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Effect of Sensory Stimulation Interventions on Physiological Stability and Neurobehavioral Outcomes of Premature Neonates

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Abstract
Objective: To assess the effect of sensory stimulation interventions on physiological stability and neurobehavioral outcomes of premature neonates. Design: A quasi experimental design. Setting: The study was conducted at Neonatal Intensive Care Units at Ain Shams Maternity & Gynecological Hospital, and Abo El Reesh El Monira Children's Hospital. Subjects: The study subjects included a purposive sample of 88 premature neonates divided into study and control groups and they were matched with their gestational age and birth weight. Tools: (1) The Neonate's Medical Record, (2) Physiologic Parameters Recording Sheet and (3) Brazelton Neonatal Behavioral Assessment Scale. Methods: Premature neonates divided into two equal groups; (a) study group who receiving sensory stimulation interventions (b) control group who receiving routine hospital care only. The premature neonates were assessed their physiological stability and their neurobehavioral outcomes at initial contact, after 5 days of interventions and on discharge. Results: showed that the physiological stability and neurobehavioral outcomes of the study group were improved after 5 days of sensory stimulation interventions and on discharge than those in the control group with statistically significant differences were found between the study and the control groups. Conclusion: It was concluded from the current study findings that premature neonates who receive sensory stimulation interventions had better physiological stability and better neurobehavioral outcomes than those who didn't receive them and had only routine hospital care. Recommendations: Providing sensory stimulation interventions for premature neonates on routine hospital care.

Key words: *sensory stimulations, intervention, nursing, preterm neonates, physiological stability, neurobehavioral, outcomes*

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I. Introduction

Sensory development is a complex process, involving both neural and structural components. Nevertheless, the basic structure of the sensory receptors evolves early in fetal life. So, most development of the senses occurs during the last 16-20 weeks of gestation. After birth, environmental stimulants speed up the sensory system to complete maturity several months after birth. Stimulation via physical, chemical, sensory, social/emotional environments play a key role in shaping the development of the infant brain *(Clark and Gambelunghe, 2015).*

The ability of premature neonates to assimilate sensory stimuli and respond to them is influenced by their gestational age and the degree of medical condition. Hospitalized premature neonates undergo changes in sensory perception arising from extremely continuous intense neonatal intensive care unit environment including high noise level, bright light and a lack of sensory stimulation that they would otherwise experience in general mothering care *(Sayed, Youssef, Hassanein, Mobarak, 2015 ; Zeraati, Nasimi, Rezaeian, Shahinfar, and Ghorban 2018).*

Premature neonates are at risk for neurological impairments, adverse neurodevelopmental outcomes, and mother-infant relationship difficulties. These neonates not only face survival and developmental challenges but are also at risk of developing sensory integration problems, including deficits in learning and memory, disrupted sensory processing, attention deficit hyperactivity disorder and autism spectrum disorder. Consequently, they can grow at a slower rate than full-term neonates *(Peralta-Carcelen, Schwartz & Carcelen, 2018).*

Sensory stimulation is a modern technique aimed at organizing sensory inputs which are appropriate for growth, including tactile, vestibular, kinesthetic, auditory, oral and visual inputs, maintain and promoting the improvement of existing skills and mitigating environmental deleterious effects. It allows the efficient use of one's body by stimulating the body and the environment. The positive effects, however, include weight gain, positive behavioral improvements, decreased stress rates and heart rate, useful for improving few adverse neurological impacts for birth and negative complications of long-term hospitalization (Anand, Berqvist, Hall, Carbajal, 2011; Mohamed, Abdelazeim, Elshafey, Nasef, 2018).

Correct preparation for sensory interventions should include; ensuring that sensory interventions are properly coordinated according to the neonate's readiness to recognize and benefit from stimuli, based on the sequential order of development and maturation of the sensory system; making modifications accessible to neonates with specific medical conditions; and ensuring the intervention quantities and forms are accessible with different maturation stages (Pineda, Guth, Herring, Reynolds, Oberle, Smith, 2017).

Nursing care provided to premature neonates is a stress factor, which later has a direct effect on the growth of children. Sensory stimulation intervention approaches are distinguished by certain methods of handling that include a range of interactions and adjustments between caregivers and premature neonates (Knobel, Levy, Katz, Guenther, Holditch-Davis, 2013). In addition, frequent application of sensory stimulation interventions improves adaptive behavior, which helps premature neonates' transition more easily to the new environment which catch up with full term neonates (Aliabadi & Askary, 2013).

Significance of the study:

Prematurity is an important public health issue not only because of the high prevalence of infants' deaths but also because of short and long-term adverse neurodevelopmental outcomes, which lead to long-term complications of the nervous system that require medical, educational, rehabilitative and social services (Loe and Feldman, 2017).

In recent years, much research has been conducted on the effects of supplemental stimulation with premature infants and on the maturation and capabilities of their sensory systems. Studies also indicate similarities and differences in the healthy premature infant's behavior and motor abilities at the age equivalent of the full-term newborn. Although advances in perinatal care have improved premature infant survival rates, these infants still experience more neurosensory impairments than full-term infants .
(American Journal of Occupational Therapy, 2017).

In Egypt, limited studies conducted and focused on application of sensory stimulation therapies for caring of premature neonates Hence, the current study was undertaken to assess the effect of implementing sensory stimulation interventions on physiological stability and neurobehavioral outcomes of premature neonates. Hopefully, the results will set a standard

Aim of the study:
This study aimed to assess the effect of implementing sensory stimulation interventions on physiological stability and neurobehavioral outcomes of premature neonates.

Research hypothesis:
The researchers hypothesized that the implementation of sensory stimulation interventions program would positively improve the physiological stability and neurobehavioral outcomes of premature neonates.

- Premature neonates who are received sensory stimulation interventions will exhibit better physiological stability compared to the controls.
- Premature neonates who are received sensory interventions will exhibit better neurobehavioral outcomes compared to the controls.

