

Effect of Foot Reflexology on Physiological Index for Neonates with Hyperbilirubinemia at Neonatal Intensive Care Unit

Noura M. Mahdy¹, Hekmat E. Abed El Kreem², Nahed T. Mohamed³ & Safwat M. Abdel Aziz⁴

¹ Corresponding Author, Assistant Lecturer at Pediatric Nursing Department, Faculty of Nursing, Assiut University, Egypt

² Professor of Pediatric Nursing, Faculty of Nursing, Assiut University, Egypt.

³ Professor of Pediatric Nursing, Faculty of Nursing, Assiut University, Egypt.

⁴ Assistant Professor of Pediatrics, Faculty of Medicine, Assiut University, Egypt.

Abstract

Background: Neonatal hyperbilirubinemia is one of most common issues at neonatal stage, as a result, foot reflexology is one of the most popular forms of therapy and is useful for both preserving and treating health. **Aimed of the present study** was to determine the effect of foot reflexology on physiological index for neonates with hyperbilirubinemia at Neonatal Intensive Care Unit **Design:** A quasi-experimental research design was utilized. **Setting:** Neonatal Intensive Care Unit (NICU) at Assiut University Children Hospital. **Subjects:** A convenience sample included sixty neonates with hyperbilirubinemia. **Tools:** Two tools were utilized to gather the required data. **(tool 1)** structure questionnaire form, **(tool 2)** The physiological index evaluation form. **Results:** On the fifth day following the foot reflexology intervention, neonates in the study group's mean heart rate was 144.50±5.84 b/m, while those in the control group was 141.30±6.37 b/m. Neonates in the study and the control groups' mean respiratory rates were 46.20±5.52, 44.13±4.36 c/m respectively. Mean oxygen saturation was 94.13±1.35, and 91.93±0.82 for neonates in the study and the control groups respectively. **Conclusion:** Foot reflexology had an influential effect on stabilization and improving physiological index for neonates with hyperbilirubinemia. **Recommendations:** Foot reflexology is a safe, economical, and well-tolerated modality for neonates and it should be considered as an adjunctive modality that is integrated into nursing care.

Keywords: Foot reflexology, Hyperbilirubinemia, Neonates & Physiological Index.

Introduction:

Neonatal hyperbilirubinemia is a yellowish coloring of the skin, sclera, and mucous membranes of neonates caused by an elevated level of serum bilirubin in the bloodstream. Both conjugated and unconjugated bilirubin can build up in the blood and induce hyperbilirubinemia; however, unconjugated bilirubin accumulation accounts for the majority of neonatal hyperbilirubinemia. Hyperbilirubinemia is a common health issue in both term and late preterm neonates; in the first week of life, it affects about 60% of term and 80% of preterm neonates (Guindy et al., 2022).

One of the byproducts of hemoglobin breakdown is bilirubin, which its increase in neonates can cause its deposition on the skin, mucous membranes and lead to neonatal jaundice. In nearly 5% of cases of neonatal hyperbilirubinemia had kernicterus that is a potentially deadly consequence and can be brought by high bilirubin levels. Additionally, 80% of survivors encountered neurodevelopmental problems such mental retardation, motor disorders, seizures, hearing loss, and speech abnormalities. For this reason, it is essential to diagnose and treat neonates with hyperbilirubinemia as soon as possible (Abdellatif et al., 2020).

Hyperbilirubinemia can currently be treated with a variety of techniques, including phototherapy, blood exchange transfusion, and pharmaceutical treatment. However, phototherapy is the primary mode of treatment (Boskabadi et al., 2021). It entails applying fluorescent light on the neonates' naked skin in order to facilitate bilirubin excretion by photoisomerization, that process changes bilirubin's structures from the insoluble to the soluble form for simpler excretion (Kassem & Ismail, 2021). Numerous short- and long-term adverse effects, including dehydration, transient skin rashes, mild hyperthermia, retinal and DNA damage and epilepsy, have been associated with phototherapy. Therefore, it's critical to shorten the duration of phototherapy and identify alternative therapeutic approaches in order to lessen side effects and reduce neonatal jaundice by promoting bowel movements, facilitating meconium excretion, and lowering bilirubin levels (Acharya & Paneru, 2021).

