of physiological functions that are not fully developed in preterm newborns ***(Lau et al., 2012)***.

Significance of the study:

Oral feeding remains a critical concern for preterm newborns' parents and healthcare practitioners. It is an essential factor in the growth and development of preterm newborns; their ability to breastfeed is an important criterion for hospital discharge. They are more likely to develop feeding problems, with an estimated 40% of preterm newborns having difficulty transitioning from tube feedings to full breastfeeding. ***(Davis et al., 2016).***

Improving oral skills is a challenge for neonatal nurses who are caring for preterm newborns for hospital discharge. Thus, breastfeeding problems may cause long-term hospitalization and high costs. To facilitate the development of oral motor skills, shorten the transition time to full oral feeding, and shorten the length of hospitalization, an oral sensory stimulation program using expressed breast milk is required ***(Mahmoodi et al., 2019).***

Aim of the study:

The current study aimed to investigate the effect of implementing an oral sensory stimulation program with expressed breast milk on breastfeeding outcomes of preterm newborns.

Research hypotheses:

- The researchers hypothesized that the application of oral sensory stimulation program with expressed breast milk would positively improve breastfeeding outcomes of preterm newborns.
- Preterm newborns who are cared for by oral sensory stimulation program with expressed breast milk will exhibit more breastfeeding readiness behaviors compared to their controls.
- Preterm newborns who are cared for by oral sensory stimulation program with expressed breast milk will exhibit reduced the

transition time from gavage to full oral feeding compared to their controls.
- Preterm newborns who are cared for by oral sensory stimulation program with expressed breast milk will exhibit more gaining of weight compared to their controls.
- Preterm newborns who are cared for by oral sensory stimulation program with expressed breast milk will exhibit reduced length of hospital stays compared to their controls.

Operational Definitions:

- **Oral sensory stimulation:** referred to stroking or applying pressure to the peri and intra-oral tissues such as the cheeks, lips, jaw, tongue, palate, and gums, as well as non-nutritive sucking with an index finger.
- **Breastfeeding outcomes:** referred to the transition time from gavage to full oral feeding, time to discharge, and weight gain during the transition.
- **Breastfeeding readiness behaviors:** referred to the newborn's optimal feeding posture, latched on deeply at the breast, and advanced milk forward from the breast into the newborn's mouth.

Subjects & Methods

Research design:

- A quasi-experimental research design was utilized to determine the causality of an independent variable on the dependent variable ***(Dutra & Dos Reis 2016***). The independent variable, was an oral sensory stimulation program with expressed breast milk on the dependent variable was breastfeeding outcomes, included preterm newborns' breastfeeding readiness behaviors, the transition time from gavage feeding to full breastfeeding, the length of hospital stays, and weight gain. In which the preterm newborns were assigned to the control group and the intervention group to measure the effect of the oral sensory stimulation program with expressed breast milk on their breastfeeding outcomes.

Research Setting:

The study was conducted at NICUs of Cairo University Hospitals which were considered one of the main well equipped university hospitals with high rate of preterm newborn's admission in Cairo, Egypt.

- The NICU of Cairo University Hospitals was divided into five rooms namely; intensive care room, two feeding room, jaundice room, and isolation room.

Subjects:

A purposive sample that composed of 80 preterm newborns who were recruited in this study according to their inclusion criteria. A simple random method was used to select them from the admission schedule of the unit. The sample size was calculated according to the total number of admissions in the past three months from October to the end of December 2019 was 111, ***Statistical report of NICU of Cairo university hospital (2019)***, and based on the previous study of ***Muelbert et al, (2019),*** the following assumption of Power Analysis to define sample size.

$$n = \frac{t^2 \times P(P-1)}{m^2}$$

n= the required sample size.
t = the confidence level at 95% (standard value of 1.96).
p = estimated prevalence of preterm neonates.
m = the margin of error at 5% (standard value of 0.05).

Inclusion criteria:

- Preterm newborns on tube feeding, of both sexes, with gestational age ranging between 32-36 weeks and birth weight of 1200 gm to 2500 gm. Those who were appropriate for their gestational age, which was set in accordance with the date of last menstruation and the first-trimester ultrasound, were medically stable, but their duration of hospital stay was more than 72 hours to ensure their stability of their hemodynamic condition.

Exclusion Criteria:

- The study excluded severely ill preterm newborns with major health problems including: necrotizing enterocolitis, bronchopulmonary dysplasia, encephalopathy of any grade, intraventricular hemorrhage, congenital malformation, oro-nasal malformation such as cleft lip and palate, sepsis, and those who

were receiving conventional ventilation or sedative drugs.