Operational definitions:

- Sensory stimulation interventions are effective non-pharmacological methods including (auditory, tactile, vestibular and visual stimulation), aiming to improve neuromuscular and behavioral outcomes of premature neonates.
- Physiological stability: is the ability of premature neonate to maintain hemostasis and a stable balance of subsystems (heart rate, respiratory rate, blood pressure and oxygen saturation).
- Neurobehavioral outcomes: the pattern of interaction of premature neonates that will be established with the environment. Or the neonates' current ability to organize and modulate the five highly interactive subsystems including; the autonomic physiological, motor, state organizational, attention-interactive and self-regulatory system.

II. Subject and Methods

Research Design

A quasi-experimental research design was utilized in this study to establish the causality, the effect of an independent variable on the dependent variable. The independent variable are the sensory stimulation interventions and the dependent variables including physiological stability and neurobehavioral outcomes of premature neonates. In which the preterm neonates were assigned to the control group and study group to measure the effect of implementing sensory stimulation interventions on physiological stability and neurobehavioral outcomes of premature neonates.

Research Settings:
The study was carried out at the Neonatal Intensive Care Units at:

- Maternity & Gynecological Hospital affiliated to Ain Shams University Hospitals. This NICU composed of 5 rooms namely as; ordinary (feeding) care, intermediate care (intravenous fluid room), the intensive care for critically ill neonates who needed assistance ventilation and two isolation room for critically ill neonates with a serious infection. The capacity of each room is 8-10-10-3-2 incubators for each room respectively.
- Abo El Reesh El Monira Children's Hospital affiliated to Cairo University Hospitals .This NICU composed of 4 rooms namely as; ordinary (feeding) care, intermediate care (Jaundice room), the intensive care for critically ill neonates who needed assistance ventilation and one isolation room for critically ill neonates with a serious infection. The capacity of each room is 10-10-10-20 incubators for each room respectively.

Subjects:
A purposive sample that composed of 88 premature neonates. The sample size was calculated using the following assumption with 95% confidence level and 90% test power. First, 88 premature neonates were selected using accessible random sampling and were randomly divided equally into two groups of control and study group.
n=
n= the required sample size.
t = the confidence level at 95% (standard value of 1.96).
p = estimated prevalence of physiological stability and neurobehavioral outcomes among premature neonates.
m = the margin of error at 5% (standard value of 0.05).
The following inclusion criteria were considered:
Premature neonates from both sexes with gestational age ranging between 30-36 weeks and their birth weight of 1000 gm to ≥ 2500 gm within the first 48 hours, Apgar score >7 at 1 and 5 minutes. Those who were appropriate for their gestation, medically stable, and their duration of hospital stay is more than 72 hours to ensure their stability of the health condition.

Exclusion criteria:

- The researchers excluded severely ill premature neonates with major health problems that may influence on the neonate's physiological stability behavioral outcomes including; (chronic lung diseases, respiratory distress grade II or greater, necrotizing enterocolitis, chromosomal and metabolic abnormalities, serious infectious diseases, congenital anomalies, hemorrhagic/ ischemic brain injury and seizure).
- Premature neonates under ventilatory support or on a high frequency mode.
- Requiring surgery
- Sedative medications.
- Diagnosed with grade II, III or IV intraventricular hemorrhage and / or hydrocephalus,
- Have a device for invasive blood pressure, arterial lines and chest tubes.
- Having an oxygen requirement of more than 30% to maintain oxygen saturation within the limits indicated by the NICU (neonatal intensive care unit).

Premature neonates who met the selection criteria were randomly divided into two groups of control group (n=44) and study group (n=44) using the Research Randomizer, to ensure that every subject has the same probability of being chosen.

Tools of The Study
The data collected through the following tools:

- The Neonate's Medical Record (Admission Sheet) to obtain data related to the characteristics of the studied premature neonates about: mother name, gender, date of delivery, type of delivery, birth/ daily weight, gestational age, chronological age, medical diagnosis, and the length of the hospital stay.
- Physiologic Parameters Recording Sheet: presented in a special sheet designated by the researchers for measuring the physiological stability of the premature neonates. It included respiratory rate (RR), heart rate (HR) oxygen saturation (O^2 Sat.). According to Holditch-Davis et al., (2003) the operational definitions of the physiological indicators as:

• Heart rate (HR)	HR < 100 b. /m. Or > 160 b. /m., or an increase in baseline 5 b. /m. Or more.
• Oxygen saturation (O^2 Sat.)	<90 mg.% or a decrease of 2.5% or more
• Respiratory rate (RR)	Irregular, less than 40 breaths per minute or greater than 60 breaths per minute, or an increase in baseline 7 breaths per minute or more.

The researchers were counted the respiratory rate by number of times the neonates' chest rises, for one full minute. Heart rate & oxygen saturation was monitored and recorded from a pulse oximeter obtain the required data.

- Brazelton Neonatal Behavioral Assessment Scale (BNBAS) developed by Brazelton & Nugent (1997) was used to assess the premature neonates' neurobehavioral outcomes. It is a multidimensional, multi-item scale. The basic score sheet included 28 behavioral items and 18 reflex items. The clusters were as follows:
- Habituation, which included response decrement to light, bell, rattle and foot probe.
- Social interactive organization, which included animal visual, animate visual and auditory, inanimate visual, inanimate visual and auditory, inanimate auditory, animate auditory and alertness.
- Motor performance, which included general tone, motor maturity, pull to sit, defensive response and activity level.
- Range of states, which included peak of excitement, rapidity of buildup, irritability and liability of states.
- State regulation, which included cuddliness, consolability, self-quieting and hand to mouth.
- Autonomic stability, which included tremulousness, startles, liability of skin color and smiles.
- Reflexes

The behavioral items of BNBAS were scored 0 n 9 points (9 points represent the optimal status function or high level of functioning, 5 represents central level of functioning and 1 represents very low level of functioning). Reflex items were scored on 4 points (ranging from 0 to 3, where 3 points represents hyperactive response, 2 points represents normal response, 1 represents hypoactive response and 0 point represents reflex not able to be elicited despite several attempts).