Reflexology can be defined as, the science of stimulating points located in the hands, ears, and feet that correspond to the internal organs of the body. Foot reflexology is one of the most popular forms of therapy in the world, and it's useful for both maintaining health and treating illnesses. It is one of

complementary and alternative therapy to improve neonatal physiological index with hyperbilirubinemia (Jazayeri et al., 2021).

Moreover, foot reflexology promotes calmness, healthy immune and digestive systems in addition to stabilizing neonatal physiological indexes such as heart rate, respiration rate, and oxygen saturation (Oshvandi et al., 2019). Additionally, foot reflexology contributes to weight gain, a sense of security, as well as promotes the physical, mental, and emotional development of neonates (Smith et al., 2022).

Neonatal nurses are key persons in NICU and they have a proactive role in assessment and treatment of neonatal hyperbilirubinemia. So that, they should be equipped with the most innovative evidences in neonatal care. To improve the quality of care and preserve the best long-term outcomes for neonates, neonatal nurses should be aware of the most effective complementary and alternative therapies, such as foot reflexology (Sheikhi et al., 2022).

Significance of the study:

Today, a few clinical trials have been conducted to find out how foot reflexology affects the physiological index for neonates with hyperbilirubinemia. Worldwide, the incidence of neonatal jaundice is approximately 89,000 per 100,000 neonates, thus affecting 119,000 or more neonate each year (Ruud, 2021). Throughout scientific examination at (NICU) in Assiut University Children Hospital, it was observed that, the number of neonatal with hyperbilirubinemia was increasing continuously and the incidence of neonatal jaundice in the previous two years was 40.3% of the total admission to NICU (Unpublished Statistical Records, NICU Assiut University Children Hospital, from 2021 to 2022). Therefore, the main aim of this study was to determine the effect of foot reflexology on the physiological index for neonates with hyperbilirubinemia.

Aim of the study:

Aimed of the present study was to:

Determine the effect of foot reflexology on the physiological index for neonates with hyperbilirubinemia.

Research hypothesis:

1. Neonates with hyperbilirubinemia who received foot reflexology intervention exhibited improvement in their physiological index than those in the control group.
2. There were a significant relation association between the physiological index among neonates with hyperbilirubinemia with their selected demographic variables.

Null hypothesis:

1. Neonates with hyperbilirubinemia who received foot reflexology intervention were just as likely as those in the control group related to improvement in their physiological index.
2. There were no a significant relation association between the physiological index among neonates with hyperbilirubinemia with their selected demographic variables.

Subjects and Method:

Research design: A quasi-experimental research design was utilized to collect data for the present study.

Setting: This study was conducted at NICU in Assiut University Children Hospital that served as study's location. This unit serves multiple provinces, ranging from EL-Minia to the Red Sea province. It has 60 incubators and admits about 134 neonates per month. NICU contains 13 rooms, an examination room, seven rooms for care of neonates with critical condition, a bed room for stable neonates who were only receiving phototherapy, a feeding preparation, a clinical pharmacy, incubator sterilization, and breastfeeding rooms. Twelve mechanical ventilators are also available in the NICU for critically ill neonates.

Subjects: A convenient sample included sixty neonates with hyperbilirubinemia. They were chosen and divided into two groups randomly:

Group I study group: Consisted of neonates who received foot reflexology intervention.

Group II control group: Consisted of neonates who received standard hospital care.

Inclusion criteria included:

- Neonates with hyperbilirubinemia, who were 5-28 days, had a gestational age of 37- 40 weeks, weight more than 2500g at birth, serum bilirubin level of 15- 20 mg/dl and consume feeding 150cc or more per day.
- Neonates with stable hemodynamic conditions.

Exclusion criteria included:

- Neonates without any neurological conditions, congenital abnormalities, or chronic diseases.
- Neonates who were free from diseases such as hypothyroidism, congenital heart disease, ABO and Rh incompatibility and gastrointestinal issues that could cause neonatal jaundice.

Data collection tools:

Tool one: Structure Questionnaire Form:

It was developed by the researcher to gather the necessary data and had three parts:-

Part one: Biosocial data of neonates such as (Gestational age, gender, neonate's age, residence, neonate's weight at birth and birth order).

Part two: Medical data such as (Diagnosis, birth date, date of admission, method of feeding, weight, total serum bilirubin level on admission and date of discharge).