Tools of data collection:

The data collected through the following tools:

Tool I:

The Newborn's Assessment Record: the researchers designed that after reviewing the relevant and related literature, ***(Mahmoodi et al., 2019)*** to obtain data regarding the following:

First part: it was concerned with characteristics of the studied preterm newborns including; gender, date of birth, date of admission, type of delivery, birth weight, gestational age, post-natal age, medical diagnosis, and duration of hospital stay.

Second part: it was concerned with the preterm newborns' physiological parameters including respiratory rate, heart rate, and oxygen saturation.

According to (***Holditch-Davis et al., 2003)*** the operational definitions of the physiological parameters were described as the following:

Physiological parameters operational definitions:	
Heart rate Beats/min.	Normal heart rate was ranged 100 ≥160 beats/min.
Oxygen saturation (%)	Normal oxygen saturation was ≥ 90 %
Respiratory rate Cycle/min.	Normal heart rate was ranged 35 ≥60 cycle/min.

Tool II:

Feeding Progress Record:

it was adapted from **Crow et al., (2016) and Beker et al., (2019),** assessing feeding progress in the form of daily weight gain, weight on discharge, length of hospital stays, and times of transition from tube feeding to full breastfeeding.

Tool III:

Preterm Infant Breastfeeding Behavioral Scale (PIBBS):

it was adopted from ***Nyqvist et al, (1999)*** and was used to assess preterm newborns breastfeeding readiness behavior. It was consisted of six items including; 1-Rooting, 2-Areolar grasp, 3-Latched on and fixed to breast, 4- Sucking, 5-Longest sucking burst, and 6- Swallowing. The total score of PIPPS was (19), each item of PIBBS had classified into subscale rating scores as the following:

1. **Rooting** including 3 subscales rating scores, (0= Didn't root, 1= showed some rooting behavior, 2= showed obvious rooting behavior).
2. **Areolar grasp** including 4 subscales rating scores, (0= None, the mouth only touched the nipple,1=part of the nipple, 2=the whole nipple, not the areola,3=the ni pple and some of the areola).
3. **Latched on and fixed to breast** including 4 subscales rating scores, (0=did not latch on at all so the mother felt i t,1=Latched on for ≤ 5 minutes, 2= latched on for 6-10 minutes, 3= latched on for ≥ 11-15 minutes).
4. **Sucking** including 4 subscales rating scores, (0=no sucking, 1=licking and tasting, but no suckig,2=singl e sucks, occasional short sucking bursts (2-9 sucks), 3= repeated short sucking bursts, occasional long bursts (≥10 sucks) repeated (≥ 2) long sucking bursts).
5. **Longest sucking burst** including 6 subscales rating scores (0= 1 to 5 consecutive sucks, 2= 6 to 10 consecutive sucks, 3 = 11 to 15 consecutive sucks, 4= 16 to 20 consecutive sucks, 5= 21 to 25 consecutive sucks, 6= ≥ 26 to 30 consecutive sucks).
6. **Swallowing** including 3 subscales rating scores (0= swallowing was not noticed, 1= occasional swallowing was seen, 2= repeated swallowing was noticed).

Validity & reliability:

A jury of three experts included; two professors of the pediatric nursing from the Faculty of Nursing, Ain Shams and one professor of pediatrics and neonatal medicine

Faculty of Medicine, Cairo University to test the data collection tools for their clarity, comprehensiveness, relevance, simplicity, and applicability. All modifications required were made according to the experts' judgment on the clarity of sentences, relevance of the content, and sequence of items. The experts agreed on the data collection tools contents. The reliability of the data collection tools was done by using Cronbach's alpha test, which used to figure out the reliability score of each study tool including; (0.841) for newborn's assessment record and (0.7.95) for feeding progress record and was (0.812) for preterm infant breastfeeding behavioral scale.

Ethical considerations:

An official permission to carry out the study was obtained through an issued letter from the Dean of the Faculty of Nursing at Ain Shams University to the Director of Children's Hospital to get the agreement to conduct the study. The research was authorized by the Scientific Research Ethical Committee of Ain Shams University's Faculty of Nursing in Cairo, Egypt. Each participant gave their verbal agreement (parent of the preterm newborn). To get consent to participate in the study, the researchers presented the aim and procedure of the oral sensory stimulation program with expressed breast milk to the parents of the preterm newborn involved in the study. Furthermore, parents were given guarantees that their newborn's medical condition would be kept private, and they were free to agree or disagree with their newborn's participation in the study group.