Tools Validity and Reliability

Content validity was checked before the pilot study and the actual data collection, through distribution of the tools to five experts in the field of the study, with a covering letter and explanation sheet that explains the study purpose, objectives and other related information to ensure appropriateness, relevancy, clarity and completeness of the tool. Most of the tool items had consensus from the experts. Modifications and changes were introduced as required. Reliability was measured by using Alpha Chronbach's Coefficient, which was equal to (0.812).

Procedures:

The of sensory stimulation interventions protocol based on reviewing related literature (Nasimi, Zeraati, Shahinfar, Boskabadi, Ghorbanzade, 2016). Also, a group of five experts in neonatal nursing were reviewed the study intervention protocol and evaluated the tool content validity.

Ethics approval granted from the Scientific Research Ethical Committee of Faculty of Nursing, Ain Shams University. Oral consent obtained from each subject (parent of the premature neonates). The researchers explained the purpose and procedures of the study to the parent of the premature neonates included in the study. The rights of withdrawal from research at any time have explained to each parent. Also, parents of neonates were assured that the data collected would be kept confidential.

An official permission to carry out the study obtained through an issued letter from the Dean of the Faculty of Nursing / Ain Shams University to the director of each hospital to get the agreement to conduct the study.

A pilot study was applied on 10% (n=9) of the studied subjects (88) to test applicability, clarity of the study tool, to estimate the time needed to fill each tool, as well as to test the feasibility of the research process. The studied preterm neonates included in the pilot study were included in the study sample while there was no modification required in the study tools.

The actual fieldwork carried out during the period that started from January 2019 to the end of April 2019. Where, each researcher was available two days per week from 9 am to 4 pm to gather the necessary data and apply the sensory stimulation intervention using the previously mentioned study tools.

The researchers selected the premature neonates according to their eligibility criteria identified and recruited. The researchers greeted, introduced themselves to the parents of the neonate, explained the technique and purpose of the sensory stimulation interventions to obtain their agreement to participate in the study.

The baseline data were collected, which included characteristics of the studied as regard their names, medical diagnosis, gender, date of delivery, type of delivery, birth/ daily weight, gestational age and chronological age.

Implementation of The Study Interventions:

Study intervention method were included sensory stimulation interventions including; tactile stimulation, auditory stimulation, visual stimulation and vestibular stimulation (Nasimi et al., 2016).

For the study group, the sensory stimulation interventions were done by the researchers in the fifth day of life until stabilization of autonomic system and premature neonates' conditions. The sensory stimulation intervention sessions were applied twice per day one in the morning shift and one in the afternoon shift for five consecutive days with total of ten sessions, 14 minutes each time (5 minutes for tactile stimulation, 3 minutes for auditory stimulation, 3 minutes for visual stimulation and 3 minutes for vestibular stimulation) for 5 times a week until the day of discharge from NICU. The interventions started 30 minutes before feeding.

Tactile stimulation was performed for each premature neonate in the study group by massaging neonate's skin, from a head-to-toe direction over the neonate's entire body surface at a rate of 12 strokes per minute and in the following sequence: The premature neonate was placed in prone position and rubbed in circular motion by warmed palm of hand for 5 minutes period (1 minute for each region) from the neonate's head and face to the neck, from the neck across the shoulder, from the shoulder to the hand of both arms, from the upper back to the waist, from the thigh to the foot of both legs *(Sayed, Youssef, Hassanein and Mobarak, 2015).*

Auditory stimulation was done for each premature by speaking in a soft soothing voice and calling neonate's name for 3 minutes. The researchers avoided inappropriate stimulations through eliminated extra noises by turning suction off and avoid slamming portholes or striking incubators.

Visual Stimulation was done by hanging black and white cards inside the incubator for 3 minutes, placed within visual range (19-22 cm), and turned to the "Enface" position as neonates lie prone. ("Enface" aligns the eyes on the drawing and the neonate's eyes along the same vertical plane (Kanagasabai, Mohan, Lewis, Kamath, Rao Bhamini, 2013).

Vestibular stimulation: was done by gently swing the neonates in vertical and horizontal shaking for 3 minutes (Kanagasabai, et al., 2013).

During interventions, the premature infant was examined each 10 seconds regarding signs of stress including (facial grimace, finger splay, salute, yawning, breath hold and any color change). In case of observing one of the signs of stress, the intervention was stopped for 15 minutes and was started again after that. If any sign of stress was repeated for three times, the intervention was stopped in that interval.

Evaluation phase:

The neurobehavioral outcomes were assessed in the beginning of the study for every premature neonate in the study and control groups and reassessed after 5 days from implementing sensory stimulation sessions and before discharge. Any premature neonate died or not assessed on his/her discharge was excluded from the study.

The observations of HR, RR and SaO2 were observed and recorded before the application of sensory stimulation interventions. Once again, the observations were recorded at 60th minute & simultaneously recorded for the neonates of the study group. Similarly, the same parameters were observed and recorded before the routine care & once again at 60th minute & simultaneously recorded for the neonates of the control group. The same procedure was continued for five consecutive days, and the readings were recorded.

Data Analysis

All the data were checked carefully, immediately after collection to avoid any missing or wrongly entered data. Data were revised, coded, tabulated, analyzed, and presented using Statistical Package for Social Sciences (IBM SPSS V21), and the confounding factors have also been considered. Frequencies, percentages, arithmetic mean, and standard deviations were used for quantitative variables. Chi-square used for testing the difference between qualitative variables. The student t-test used for comparisons of quantitative variables between the control and study group. Data were analyzed applying appropriate statistical methods to determine the statistically significant differences as follows:

P-value ≤ 0.05= was considered significant statistical differences.

P-value >0.05= was considered non-significant statistical differences.