Part three: Maternal data such as (Mother's age, mother's education, mother's occupation, number of gravidities, number of parties, place, type of delivery and if presence any maternal illness).

Tool two: Physiological index assessment form:

The researcher assessed the effect of foot reflexology on physiological indexes, such as (heart rate, respiratory rate and oxygen saturation). Physiological indexes were monitored and recorded for each neonate before and after foot reflexology intervention for five consecutive days and the results were then compared between the two groups.

Method of data collection:

- An official permission was obtained from the chairmen of NICU in Assiut University Children Hospital to collect the necessary data for this study.
- Six (10%) neonates participated in a **pilot study** to test the tools' clarity and applicability as well as to estimate the time needed to complete it. These participants were not included in the study's total sample. The final form was developed and no modifications were made.
- Written parent consent for participation of their neonates in the study was obtained after explaining the aim of the study and confidentiality of obtained data.
- **Validity of** tools was tested by using contents validity index by 5 jures in both pediatric nursing and pediatrics fields and its result was 0.953.
- **The reliability** of tool two was measured using Cronbach's alpha coefficient for neonatal assessment sheet, which was found $r = 0.91$ by (Jazayeri et al., 2021).

Interventions:

- The actual work started when researcher attended at NICU and took all neonates with hyperbilirubinemia, then assigned the neonates randomly to the study and the control groups.
- Neonates in the control group received standard hospital care, which included nursing them in an overhead radiant warmer bed to maintain a suitable neutral thermal environment, monitoring their skin and eyes every two hours when they were received feeding, and starting phototherapy as a non-invasive treatment for faster excretion through the stool and urine.
- Neonates in the study group received all standard hospital care and foot reflexology intervention as the following:
 - The neonate was placed in a supine position with its head raised 35 degrees, and the researcher was

seated in front of the neonate's feet in a relaxed and comfortable position. Subsequently, using reflexology charts as a guide, the researcher conducted foot reflexology.

- Foot reflexology intervention was performed once a day for 20 min on both feet (10 minutes for each foot) for five consecutive days. Reflexology for the solar plexus reflex point performed by using the thumb walking technique and repeat this movement several time for each foot to improve physiological index for neonates.

Field of the work:

Six months, from the beginning of November 2022 to the end of April 2023, were dedicated to conduct this study. The researcher performed foot reflexology guided by points location according to reflexology charts. Foot reflexology intervention was performed once a day for five consecutive days, 20 min on both feet. To improve the physiological indexes for neonates, foot reflexology for the solar plexus reflex point is carried out on each foot using the thumb walking technique.

Fidelity of the study:

The researcher received training on foot reflexology techniques and massage at the Department of Physical Medicine and Rehabilitation which is located on the first floor of the Main Assiut University Hospital. The researcher received training on these techniques three days a week on (Sunday, Tuesday, and Thursday) for two months and was given a certificate which was signed by the head of the Department.

Ethical considerations:

Research proposal was approved from Ethical Committee in the Faculty of Nursing, Assiut University. Parents received assurances that the research's data would only be utilized for that purpose. Informed consent was obtained from neonates' parents after explaining the purpose of the study. Confidentiality and anonymity were guaranteed. Parents had the right to refuse to participate or withdraw their neonates from the study at any time without any effect on the care provided for their neonates.

Statistical analysis of data:

SPSS V.26 was used to organize, categorize, code, tabulate and analyze the acquired data. Numbers, percentages, averages and standard deviations were used to portray data in tables and charts. The Pearson correlation between variables was employed, chi-square test was performed to ascertain statistical significance. T-test was used to compare the means of variables. P-value of 0.05 was considered statistically significant.