Pilot study:

A pilot study was applied to 10% of total sample size (n = 8) to test the applicability and clarity of the study tools, to estimate the time needed to fill each tool, and to test the feasibility of the research process. The preterm newborns studied in the pilot study were included in the study sample while, there was no modification required in the study tools.

Fieldwork:

The actual fieldwork was carried out during the period that started in January and ended in March 2020. The intervention group obtained an oral sensory stimulation program with expressed breast milk, while the control group received no stimulation other than routine hospital care.

Procedure:

The sensory stimulation program with expresses breast milk was designed by the researchers in the light of ***Fucile et al., (2018)***. The researchers were assessed the preterm newborn at the initial day of the study intervention, at 5th day and on discharge.

Assessment phase:

During this phase, the researchers chose the preterm newborns who met the inclusion criteria of the study. The preterm newborns were then randomly assigned using a simple randomization approach and divided into two equal groups, intervention (n=40) and control groups (n=40). A card on each newborn's incubator identified him or her as being a subject in the study. However, group assignments were blinded to the nursing, medical staff, and parents for both the intervention and control groups.

The baseline data was obtained, which included medical diagnosis, gender, type of delivery, gestational age, chronological age, birth weight, and recent weight before starting the study intervention.

In addition, the mean physiological parameters were measured 40 minutes prior to application of an oral sensory stimulation program with expressed breast milk by a cardio-respiratory monitor to assess the mean heart rate, respiratory rate and oxygen saturation for each preterm newborns included in the study.

Implementation phase:

The oral sensory stimulation program with expressed breast milk was guided by the Premature Infant Oral Motor Intervention [PIOMI] study intervention (***Lau, 2007).***

According to the newborn's clinical stability, it began in the 32nd week of postmenstrual age. The program was carried out once a day for seven consecutive days in the morning shift, at 8.15 a.m. 20 to 40 minutes prior to gavage feeding at 9 a.m. The associated physician was responsible for starting and progressing oral feeding.

The program was performed using (PIOMI) for 5 minutes of oral sensory stimulation with expressed breast milk based on the following order: 1) stimulation of the cheeks (twice for 30 seconds), 2) stimulation of the lips (once every 30 seconds), 3) pursing the lips (once for 30 seconds), 4) gum stimulation (twice for 30 seconds), 5) stimulating the lateral sides of the tongue and cheek (twice for 15 seconds), 6) stimulation of the medial septum of the tongue and palate (twice for 30 seconds), and 7) non-nutritive sucking with wiped up the little finger with expressed breast milk to get the smell and taste of breast milk for (two minutes), protective gloves were worn (***Fucile et al., 2018)***. Throughout the seven consecutive days of the study intervention, both groups were monitored for their heart rate, respiratory rate and oxygen saturation using cardiorespiratory 40 minutes before gavage feeding.

If the preterm newborn showed signs of medical instability including; oxygen desaturation, or apnea/bradycardia and signs of feeding intolerance, the program was stopped and they excluded from the study sample.

The preterm newborns of the control group were received routine hospital care during the period of the study intervention.

Outcome Measure:

The time to attain oral feed was calculated as the number of days required for newborns to transition from gavage feeding to breastfeeding. A successful feeding was defined as the completion of the feeding without the incidence of oxygen desaturation and/or apnea/bradycardia and feeding intolerance.

Breastfeeding was started and progressed according to the unit's established procedure, which was similar for both groups. The preterm newborns in both groups were observed by the researchers for 10 to 15 minutes during the time breastfeeding to assess their breastfeeding readiness behaviors using PIBBS at the first attempt of breastfeeding, second attempts, and before discharge.

The length of hospital stay was determined by the number of days the newborns spent in the hospital from birth to discharge. Weight gain was established by measuring how much weight was gained by the preterm newborns throughout the study intervention for the both groups. A sensitive digital scale with periodic calibration was used to measure and record each newborn's weight gain before gavage feeding every day at 9 a.m. The newborns were weighed without clothes or diapers and before being fed by the same nurse.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) V19 was used to revise, code, tabulate, analyze, and present data. Frequencies, percentages, arithmetic mean, and standard deviations were used for quantitative variables. Chi-square (x^2) is used for testing the difference between qualitative variables. The independent t-test was used for comparisons of quantitative variables between the control and intervention groups. The following statistically significant differences were determined after the data was analyzed using appropriate statistical methods:

- P-value > 0.05 to be statistically insignificant.
- P-value < 0.05 to be statistically significant.
- P-value < 0.001 to be highly statistically significant.