III. Results:

The two groups were homogenous regarding their demographic variables, gender and type of delivery. Also, there was no significant relationship between the two groups in terms of these variables. Moreover, based on statistical tests, there was not a significant difference between the two groups in terms of variables of their weight, gestational age at birth and post-natal age. Table (1): Concerning characteristics of the studied neonates, the results of the current study evident that birth weight of control group from 1000 -< 1500 (grams) was 54.5 % compared to 52.3 % of study group with mean birth weight 1482.27±99.367g and 1489.32±107.149g for control and study groups respectively. The mean gestational age of control group was 32.59± 0.996 compared to 32.61±.970 of study group. In addition, more than half the mean of premature

neonates in both the study and control groups were less than 10 days of post-natal (63.6% and 68.2% respectively) with mean age 10.27±1.835 and 9.66±1.855 for the control and study groups respectively.
It is clear from figure (1) that, 68.2% of the preterm neonates of the control group were girls compared to 63.6% of the study group.

Figure (2) showed that, 68.2% of the neonates of the control group were delivered by cesarean section compared to 59.1% of the study group.

Figure (3): the period of hospitalization in NICU for study group and control group were 19.27± 3.47 and 29.36±3.47 days, respectively, with statistically significant differences (t= 20.211).

Table (2) and figure (4): Based on intergroup comparison, the mean weight of neonates on the first day was 1559.77±36.088g in study group and 1505.58± 118.790 g in control group. On discharge, mean weight of neonates was 1936.05± 73.165g in study group and 1734.19± 77.926g in control group with the mean daily weight gain was 55.80±33g and 55.80±33 for study and control groups respectively. The intergroup test results demonstrated statistically significant differences between mean values of weight gain among the study and control groups after 5 days intervention (t-test 6.718) and (t-test 11.701) before discharge at P<0.05.

As regards the effect of sensory stimulation interventions on the values of physiological stability among the study and control groups table (3), the intergroup test results demonstrated that there is statistically significant difference between the two groups regarding heart rate. However, figure (5) showed that the mean heart rate of neonates on the first day was 153.9±3.6 in study group and 155.8±3.6 in control group. On discharge, mean heart rate of neonates was 141.5±7.7 in study group and 149.6±6.1 in control group with highly statistically significant difference between the two groups t- test 6.459 at (p=<0.001). On other hand, figure (6&7) indicated that, there is no significant differences between the two groups regarding respiratory rate and oxygen saturation after 5 days and throughout the days of the study intervention.

Table (4) illustrates the effect of sensory stimulation interventions on means of premature neonates' habituation and social interactive organization as neurobehavioral outcomes in the study and control groups. It was observed that the mean values of the premature neonates' habituation and social interactive increased for both the study and control groups after 5 days of intervention and on discharge. It is clear from the table that, the highest habituation responses on discharge of study intervention, the premature neonates' responses to light, bell, rattle and foot probe in both the study group were the highest habituation response, where their means were 6.84±0.7, 6.82±0.7, 6.91±0.6and 6.95±0.8for each among the study group compared to 3.80±0.5±0.5, 3.32±0.5, 3.48±0.6 and 3.91±0.5 for the control group respectively with statistically significant differences between both groups (t=0.000). On other hand, the means of the premature neonates' responses in all elements of social interactive organization in both the study and control groups increased on discharge than after 5 days with statistically significant differences found between the both groups (t=0.000).

Table (5) represents effect of sensory stimulation interventions on means of premature neonates' motor system, range of states as neurobehavioral outcome in study and control groups. It was noticed that, there are statistically significant differences between the study and control groups regarding all items of motor performance and range of state after five days of intervention and on discharge (t=0.000).

Table (6) regarding to neonate responses values of state regulation cuddliness & hand-to-mouth of control group after five day intervention ± SD 3.52±0.73 versus study group after five day intervention with ± SD 5.93±0.92 with t-test 13.16 and increase before discharge with t-test 32.50. also, there is statistically significant differences between both groups in all items of autonomic system after 5 days of intervention and on discharge (t=0.000).

Table (7) indicates effect of sensory stimulation interventions on means of premature infants' neurological reflexes as neurobehavioral outcomes in the study and control groups. a Statistical significant differences was found between the study and control groups after five days in all neurological reflexes (t=0.000) except planter reflex. It noticed also there were no statistical significant differences found between the two groups on discharge.

Table (1): Number and percentage distribution of the studied preterm neonates according to their demographic characteristics (no=88).

Characteristics	Total (No. = 88)				t-test
	Control group (n=44)		Study group (n =44)		
	No.	%	No.	%	
Birth weight (grams)					
• 1000 -< 1500	24	54.5	23	52.3	1.342
• 1500 -< 2000	20	45.5	21	47.7	
• ≥ 2000					
± SD	1482.27±99.367		1489.32±107.149		

Gestational age (weeks)					0.868
• 32-<34	35	79.5	33	75.0	
• 34 -≤37	9	20.5	11	25.0	
± SD	32.59± 0.996		32.61±.970		
Post-natal age (days)					2.838
• 1 -< 10	28	63.6	30	68.2	
• 10-< 20	16	36.4	14	31.2	
± SD	10.27±1.835		9.66±1.855		

∞ Statistical insignificant difference

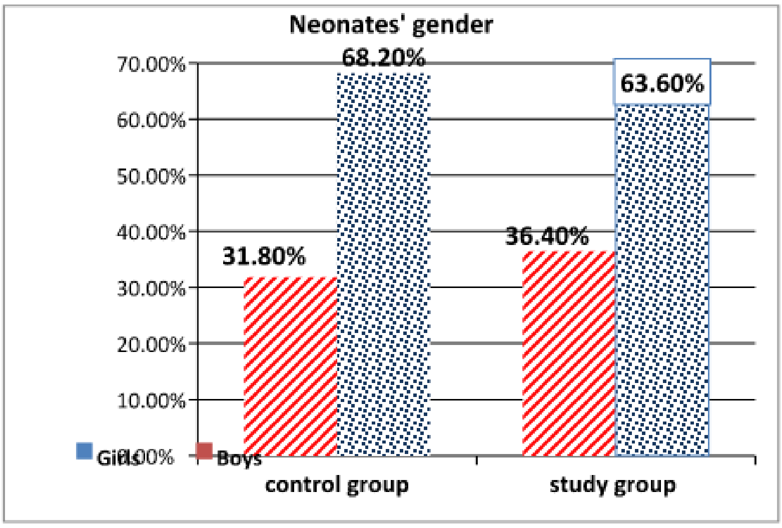

Figure (1): Percentage distribution of the studied neonates according to their gender (no=88).