Results:**Table (1): Percentage distribution of the studied neonate's regarding their maternal data (n= 60):**

Maternal data	Study group (n=30)		Control group (n=30)		P value
	No.	%	No.	%	
Mother's age/ year:					
▪ < 25	6	20	3	10	0.532
▪ 25: < 35	14	45.7	12	40	
▪ 35 and more	10	34.3	15	50	
Mean ± SD	31.73±7.42		35.26±6.66		0.052
Mother's level of education:					
▪ Illiterate	3	10	2	6.7	0.605
▪ Read and write	2	6.7	1	3.3	
▪ Basic Education	2	6.7	6	20	
▪ Secondary Education	12	39.9	10	33.3	
▪ Bachelor degree or others	11	36.7	11	36.7	
Mother's occupation:					
▪ Housewife	18	60	19	63.3	0.794
▪ Employee	12	40	11	36.7	
Place of delivery:					
▪ Hospital	20	66.7	20	66.7	1.0
▪ Private clinics	10	33.3	10	33.3	
Type of delivery:					
▪ Normal vaginal delivery	12	40	6	20	0.093
▪ Caesarean section	18	60	24	80	
Presence any maternal illness:					
▪ No illness	19	63.3	17	56.7	0.412
▪ Diabetes mellitus	7	23.4	5	16.6	
▪ Pregnancy induced hypertension	4	13.3	8	26.7	

*Statistically significant difference *t*-test was used *chi square test* was used

Table (2): Percentage distribution of the studied neonate's regarding their personal data (n= 60):

Biosocial data	Study group (n=30)		Control group (n=30)		P- value
	No.	%	No.	%	
Gestational age/ weeks:					
▪ 37- < 40	30	100	30	100	0.872
Mean ± SD	37.80±0.76		37.80±0.76		
Gender:					
▪ Male	15	50	10	33.3	0.195
▪ Female	15	50	20	66.7	
Neonate's age/ day:					
▪ 1: < 7 day	24	80	25	83.3	0.486
▪ 7: < 14 days	6	20	5	16.7	
Mean ± SD	4.46±2.16		4.80±1.44		0.736
Residence:					
▪ Urban	20	66.7	15	50.0	0.192
▪ Rural	10	33.3	15	50.0	
Neonate's weight at birth/ grams:					
▪ 1000: < 3000g	22	73.3	25	83.3	0.345
▪ ≥ 3000g	5	16.7	8	26.7	
Mean ± SD	2.86±0.2		2.76±0.18		0.052
Birth order:					
▪ First	6	20	2	6.7	0.416
▪ Second	9	30	13	43.3	
▪ Third	11	36.7	10	33.3	
▪ Fourth or more	4	13.3	5	16.7	

*Statistically significant difference

Table (3): Percentage distribution of the studied neonate's regarding their medical data (n= 60):

Medical data	Study group (n=30)		Control group (n=30)		P value
	No.	%	No.	%	
Diagnosis: ▪ Neonatal jaundice	30	100.0	30	100.0	1.0
Methods of feeding:					
▪ Bottle feeding only	24	80	22	73.3	
▪ Breast feeding & Bottle feeding	6	20	8	26.7	
Mean Weight on admission	2.86±0.2		2.76±0.18		0.052
Mean Total serum bilirubin level on admission	16.68±0.89		16.99±0.83		0.174

*Statistically significant difference

Table (4): Effect of foot reflexology on the studied neonate's mean of heart rate for five consecutive days (n= 60):

Heart rate (b/m)	Before application of foot reflexology		P value	After application of foot reflexology		P value
	Study Group(n=30)	Control Group(n=30)		Study Group(n=30)	Control Group(n=30)	
The First Day	145.06±6.89	142.36±6.51	0.125	147.90±6.81	143.166±6.14	0.006*
The Second Day	144.50±6.24	141.166±6.29	0.043*	147.13±6.63	141.70±5.94	0.001*
The Third Day	143.33±6.08	141.00±6.75	0.156	146.63±5.76	141.70±6.06	0.002*
The Fourth Day	142.53±5.85	142.36±6.13	0.915	146.00±5.64	143.46±4.86	0.006*
The Fifth Day	140.86±7.17	140.40±6.43	0.799	144.50±5.84	141.30±6.37	0.004*