Results:

The intervention and control groups were not statistically significant different according to their baseline characteristics, including birth weight, gestational age and chronological age (table 1). In addition, there was no significant difference between the two groups in terms of their gender (x^2=0.35, P-value <0.05) (figure 1) and type of delivery (x^2=0.83, P-value <0.05) (figure 2).

Considering the transition time from gavage feeding to full breastfeeding of the studied preterm newborns in both groups, the mean time of transition in the intervention group was 9.55±2.2 days, and 12.5±3.03 days in the control group. Where, the transition time of 57.5% of the intervention group ranged between for 7-10 days compared to only 20% of the control group. However, the transition time for 35% of the control group ranged between 14-19 days compared to 10% in the intervention group showing that breastfeeding started earlier in the intervention group compared to their control (Figure 3). Furthermore, the independent t-test was used to compare the time of feeding transition for readiness to breastfeeding in the intervention and control group, which reflected a high statistically significant difference (t=4.98, p-value <0.001).

In addition, the mean length of hospital stay in the intervention and control groups were 14.38±2.01days and 19.45± 1.64 days respectively (Figure 4). the length of hospital stays between the groups, which reflected a statistically significant difference (t= 11.55, p-value <0.05).

Table (2), based on the intergroups comparison, showed that the mean weight gain of newborns on the first day was 1513.00±78.51grams in the intervention group and 1495.00 ±97.82 grams in the control group. The average weight of newborns at discharge was 1849.00 ± 73.89 grams in the intervention group and 1743.75 ±66.62 grams in the control group. Furthermore, the independent t-test was used to compare the mean values of weight gain in the intervention and control groups, which reflected a significant difference after 5 days of the study intervention (t=4.753, p-value < 0.001) and before discharge (t=6.90, p-value <0.001).

Table (3) The mean heart rate of newborn at the beginning of the intervention was 146.9±4.2 beats/ minute in the intervention group and 149.2±7.5 beats/ minute in the control group, before discharge, the mean heart rate of newborns was 139.5±7.34 in the intervention group and 146.8±8.2 in the control group, with a high statistically significant difference between the two groups (t-test 4.174, p-value < 0.001). On the other hand, there are no statistically significant differences between the two groups in terms of respiratory rate and oxygen saturation after 5 days of the study intervention and before discharge (p-value >0.05).

Table (4), shows the effect of an oral sensory stimulation program with expressed breast milk on all six items of PIBBS of studied preterm newborns in the intervention and control groups in the first attempt and second attempts of breastfeeding and before discharge. It was found that, there were high statistically significant differences between the both groups in all items of preterm infant breastfeeding behavior scale at the second attempt of breastfeeding and before discharge (p-value < 0.001).

Table (1): Number and percentage distribution of the studied preterm newborns based on their baseline characteristics

Characteristics	Total (No. = 80)				t-	p-value
	Control group (n=40)		Intervention group (n =40)			
	No.	%	No.	%		
Weight at birth (grams)						
– 1200 -< 1500	21	52.5	19	48.5		
– 1500 -< 2000	19	48.5	21	52.5		
$\bar{X}$ ± SD	**1493.50±120.60**		**1507.50±99.22**		**0. 567**	**0. 572**
Gestational age (weeks)						
– 32-<34	22	55.0	21	52.5		
– 34 -≤36	18	45.0	19	48.5		
$\bar{X}$ ± SD	**32.88± 1.11**		**32.70±.1.26**		**0.657**	**0.513**
Chronological age (days)						
– 2-<4	17	42.5	20	50.0		
– 4-≤ 7	23	47.5	20	50.0		
$\bar{X}$ ± SD	**3.50±1.01**		**3.68±1.14**		**0. 725**	**0. 470**

$\bar{X}$ = Arithmetic mean, and SD = Standard deviation.
Insignificant statistical difference p-value >0.05.