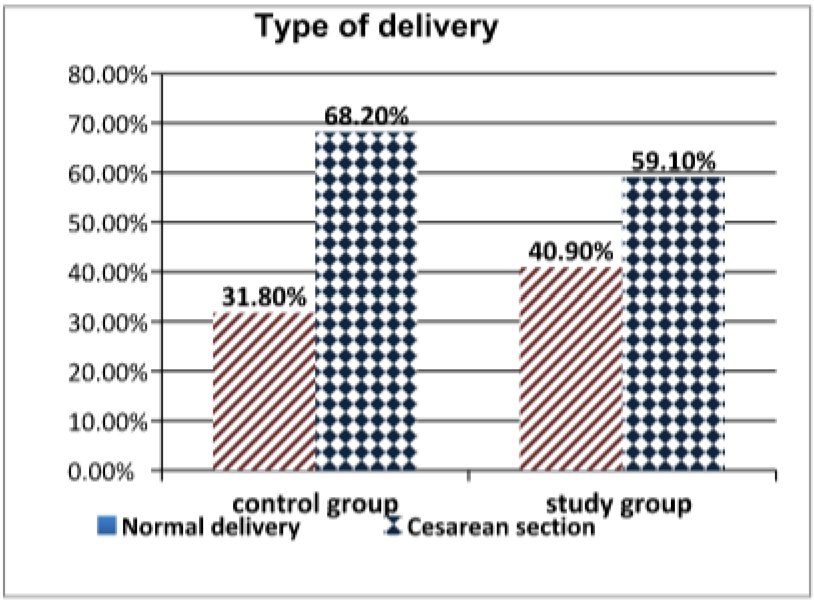

Figure (2): Percentage distribution of the studied neonates according to their type of delivery (no=88).

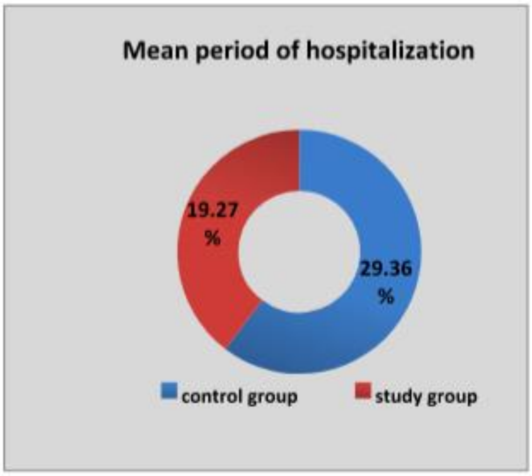

Figure (3): Percentage distribution of the studied neonates according to their mean period of hospitalization (no=88).

Table (2): Mean values of weight gain among both control and study groups (no=88).

Items	Total (No. = 88)		t-test
	Control (N =44)	Study (N =44)	
	Mean (SD)	Mean (SD)	
Weight gain (grams)			
• Initial day	1505.58± 118.790	1559.77±36.088	3.056
• After 5 days	1638.84±109.315	1748.58±36.218	6.718*
• On discharge	1734.19± 77.926	1936.05± 73.165	11.701*
Daily weight gain (grams)	36.64±23	55.80±33	

P-value ≤ 0.05= was considered significant statistical differences.
P-value >0.05= was considered non-significant statistical differences.

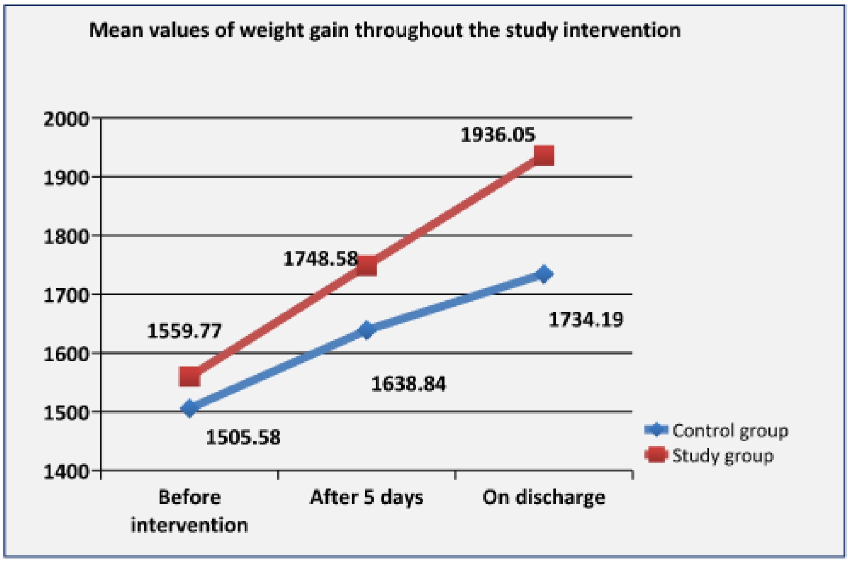

Figure (4): Mean values of weight gain among both control and study groups throughout the days of the study intervention (no=88).

Table (3): Effect of sensory stimulation interventions on the mean values of physiological outcomes among the study and control groups(no=88).