*Statistically significant difference *t*-test was used

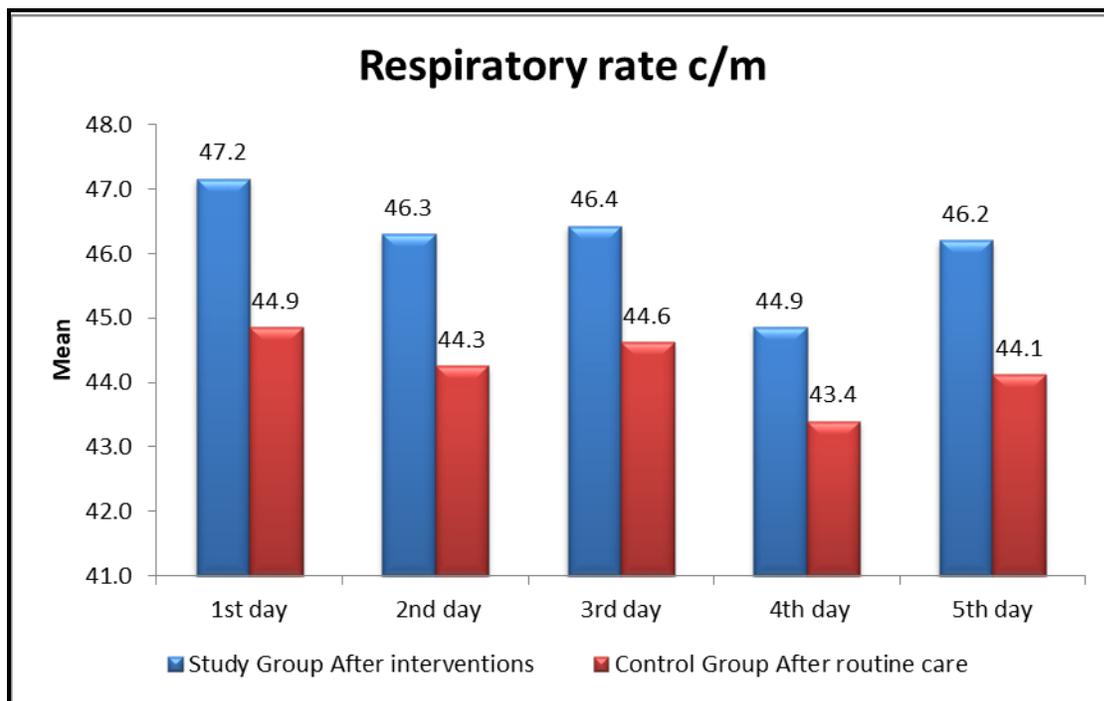


Figure (1): Effect of foot reflexology on the neonates' mean of respiratory rate for five consecutive days

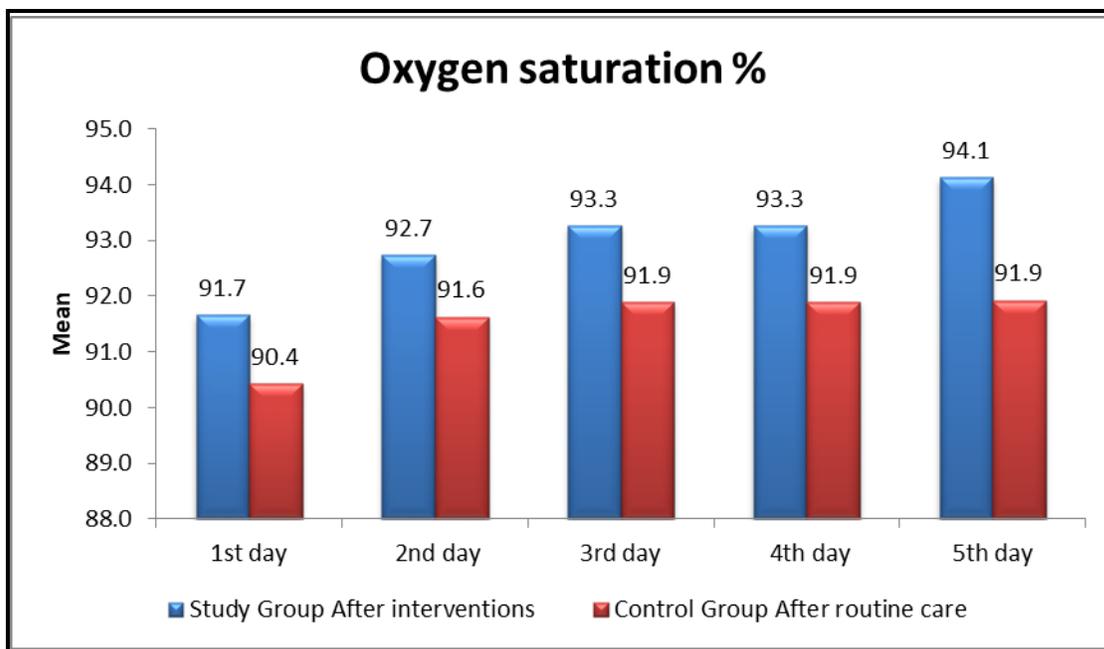


Figure (2): Effect of foot reflexology on the neonates’ mean of oxygen saturation for five consecutive days