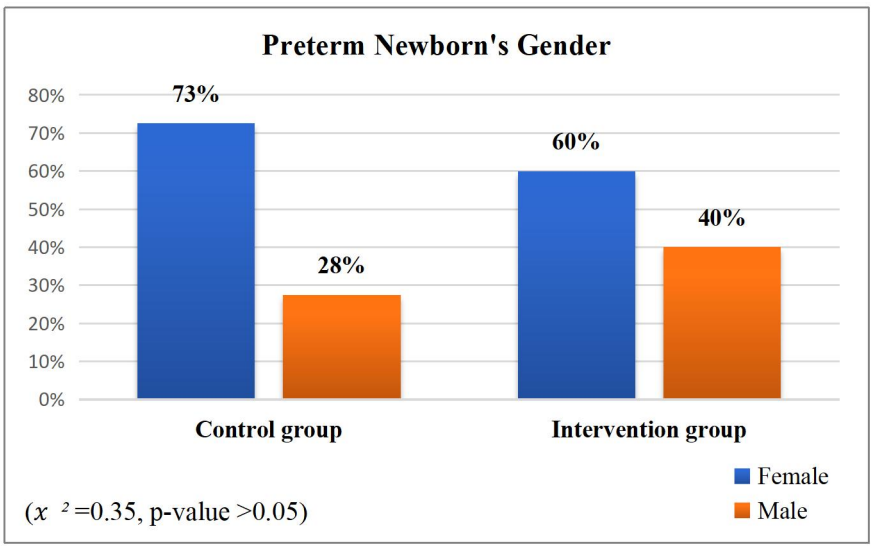

Figure (1): Percentage distribution of the studied preterm newborns according to their gender

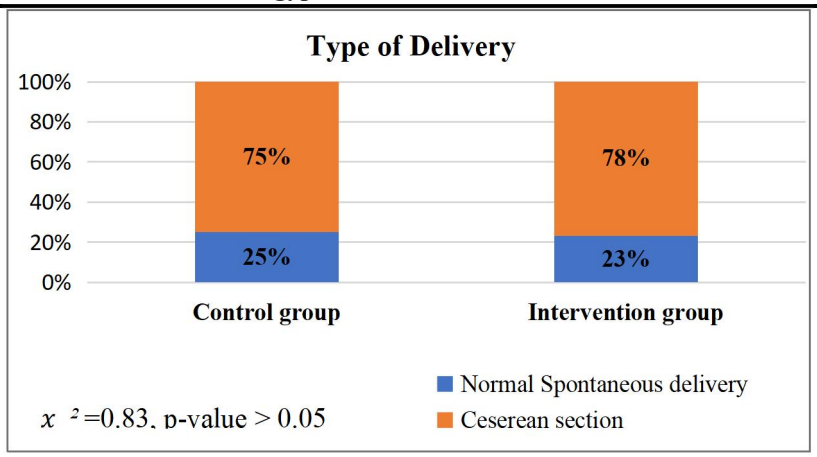

Figure (2): Percentage distribution of the studied preterm newborns according to their type of delivery

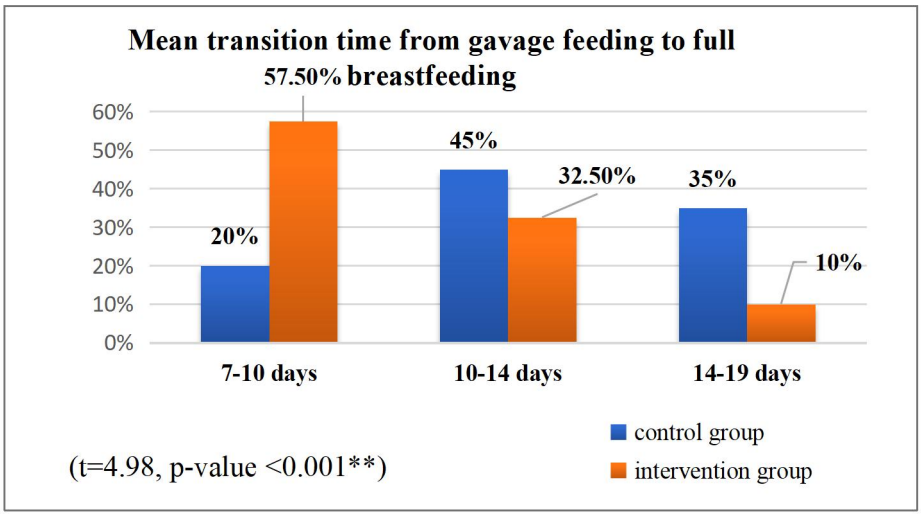

Figure (3): Percentage distribution of control and intervention groups according to their mean transition time from Gavage feeding to full breastfeeding

