Effect of Foot Reflexology on Clinical Outcomes of Neonates with Hyperbilirubinemia

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Abstract: Background and objectives**:** Neonatal hyperbilirubinemia is the most common reason for admission to Neonatal Intensive Care Unit (NICU) that can progress to critical levels. So, foot reflexology is one of the most widely used treatments and it is effective not only in the treatment of illnesses but also in maintaining health. Objectives: This study aimed to determine the effect of foot reflexology on the clinical outcomes of neonates with hyperbilirubinemia.Methods: A quasi-experimental research design was utilized in this study. The study subjects were 60 neonates with hyperbilirubinemia, recruited from NICU in Assiut University Children's Hospital. They were selected randomly and divided into two groups: the study group received foot reflexology interventions and the control group received routine care. Two tools were used to collect the necessary data, which included a personal structure questionnaire and neonataloutcomes assessment sheet.Results: On the fifth day, the mean of total serum bilirubin over the study group was 7.89±1.12 mg/dl, and over the control group was 10.55±0.55 mg/dl. According to the mean of the

duration of phototherapy and hospital stay, the study group was 3.86±0.86- 6.80±0.88 respectively, but over the control group was 5.33±0.75- 10.40±1.22 respectively.Conclusions: A statistically significant positive correlation between applying foot reflexology interventions and improving clinical outcomes of neonates with hyperbilirubinemia. We recommended that in-service training and education programs for neonatal nurses should be conducted on a regular basis to teach them non-pharmacological strategies such as foot reflexology techniques.

Keywords: Foot Reflexology, Neonates, Hyperbilirubinemia, Clinical Outcomes

1. INTRODUCTION

Neonatal hyperbilirubinemia is one of the most frequently encountered problems in the neonatal stage and is defined as yellowish discoloration of the skin, sclera and mucous membranes due to raised serum bilirubin level in the circulation. It is a prevalent health problem among term and late preterm neonates, approximately 60% of term and 80% of preterm neonates develop hyperbilirubinemia in the first week of their life (Kliegman et al., 2022).

Recently, several methods have become available for the treatment of hyperbilirubinemia; however, phototherapy is still the primary treatment modality. Phototherapy has been associated with numerous short-term and long-term side effects, such as dehydration, diarrhea, DNA damage, increase the risk of childhood cancer and epilepsy. Hence, finding alternative therapeutic modalities is important to decrease neonatal jaundice through increasing bowel movements, facilitating excretion of meconium and decreasing the bilirubin levels (Acharya & Paneru, 2021).

Reflexology can be defined as, the science of stimulating points that related to the internal organs of the body that are present in hands, ears and feet. Worldwide, the use of foot reflexology is one of the most widely used treatment and it is effective not only in the treatment of illnesses but also in maintaining health. Foot reflexology therapy is one of the complementary alternative therapies that can help to upgrade neonatal clinical outcomes with hyperbilirubinemia. (Jazayeri et al., 2021).

Foot reflexology is the most prevalent form of reflexology, as feet are sensitive to pressure, traction and movement. Different degrees of pressure stimulate the end of the sensory nerves connected to the receptors of organs, such as the gastrointestinal system (Moghadam et al., 2021). The beneficial effects of foot reflexology have been shown on intestinal functions by accelerating the first stool excretion as well as increasing the frequency of defecation in healthy neonates. Therefore, increased bowel movements lead to decrease bilirubin levels and neonatal jaundice (Eyvanbagha et al., 2019).

Moreover, foot reflexology has positive impact on stabilization of neonatal physiological parameters, maintaining calm and maintaining healthy immunological and digestive system (Oshvandi et al., 2019). Foot reflexology, also, causes sense of security, increases weight gain, as well as promotes the physical, mental and emotional development for neonates (Smith et al., 2022).

Neonatal nurses should use the recent effective interventions to promote neonatal health and should apply foot reflexology techniques to improve neonatal clinical outcomes, such as reducing total serum bilirubin, duration of phototherapy, length of hospital stay and increasing amount of feeding intake, frequency of defecation as well as enhancing neonates' weight gain (Badr & Ibrahim, 2023).