Table (5): Comparison of mean of physiological index among neonates in the study group after intervention and the control group for five consecutive days (n= 60):

Days	Heart Rate		P value	Respiratory Rate		P value	O2 saturation		P value
	Study group (n=30)	Control group (n=30)		Study group (n=30)	Control group (n=30)		Study group (n=30)	Control group (n=30)	
The First Day	147.90±6.81	143.166±6.14	0.006*	47.16±4.77	44.86±5.43	0.083	91.66±1.26	90.43±0.93	0.000*
The Second Day	147.13±6.63	141.70±5.94	0.001*	46.30±3.81	44.26±5.19	0.081	92.73±1.08	91.63±1.21	0.001*
The Third Day	146.63±5.76	141.70±6.006	0.002*	46.43±3.90	44.63±4.67	0.114	93.26±1.36	91.90±0.88	0.001*
The Fourth Day	146.00±5.64	143.46±4.86	0.006*	44.86±3.84	43.40±4.66	0.184	93.26±1.36	91.90±0.88	0.000*
The Fifth Day	144.50±5.84	141.30±6.37	0.004*	46.20±5.52	44.13±4.36	0.112	94.13±1.35	91.93±0.82	0.000*

*Statistically significant difference t-test was used

Table (1): Illustrates percentage distribution of the studied neonate's regarding their maternal data. Findings revealed that, no statistical significant differences were found between mothers in the study and the control groups related all items in the table except their age. Regarding the mother's age, (45.7%) of the mothers in the study group compared to (40%) of them in the control group, their age was ranged between 25: < 35 year. According to mother's level of education, it was found that, (39.9%) of them in the study group had secondary level of education compared (33.3%) of them in the control group. In addition, the results indicated that, (60 % & 63.3%) of the mothers in the study and control groups respectively were housewife. Moreover, the findings found that, the same percentage of the mothers in the

two groups (66.7%) were delivered in the hospital. The current study illustrated that, more than half (60%) of the mothers in the study group compared to (80%) of them in the control group were delivered by caesarean section. Finally, the results found that, (63.3%) compared with (56.7%) of the mothers in the study group and control group respectively had no illness.

Table (2): Indicates percentage distribution of the studied neonate's regarding their personal data. Findings revealed that, no statistical significant differences were found between neonates in the study and the control groups related all items in the table except their weight at birth. All of the studied neonates (100%) were in gestational age 37-< 40 weeks with mean ± SD 37.80±0.76 & 37.80±0.76 for

the study and the control groups respectively. As regard of gender, it was found that (50%) of neonates in the study group were females compared with (66.7%) of them in the control group. Regarding the neonate's age/ day, the results indicated that, (80% & 83.3%) of them in the study and the control groups respectively had 1:< 7 days. According to residence, more than two-thirds and half of neonates (66.7% & 50%) in the both groups respectively were from urban areas. Moreover, as regards the neonate's weight at birth/ grams the results found that, (73.3%) of neonates in the study group and the most (83.3%) of neonates in the control group had 1000 :< 3000g. As regards birth order, the table revealed that (36.7%) of neonates in the study group and (33.3%) of them in the control group were born in the third birth order.

Table (3): Demonstrates percentage distribution of the studied neonate's regarding their medical data. It was found that, all neonates in the two groups were diagnosed with neonatal jaundice. Regarding the methods of feeding, the most (80%) of them in the study group and (73.3%) of them in the control group received bottle feeding only. One fifth (20%) of them in the study group and (26.7%) of them in the control group received both breast feeding & bottle-feeding. As regards weight on admission, mean \pm SD of neonates in the study group was 2.86 ± 0.2 , compared to 2.76 ± 0.18 for those in the control group. According to total serum bilirubin level on admission, mean \pm SD was 16.68 ± 0.89 for neonates in the study group compared to 16.99 ± 0.83 for those in the control group.