Physiological outcomes	Initial day		t-test	After 5 days		t-test	On discharge		t-test
	Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD	
Heart rates	155.8±3.6	153.9±3.6	3.805	150.7±4.8	144.8±5.7	6.276*	149.6±6.1	141.5±7.7	6.459*
Respiratory rates	55.6±4.8	54.1± 2.1	1.960	43.3±2.2	42.9±2.1	0.844	43.2±2.09	42.6±2.2	1.266
Oxygen saturation	94.9±0.5	94.9±0.5	0.323	94.8±0.3	94.8±0.4	1.000	95.4±0.5	95.4±0.6	1.000

P-value ≤ 0.05= was considered significant statistical differences.
P-value >0.05= was considered non-significant statistical differences.

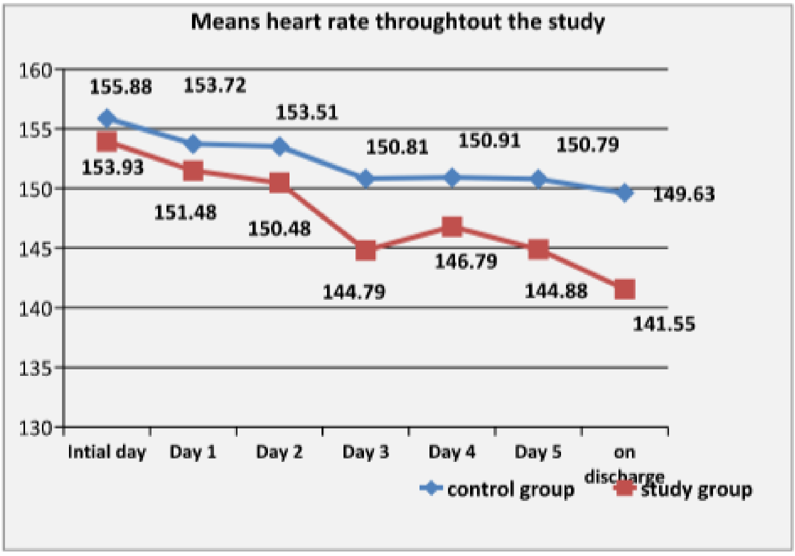

Figure (5): Mean values of heart rates among the study and control groups throughout the days of the study intervention(no=88).

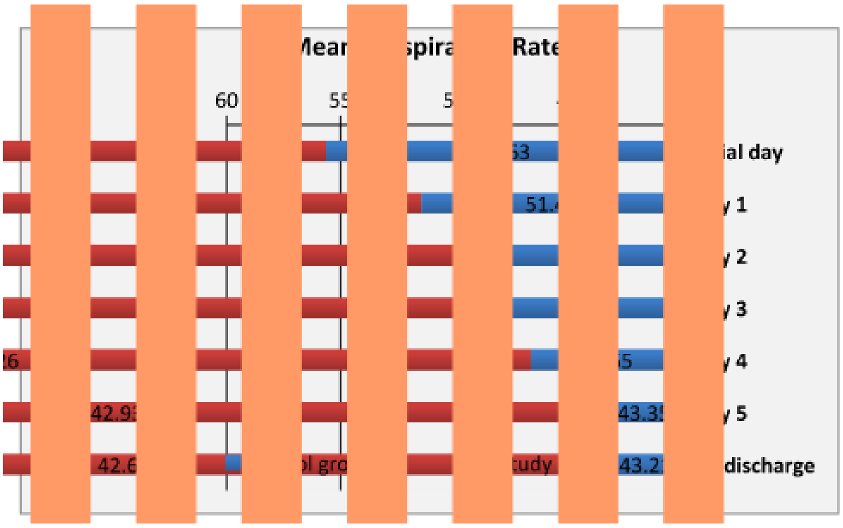

Figure (6): Mean values of respiratory rates among the study and control groups throughout the days of the study intervention (no=88).

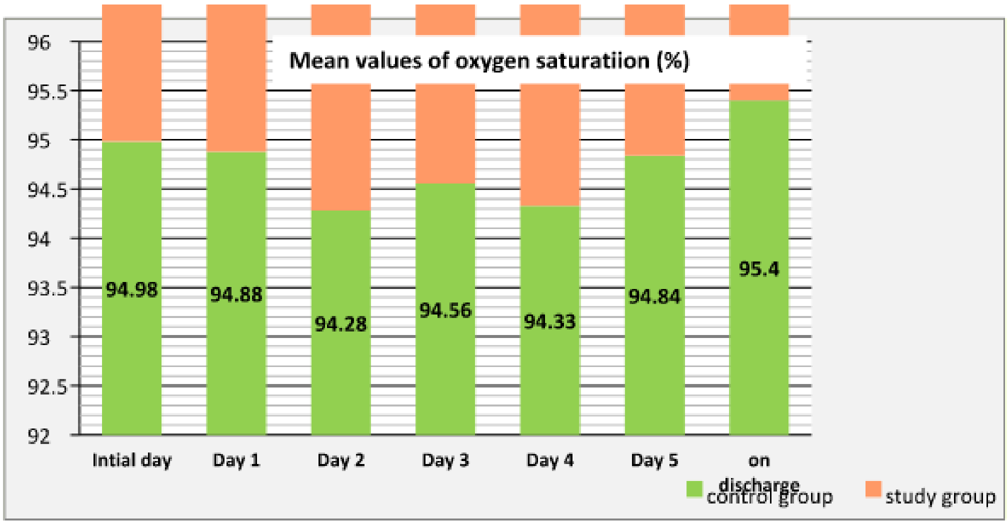

Figure (7): Mean values of Oxygen saturation among the study and control groups throughout the days of the study intervention(no=88).

Table (4): Effect of sensory stimulation interventions on the mean values of habituation and social interactive organization as neurobehavioral outcomes of study and control groups (no=88).