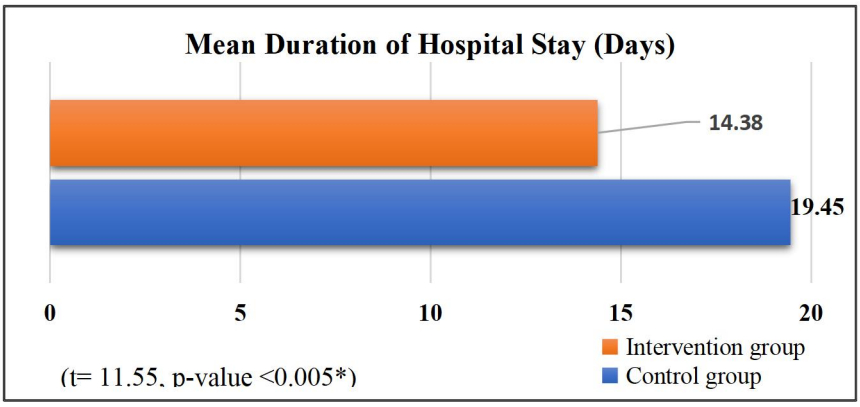

Figure (4): Mean length of hospital stay among the studied preterm newborns

Table (2): Mean values of weight gain among the studied preterm newborns in control and intervention groups throughout the study intervention

Gaining weight (grams)	Total (No. = 80) Control group (N =40) Mean (SD)	Intervention group (N =40) Mean (SD)	t-test	p-value
– Initial day of intervention	1495.00± 97.82	1513.00±78.51	**0.908**	**0.367**
– After 5 days	1586.38±84.06	1663.63±59.15	**4.753**	**0.000****
– Before discharge	1743.75± 66.62	1849.00± 73.89	**6.690**	**0.000****

*P-value <0.05 statistically significant difference, **P-value <0.001 high statistically significant difference
P-value ≥ 0.05 no statistically significant difference.

Table (3): Mean values of physiological parameters among the studied preterm newborns in intervention and control groups throughout the study intervention

Physiological parameters	At the beginning		t-test (1) p-value	After 5 days		t-test (2) p-value	Before discharge		t-test (3) p- value
	Control group $\overline{X}$ ± SD	Intervention group $\overline{X}$ ± SD		Control group $\overline{X}$ ± SD	Intervention group $\overline{X}$ ± SD		Control group $\overline{X}$ ± SD	Intervention group $\overline{X}$ ± SD	
Heart rates	149.2±7.5	146.9±4.2	1.767 0.081	148.8±6.4	145.3±4.5	2.817 0.006	146.8±8.2	139.5±7.4	**4.174 0.000****
Respiratory rates	55.6±5.0	53.6± 2.4	2.342 0.022	46.6±2.6	47.2±2.5	1.031 0.306	43.0±2.2	42.7±2.1	0. 601 0.549
Oxygen saturation	95.1±0.7	95.2±0.8	0. 272 0.786	94.6±0.3	94.7±1.2	0. 374 0. 710	95.4±0.5	95.4±0.6	0.967 0.337

$\overline{X}$ = Arithmetic mean, and SD = Standard deviation.
*P-value <0.05 statistically significant difference,** P-value <0.001 high statistically significant difference
P-value ≥ 0.05 no statistically significant difference.
t-test (1): independent t test between the control and intervention group at the beginning of intervention.
t-test (2): independent t test between the control and intervention group at 5 days of intervention.
t-test (3): independent t test between the control and intervention group before discharge.

Table (4): Effect of oral sensory stimulation program with expressed breast milk on breastfeeding behavioral readiness among the studied preterm newborns in intervention and control groups

Breastfeeding Behaviors	First attempt		t-test (1) p-value	Second attempt		t-test (2) p- value	Before discharge		t-test (3) p-value
	Control group $\bar{X}$ ± SD	Intervention group $\bar{X}$ ± SD		Control group $\bar{X}$ ± SD	Intervention group $\bar{X}$ ± SD		Control group $\bar{X}$ ± SD	Intervention group $\bar{X}$ ± SD	
– **Rooting**	0.6±0.5	0.65±0.6	0.369 0.713	1.20±0.4	1.68±0.4	**4.816** **0.000****	1.45±0.5	1.90±0.3	**4.837** **0.000****
– **Areolar grasp**	0.8±0.5	0.95±0.5	0.578 0.565	1.53±0.6	1.98±0.5	**3.424** **0.001*****	2.18±0.5	2.80±0.4	**5.790** **0.000****
– **Latching on**	0.9±0.6	0.98±0.6	0.000 1.000	1.55±0.6	2.10±0.5	**4.000** **0.000****	1.93±0.6	2.93±0.2	**8.933** **0.000****
– **Sucking**	1.1±0.5	1.08±0.6	0.173 0.863	1.45±0.5	2.05±0.6	**4.341** **0.000****	2.28±0.4	2.90±0.3	**7.256** **0.000****
– **Longest sucking burst**	1.45±0.5	1.45±0.5	0.000 1.000	2.30±0.5	3.53±0.7	**8.252** **0.000****	3.63±0.7	5.00±0.5	**9.696** **0.000****
– **Swallowing**	0.7±0.5	0.85±0.4	0.697 0.488	1.20±0.4	1.70±0.4	**5.133** **0.000****	1.38±0.4	1.93±0.2	**6.232** **0.000****
Total	5.74±1.60	5.95±1.69	0.55 0.58	9.1±2.1	12.9±1.54	**9.31** **0.000****	12.64±1.98	17.35±0.92	**13.6** **0.000****