Table (4): Presents the effect of foot reflexology on the studied neonate's mean of heart rate for five consecutive days. It was revealed that, a statistically significant differences were detected between neonates in the study and the control groups before foot reflexology application regarding mean of heart rate in the second day only (p value = 0.043). While a statistically significant differences were detected between them after foot reflexology application in all days (1st, 2nd, 3rd, 4th, and 5th day) p value= 0.006, 0.001, 0.002, 0.006 & 0.004 respectively.

Figure (1): Presents the effect of foot reflexology on the neonates' mean of respiratory rate for five consecutive days. It was found that, mean respiratory rate of neonates in the study and the control groups was within the normal range during all follow up days with higher mean rate in neonates in the study than those in the control groups. Findings revealed that, in the first day, the mean of respiratory rate for neonates in the study group was 47.2c/m compared to 44.9c/m for them in the control group. While in the fifth day, the mean of respiratory rate for them in

the study group was 46.2c/m compared to 44.1c/m for neonates in the control group.

Figure (2): Demonstrates the effect of foot reflexology on the neonates' mean of oxygen saturation for five consecutive days. It was found that, mean oxygen saturation % was higher among neonates in the study than those in the control groups from the 1st to the 5th day. As well as the rate was increased gradually in the two groups throughout the follow up days. In the first day, the mean of oxygen saturation% for neonates in the study and the control groups was 91.7% & 90.4% respectively. While on the fifth day, the mean of oxygen saturation % for neonates in the study and the control groups was reached 94.1 % & 91.9 % respectively.

Table (5): Presents the comparison of mean of physiological index among neonates in the study group after foot reflexology intervention and the control group for five consecutive days. It was found that, statistically significant differences were detected between neonates in the study and the control groups as regards the mean of their heart rate b/m in all follow up days (P value= 0.006, 0.001, 0.002, 0.006 and 0.004 respectively). The results also found that, there were no statistically significant differences were detected between them in the study and the control groups regarding the mean of respiratory rate c/m (P value= 0.083, 0.081, 0.114, 0.184 and 0.112 respectively). In addition, there were highly statistically significant differences were detected between neonates in the study and the control groups after intervention foot reflexology regarding the mean of oxygen saturation% throughout the 5 follow up days (P value= 0.000, 0.001, 0.001, 0.000 and 0.000 respectively)

Discussion:

Neonatal hyperbilirubinemia is one of the most common issues in the neonatal stage, that can progress to critical levels. So that, foot reflexology now considering a part of standard nursing practice that should be applied to improve physiological index for neonates with hyperbilirubinemia undergoing phototherapy (Jazayeri et al., 2021).

The present study illustrated that, near half of the mothers in the study group, their age was ranged between 25: < 35 year, compared to two-fifths of them in the control group. Also, about two-fifths of the mothers in the study group had secondary level of education compared to one-third of them in the control group and more than two-thirds of the mothers in the study and the control groups were housewife. These results were disagreement with Elkst et al. (2022) who demonstrated that, the majority of mothers in the study group had secondary level of education and were working. While, the

majority of mothers in the control group had basic level of education and were house wives.

The current study revealed that, less than two-thirds of the mothers in the study group compared to more than two-thirds of them in the control group were delivered by cesarean section. These findings could be interpreted as the passage of neonates through the vagina during birth helps to stimulate milk production in the mother's body, making the neonates nurse early lead to decrease in the amount of reabsorption of unconjugated bilirubin. Moreover, the cesarean mode of delivery was overused in Egypt (**Abd Elatay et al., 2021**).

These the same results found with **Garosi et al. (2019)** who indicated that, the mode of delivery may have an impact on the degree of neonatal hyperbilirubinemia. While these findings were incongruent with **Tavakolizadeh et al. (2020)** who indicated that, the method of delivery was not associated with the incidence of neonatal hyperbilirubinemia.

The results of the current study referred that, all of the studied neonates were in gestational age 37-< 40 weeks and the neonatal hyperbilirubinemia's incidence was higher in females' neonates than males. These findings were also obtained by **Karatas & Dalgic (2021)** who showed that, neonates in the study and the control groups had mean gestational ages ranged from 37 to 40 weeks. Also, these findings were in agreement with **Elsabel et al. (2022)** who observed that, two-thirds of neonates in the study and the control groups were females. While these findings were disagreement with **Acharya & Paneru, (2021)** who demonstrated that, males' neonates had a higher incidence of neonatal hyperbilirubinemia than females.