Neonates' responses	Initial day		t-test	After 5 days		t-test	On discharge		t-test
	Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD	
Habituation: • Light	1.57±0.6	1.57±0.5	1.22	2.45±0.5	4.48±0.7	16.34 *	3.80±0.5	6.84±0.7	26.02*
• Bell	1.34±0.5	1.50±0.5	1.85	2.16±0.6	4.52±0.8	17.58 *	3.32±0.5	6.82±0.7	23.77*
• Rattle	1.25±0.4	1.50±0.5	2.34	2.16±0.6	4.48±0.7	16.91 *	3.48±0.6	6.91±0.6	26.06*
• Foot probe	1.48±0.5	1.51±0.5	0.33	2.36±0.4	4.50±0.7	17.17 *	3.91±0.5	6.95±0.8	20.69*
Social interactive: • Animate visual	1.31±0.5	1.36±0.4	0.70	2.36±0.5	4.61±0.7	20.07 *	3.56±0.5	7.11±0.8	20.44*
• Animate visual & auditory	1.22±0.4	1.27±0.5	0.46	2.45±0.5	4.59±0.6	19.88 *	3.47±0.6	7.18±0.9	19.96*
• Auditory inanimate visual	1.09±0.5	1.30±0.5	1.64	2.38±0.5	4.57±0.6	20.93 *	3.56±0.6	7.23±0.8	20.23*
• Inanimate visual & auditory	1.38±0.5	1.34±0.5	0.46	2.54±0.6	4.59±0.6	15.75 *	3.63±0.6	7.20±0.8	20.96*
• Inanimate auditory	1.22±0.6	1.16±0.6	0.57	2.52±0.5	4.61±0.6	18.70 *	3.63±0.6	7.20±0.8	20.59*
• Animate auditory	1.15±0.6	1.16±0.6	0.36	2.45±0.6	4.61±0.7	16.63 *	3.62±0.6	7.31±0.8	20.75*
• Alertness	1.04±0.4	1.11±0.5	0.65	2.31±0.5	4.70±0.7	17.19 *	3.54±0.7	7.29±0.8	20.67*

P-value ≤ 0.05= was considered significant statistical differences.
P-value >0.05= was considered non-significant statistical differences.

Table (5): Effect of sensory stimulation interventions on the mean values of motor performance, range of state as neurobehavioral outcomes of study and control groups (no=88).

Neonates' responses	Before intervention		t-test	After 5 days		t-test	On discharge		t-test
	Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD	
Motor performance:	1.13±0.4	1.27±0.5	1.35	2.52±0.73	4.84±0.74	19.71*	3.40±0.54	7.59±0.94	25.09*

• General tone	6	4							
• Motor maturity	1.09±0.60	1.06±0.54	0.167	2.31±0.47	4.81±0.72	17.33*	3.50±0.54	7.56±0.92	27.7*
• Pull-to-sit	1.11±0.57	1.27±0.62	1.47	2.40±0.62	4.93±0.75	16.73*	3.52±0.62	7.68±1.0	23.77*
• Defensive	1.36±0.74	1.09±0.60	2.07	2.56±0.58	4.65±0.71	16.17*	3.86±0.63	7.43±0.89	22.68*
• Activity level	1.20±0.66	1.25±0.61	0.388	2.61±0.68	4.65±0.60	14.83*	3.70±0.66	7.38±0.92	20.41*
Range of state: • Peak of excitement	1.27±0.65	1.34±0.56	0.553	2.52±0.54	4.84±0.74	19.21*	3.70±0.66	7.86±0.90	23.37*
• Rapidity of build –up	1.36±0.65	1.36±0.57	0.245	2.56±0.53	4.97±0.92	16.43*	3.84±0.77	7.95±0.91	20.74*
• Irritability	1.36±0.60	1.40±0.62	0.474	2.65±0.74	5.04±0.96	13.57*	3.97±0.87	8.04±0.88	21.33*
• Liability of state	1.35±0.65	1.42±0.62	0.338	2.56±0.45	5.52±0.92	17.18*	4.09±0.74	8.22±0.85	2302*

P-value ≤ 0.05= was considered significant statistical differences.
P-value >0.05= was considered non-significant statistical differences.

Table (6): Effect of sensory stimulation interventions on the mean values of state regulation and autonomic system as neurobehavioral outcomes of study and control groups (no=88)..

Neonates' responses	Before intervention		t-test	After 5 days		t-test	On discharge		t-test
	Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD	
State regulation: • Cuddliness	1.43±0.66	1.47±0.62	0.292	3.52±0.73	5.93±0.92	13.16*	4.29±0.50	8.31±0.73	32.50*
• Consolability	1.31±0.63	1.40±0.62	0.585	3.45±0.69	5.97±0.95	13.05*	4.31±0.56	8.25±0.71	30.18*
• Self-quieting	1.47±0.66	1.31±0.67	0.045	3.59±0.68	6.0±0.86	13.45*	4.43±0.50	8.15±0.80	24.80*
• Hand-to-mouth	1.36±0.68	1.38±0.65	0.144	4.02±0.67	5.93±0.94	10.75*	4.50±0.59	8.38±0.75	31.70*
Autonomic System: • Startles	1.32±0.60	1.42±0.65	0.244	3.32±0.52	4.46±0.62	14.55*	4.29±0.50	6.38±0.77	22.10*
• liability of skin color	1.92±0.65	1.78±0.57	0.166	3.55±0.52	4.72±0.70	10.75*	0.50±4.29	0.95±7.58	*26.28
• Smiles	0.62±1.34	1.72±0.58	0.242	3.46±0.82	4.48±0.81	13.61*	0.50±4.29	0.75±6.69	*22.18

P-value ≤ 0.05= was considered significant statistical differences.
P-value >0.05= was considered non-significant statistical differences

Table (7): Effect of sensory stimulation interventions on the mean values of neurological reflexes as neurobehavioral outcomes of study and control groups (no=88).