$\bar{X}$ = Arithmetic mean, and SD = Standard deviation.

*P-value <0.05 statistically significant difference, **P-value <0.001 high statistically significant difference

P-value ≥ 0.05 no statistically significant difference.

t-test (1): independent t test between the control and intervention group at initial attempt of breastfeeding.

t-test (2): independent t test between the control and intervention group at second attempt.

t-test (3): independent t test between the control and intervention group before discharge.

Discussion:

Breastfeeding is a highly complicated and coordinated sensory action that necessitates the use of supportive care by nursing staff ***(Helenius et al., 2017).*** Transitioning from gavage feeding to breastfeeding poses challenges since it necessitates coordination of the chin, muscles, and lips, as well as the upper respiratory system, in order to keep secure sucking and swallowing. Early oral motor function and a lack of maturity can reduce the time it takes to transition to full breastfeeding ***(Han et al., 2012).*** Therefore, the current study aims to investigate the effect of an oral sensory stimulation program with expressed breast milk on breastfeeding outcomes of preterm newborns.

As regards the characteristics of the preterm newborns, the intervention and control groups were not significantly different with respect to their baseline characteristics. the results of the present study revealed that, the mean birth weight of the newborns in the intervention group was 1507.50±99.22 grams, compared to the mean birth weight of control group was 1493.50±120.60 grams. The mean gestational ages by weeks among studied preterm newborns were 32.88± 1.11 weeks in control group, compared to 32.70±.1.26 weeks for the intervention group. Furthermore, less than half of the neonates in both the intervention and control groups had a postnatal age of less than 7 days after birth, with a mean age of 3.68±1.14 and days and 3.50±1.01 days for the control study groups, respectively, and more than half of the studied preterm newborns were males in both the control and intervention groups. These means the homogeneity among the studied preterm newborns and normal distribution of the studied variables in both control and intervention groups. Where, the parametric statistical tests were used to compare between the studied variables.

These findings were consistent with the findings of ***Younesian and*** **Soleimani** ***(2015),*** who conducted a study entitled "Impact of Oral Sensory Motor Stimulation on Feeding

Performance, Length of Hospital Stay, and Weight Gain of Preterm Infants in NICU" and found that the mean gestational ages were 30.90±0.73 weeks for the control group and 31.20±0.78 weeks for the study group, except an equal number of males and females in both study groups. Moreover, these findings were not consistent with the findings of ***Amer (2015),*** who conducted a study to assess the effect of a pre-feeding oral stimulation program on preterm infant feeding performance and found that more than half of the study sample were females. The results of the current study showed that the application of an oral sensory stimulation program with expressed breast milk to preterm newborns had positive effects on their readiness behaviors to breastfeed, as well as a decreased transition time from tube feeding to full breastfeeding. These results revealed a shorter length of hospital stay in the intervention group compared with their control group and were in agreement with those of other similar studies using the oral motor intervention. A study conducted by **Rocha et al., (2007),** entitled "A Randomized Study of the Efficacy of Sensory-motor-oral Stimulation and Non-nutritive Sucking in Very Low Birthweight Infants", which showed that the times of oral feeding onset and discharge in the study group were 8.2 and 10.4 days earlier than those in the control group. However, a study conducted by ***Mahmoodi et al., (2019)*** about "The Effect of Oral Motor Intervention on Oral Feeding Readiness and Feeding Progression in Preterm Infants" and showed that the mean length of hospital stay in the intervention and control groups were 16.5±3.91 and 19.4±4.08 days respectively, revealing that the length of stay was significantly shorter in the intervention group.