The present study demonstrated that, more than two-thirds of neonates in the study group and half of neonates in the control group were from urban areas. Also, less than three-quarters of neonates in the study group and the majority of them in the control group had 1000 :< 3000g. These results interpreted as weight increase after foot reflexology intervention due to increase frequency and amount of feeding, increase frequency of defecation, decrease gastric motility and these lead to more efficient food absorption and weight gain.

These were in the same results matched by **Elsabel et al. (2022)** who found that, neonatal hyperbilirubinemia was more common in urban than rural areas. Also, these results were matched with **Badr & Ibrahim (2023)** who showed that, after foot reflexology intervention weight gain was observed for neonates in the study group in comparison to those in the control group.

The present study indicated that, more than one third of neonates in the study group and one third of them in the control group were born in the third birth order. Also, about one-third of them in the study group and more than two-fifths of them in the control group were born in the second birth order. These were in the same results reached by **Karatas & Dalgic (2021)** who indicated that, the high percentage of neonates in the two groups were born in the second and third birth order.

The present study revealed that, the majority of neonates in the study and control groups received bottle feeding only. Also, one fifth of them in the study group and more than one quarter of those in the control group received both breast feeding & bottle-feeding. These results were disagreement with **Elkest et al. (2022)** who noted that, half of the mothers in the control group depended on breast feeding while two-thirds of them in the study group depended on both breast and artificial feeding.

The result of the current study indicated that, foot reflexology intervention had positive and effective effect on physiological index for neonates with hyperbilirubinemia under phototherapy and there was a statistically significant differences were detected after application of foot reflexology as regards the mean of heart rate and oxygen saturation. Also, there was no statistically significant differences were detected after application of foot reflexology regarding the mean of respiratory rate. These findings may be related to stimulation of the vagal nerve through pressure applied to solar plexus point and with findings of **Jazayeri et al., (2021)**. From the researchers' point of view, these results validate the study hypothesis and demonstrate the beneficial effects of foot reflexology intervention on physiological indicators.

These findings were also obtained by **Jazayeri et al., (2021)** who found that, foot reflexology had a significant effect on physiological index as heart rate and oxygen saturation. While these results incongruent with **Chen et al. (2022)** who demonstrated that, no statistically significant differences were detected regarding mean of heart rate and oxygen saturation values before and after foot reflexology and massage interventions. Furthermore, these findings were disagreed with **Samadi et al. (2020)** who found that, there was no statistically significant differences were detected between physiological indicators such as O₂ saturation and heart rate in the two groups.

Finally, the present study's findings indicated that, there were statistically significant differences detected between neonates in the study and the control groups related to their heart rate and oxygen saturation after applying foot reflexology in the five

follow up days. These results were in incongruent with **Badr & Ibrahim (2023)** who indicated that, foot reflexology intervention was effective in improving physiological parameters for full-term neonates with hyperbilirubinemia who receiving phototherapy. As a result, in addition to phototherapy at NICU, this non-pharmacological approach is advised as a supplemental treatment for neonates with hyperbilirubinemia.

Conclusion:

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

Foot reflexology had an influential effect on stabilization and improving physiological index for neonates with hyperbilirubinemia. There were statistically significant differences detected between neonates in the study and the control groups with hyperbilirubinemia receiving phototherapy after application of foot reflexology related to their physiological index with more improvement observed among neonates in the study than those in the control groups.

Recommendations:

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

1. Neonatal Intensive Care Unit should offer clear booklets, CDs or videos regarding foot reflexology techniques and the mothers should be trained by specialist trained nurses to practice foot reflexology techniques successfully for their neonates at home.
2. Encouraging social agencies to use media, publication educational sessions, and lectures to raise public awareness of foot reflexology techniques.
3. Foot reflexology should be taken into consideration as a complementary modality that should be incorporated into nursing care because it is a safe, cost-efficient and well tolerated by neonates.
4. Study findings need to be replicated in different settings to confirm the efficacy of foot reflexology techniques to improve the physiological parameters for neonates with hyperbilirubinemia undergoing phototherapy.

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