Neurological Reflexes	Before intervention		t-test	After 5 days		t-test	On discharge		t-test
	Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD		Control group ± SD	Study group ± SD	
• Planter	1.4±0.6	1.4±0.5	1.212	1.92±0.22	2.2±0.72	1.17	2.21±0.3	2.41±0.4	1.02
• Babinski	1.4±0.6	1.4±0.3	0.555	1.66±0.5	1.9±0.85	0.03*	2.14±0.5	2.26±0.8	0.65
• Rooting	1.2±0.7	1.1±0.6	0.534	1.42±0.4	2.1±0.54	0.00*	2.54±0.6	2.65±0.6	0.107
• Suckling	1.3±0.6	1.2±0.6	0.122	1.8±0.55	2.1±0.22	0.00*	2.22±0.3	2.28±0.3	1.00
• Palmer	0.8±0.6	0.7±0.6	0.644	1.6±0.42	2.1±0.44	0.00*	2.42±0.6	2.36±0.5	1.00

• Standing	0.9±0.8	0.8±0.7	0.245	1.65±0.4	1.8±0.74	0.15 *	0.54±2.4	0.66±2.48	1.02
• Tonic neck	1.1±0.3	1.1±0.3	0.526	1.8±0.5	1.9±0.32	0.00 *	2.54±0.41	2.69±0.42	1.00
• Moro	1.1±0.4	1.1±0.3	0.269	1.6±0.43	2.2±0.62	0.00 *	2.21±0.32	2.26±0.42	1.00

P-value ≤ 0.05= was considered significant statistical differences.
P-value >0.05= was considered non-significant statistical differences

IV. Discussion

As regards to current study, it was demonstrated that prematurity is associated with higher rates of deficiencies in sensory processing skills and that individualized sensory integration intervention is effective in improving physiological stability and neurobehavioral outcomes of premature neonates.

Concerning to the current studied neonate's characteristics, evident that birth weight of control group from 1000 -< 1500 (grams) was 54.5 % compared to 52.3 % of study group. The gestational age of control group from 32-<34(weeks) was 32.59± 0.996 and was 32.61±.970 of study group on other hand, post-natal age from 1 -< 10 (days) of control group was 63.6 % compared to 68.2 % of study group post-natal age

As regards distribution of the studied neonates according to their gender shown from figure (1), 68.2% of the premature neonates of the control group were boys compared to 63.6% of the study group.

Results of this study indicated that mean daily weight gain of the study group was 55.80±33g compared to 36.64±23g in the control group and there was a significant difference between the two groups regarding mean weight gain during the phases of study interventions. In addition, the results of this study are in the same line with the study of Nasimi et al., (2016) who study the effect of multisensory stimulation on weight gain of premature infants. They reported that despite the same level of calorie reception in both groups, the intervention group gained more weight compared with control group and there was a significant difference between the two groups. Also, these results were disagreement with Rocha, Moreira, Pimenta, Ramos and Lucena, (2007) about the efficacy of sensory-motor-oral stimulation and non-nutritive sucking in very low birthweight infant found that there were no significant effects of sensory-motor-oral stimulation and non-nutritive sucking on weight gain in the first week. However, according to a study by Fucile and Gisel, (2010) about sensorimotor interventions improve growth and motor function in preterm infants. They found that preterm infants receiving sensory, motor and oral stimulations alone or in combination with sensory, motor and touch interventions gained more weight. Despite similarity in the level of calories received by both groups, the weight gain in multisensory stimulation group was significantly higher than control group.

From the researchers' point of view, it could be due to when premature neonates are exposed to sensory stimulation, it may improve their feeding behaviors and increase their readiness for feeding and thus improve their weight gain.

Table (4) highlighted that, the premature infants who received tactile stimulation showed better performance on the Brazelton Scale after 5 days and on discharge, specifically in the areas of habituation behavior than the premature infants who didn't receive such stimulation. Habituation behavior represents the premature infants' abilities to decrease their responses to disturbing or repeated stimuli namely light, rattle, bell and tactile stimulation to the foot, to maintain their sleeping state. This study finding was supported by Wahyutami, et al (2010), Diego, et al (2007) and Field, et al (2005).

As regards the premature infants who received tactile stimulation scored better on Brazelton behavior assessment scale after 5 days and on discharge in terms of social interactive than those who didn't receive such stimulation. Social interactive behaviors include inanimate visual, inanimate auditory, animate visual, animate auditory, animate visual and auditory, inanimate visual & auditory and alertness. The premature infants who received the tactile stimulation had better ability to follow and keep their interest to red ball in animate and inanimate visual and to rattle in animate auditory. They also had better coordination between eye movement and neck to process all information from surrounding when they saw the red ball, heard a rattle in social interactive score and became more alert than the premature infants who didn't receive tactile stimulation. These findings were congruent with Radwan (2014), Wahyutami, et al (2010), Kulkarni, et al (2010), Arora, et al (2005), Mullany, et al (2005), Field, et al (2004), Mathai, et al (2001) and Kuhn et al (1991)

Results of the current study demonstrated that nearly all the premature infants who received tactile stimulation had better scores regarding neurological reflexes on Brazelton scale than the premature infants who didn't received such stimulation after 5 days. While, no difference was found on discharge between the two groups (study and control groups). These results might be related to the improvement of neurological reflexes of premature infants which are considered criteria for their discharge even for premature infants of study or control groups; where premature infants should be discharged with good or fair reflexes. This finding was congruent with the studies of Wahyutami, et al (2010), Kulkarni, et al (2010), Mathai, et al (2001).

Conclusion

Based on the present study findings, the researchers concluded that premature neonates who receive sensory stimulation interventions including (tactile, auditory, visual and vestibular sensory stimulation interventions) had better physiological stability, weight gain and better neurobehavioral outcomes than those who didn't receive them and had only routine hospital care.

V. Recommendations:

Based on the results of the current study, the following recommendations were suggested:

- Evolving sensory stimulation interventions in the routine nursing care for stabilized premature neonates in NICUs.
- Providing on job training programs for neonatal nurses about sensory stimulation interventions focusing on improve their practical skills.
- Study the effect of integrated sensory stimulation interventions on preterm neonates on a larger sample size and over a longer period.
- Investigate the effect of different types of sensory stimulation in early childhood development.
- Further application of sensory stimulation interventions for other neonatal nursing focusing on the nurses practical skills is mandatory.

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