The results of present study showed that the application of sensory stimulation program with expressed breast milk had positive effects on the breastfeeding outcomes of the studied preterm including; enhancing breastfeeding readiness behavior, decreasing the transition time from gavage to full breastfeeding, increasing weight gain, and reducing length of hospital stays.

These results revealed a shorter length of hospital stay and were consistent with those of other similar studies using oral motor intervention. In a study conducted by ***Rocha et al., (2007)***, the duration of intervention was 15 minutes for 10 days, and the weight gaining of the newborns was not homogeneous in the two groups. On the other hand, in the present study, the duration of the intervention was 5 minutes for 7 days with a similar positive effect with statistically significant differences between both groups of the study. In the researcher point of view, these unnecessary days of prolonged hospitalization is a risk factor for preterm newborns due to risk of exposure to infection and other complications including poor maternal attachment to their newborns, in addition to imposing higher costs and hospital charge to family and health care. Therefore, the application of effective interventions for reducing the length of hospital stay in NICU can help in reduce risk and cost burden. Due to feeding problems resulting from a lack of development of digestive and respiratory systems, preterm newborns need assistance to develop and function properly. One of the best interventions is the use of oral sensory stimulation in combination to the effect of expressed breast milk taste and smell. In the present study, the PIOMI technique was used for oral stimulation program, the results of which showed that in these preterm newborns, improved their behaviors readiness to breastfeeding started earlier which led to the reduction of the hospital stay duration.

Concerning weight gain, there was a statistically significant difference between the two groups in terms of mean weight gain throughout the study intervention. The findings of current study were in accordance with those of **Khalessi et al., (2015),** who discovered that there had been no statistically significant differences in weight at the time of oral feeding introduction in the study and control groups, but that preterm infants in the study group who

received pre-feeding oral stimulation had a greater weight at discharge.

Regarding the mean heart rate of newborns was 139.5±7.34 beats/minute in the intervention group and 146.8±8.2 139.5±7.34 beats/minute in the control group, with a statistically significant difference between the two groups (P-value <0.05). On the other hand, there are no statistically significant changes between the two groups in terms of respiratory rate and oxygen saturation after 5 days and throughout the study intervention (P-value >0.05). These findings were consistent with ***Hwang et al., (2010),*** conducted a study on the Effects of pre-feeding oral stimulation on feeding performance of preterm infants who found no difference in peripheral oxygen saturation rates in the first 5 minutes following feeding after the intervention. In contrast, ***Ahmadpour et al., (2017)*** conducted a study on the effect of non-nutritive sucking on transcutaneous oxygen saturation in newborns under nasal positive airway pressure (CPAP) and found that the mean oxygen saturation values before non-nutritive sucking was 96.31±2.88%, which increased to 98.35±1.6 % after the intervention, and that this increase was statistically significant.

Concerning the preterm newborns' behavioral readiness to breastfeeding, the results of the current study revealed that, there were statistically significant differences between the intervention and control groups at second attempt of breastfeeding and before discharge in all six items of PIBBS. From the researcher point of view, oral sensory stimulation with the effect of taste and smell of the expressed breast milk is a cheap, easy and non-invasive method helps preterm newborn to enhance their feeding abilities and oral feeding performance, allowing them to achieve successful breastfeeding earlier than the newborn in the control group. These findings were consistent with a study conducted by ***Lyu et al. (2015)*** in China, entitled "Assess the Effect of An Early Oral Stimulation Program on Oral Feeding of Preterm Infants," which found that when the experimental group reached independent oral feeding, their postmenstrual age was significantly lower than that of the control group.

Conclusion:

Based on the obtained results, it can be assumed that providing an oral sensory stimulation program with expressed breast milk had a highly statistically significant effect on breastfeeding outcomes of preterm newborns including, enhancing breastfeeding readiness behavior, decreasing the transition time from gavage to full breastfeeding, increasing weight gain, and subsequently reducing length of hospital stays.

Recommendations:

Based on the findings of the current study, the following recommendations were made:

- Set oral sensory stimulation with expressed breast milk as a part of routine nursing care for preterm newborns in neonatal intensive care units.
- Empower neonatal nurses with on-the-job training as regards oral sensory stimulation technique with expressed breast milk to enhance their professional experience.
- The results should be replicated using a large probability sample.
- To attain generalization of the outcomes, the effect of oral sensory stimulation with expressed breast milk on short-term clinical outcomes for preterm newborns was advised.

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