2. SUBJECTS AND METHOD

A quasi-experimental research design was utilized in this study.This study was conducted at the Neonatal Intensive Care Unit in Assiut University Children Hospital, Egypt.The study subjects were including a simple random sample of 60 neonates with hyperbilirubinemia. Sample size determination:

Sample size n= [DEFF*Np (1-p)]/[d2/z21-α/2*(N-1)+p*(1-p)]

Population size (for finite population correction factor or fpc) (N): 60

Hypothesized % frequency of outcome factor in the population (p): 99%+/-

Population (p): 5

Confidence limits as % of 100 (absolute +/- %) (d): 5%

Design effect (for cluster surveys-DEFF): 1

Sampling techniques: The neonates were selected randomly by define the neonates' size at the NICU, assign a random sequential number to each neonate, which acts as an ID number, e.g. 1, 2, 3, 4, 5, and so on to 100 and then decide and choose the sample size number needed. These included two groups: the study group received foot reflexology interventions and the control group received routine hospital care. The control of threatening to internal validity made by using the control group.

Inclusion criteria included:

- Neonates with hyperbilirubinemia, neonate's age (5-28 day), gestational age (37- 40 weeks), weight over 2500g at birth, serum bilirubin level 15- 20 mg/dl and feeding volume 150cc/ day or more.
- Neonates who had hemodynamic stability.
- Neonates who were free from any chronic diseases, any neurological disorders, ABO and Rh incompatibility and any congenital anomalies.

Tools of data collection:

Two tools were used to collect the required data for this study:

Tool (1): Structure Questionnaire Sheet:

It was developed by the researcher to collect the required information and it included 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 (2): Neonatal Outcomes Assessment Sheet:

This tool was developed by the researcher and it included:

Neonatal clinical outcomes assessment sheet: The researcher assessed the effect of foot reflexology on clinical outcomes such as (total serum bilirubin/day, amount of feeding/day, frequency of defecation/day, frequency of urination/day, daily weight, complications (Dehydration, Bronze Children’s Syndrome or Kernicterus), duration of phototherapy and duration of hospital stay) for five consecutive days.

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.
- **A pilot study** was carried out on 10% (6) of neonates to test the clarity, applicability of the sheet, to

estimate the time need to fulfill sheet and these were excluded from the total sample of the study. No modifications were done and the final form was developed.

- 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.

- **Reliability** of tool two was measured by Cronbach's alpha coefficient for the neonatal outcomes' assessment sheet, r = 0.91 by **(Jazayeri et al., 2021).**

3. INTERVENTIONS:

The control group received routine care that included, put neonate under phototherapy that is non-invasive treatment and helped to improve the solubility of bilirubin for faster excretion through the stool and urine, nursed them in an overhead radiant warmer bed to maintain an appropriate neutral thermal environment and assessed their skin and eyes every two hours when they were removed from lights for feedings.

The study group received all routine care plus the following:

The actual work started when the researcher attended to NICU and took all neonates with hyperbilirubinemia, then made simple random assignment of neonates to study and control group.

The neonate placed in a supine position with the head elevated 35o and the researcher performed reflexology guided by points location according to reflexology charts. Foot reflexology interventions conducted for 20 min on both feet (10 min for each foot) once daily for five consecutive days.

Foot reflexology performed to the middle point of upper abdomen to stimulate the stomach by pressing with gentle circular motion for 3 min for each foot. Then, foot reflexology performed to the large and small intestines areas for 5 min for each foot, done first by stimulating the large intestine and then activating the small intestine.

Large intestine area stimulated by doing a movement like a horseshoe shape in both feet. This movement done with a thumb finger and exerted some pressure upon the sole on the neonate's right foot and then the left foot with the same technique.

Field of the Work:

This study was carried out over a period of six months from the beginning of November 2022 to the end of April 2023. The time needed for every neonate was 20 minutes.

Fidelity of the Study:

The researcher received training on foot reflexology techniques and massage at the department of Physical Medicine and Rehabitation in the Main Assiut University Hospital for three days per week (Sunday, Tuesday and Thursday) for two months and the researcher got a certificate and signatures by the head of the department of Physical Medicine and Rehabitation.

Ethical Considerations:

Research proposal was approved from Ethical Committee in the Faculty of Nursing, Assiut University. Parents were assured that, the data of this research was used only for the purpose of research. Informed consent was obtained from neonates' parents after explaining the nature and purpose of the study. Confidentiality and anonymity

were assured. Parents had the right to refuse to participate and or withdraw their neonates from the study at any time without any effect on the care provided for their neonates.

4. RESULTS:

Table (1): Percentage and frequency 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 learning	2	6.7	6	20	
▪ Secondary learning	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**
▪ 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	

Table (1): It was noted that no statistically significant difference was found between the studied neonate's regarding their maternal data.

Table (2): Percentage and frequency distribution of the studied neonate's regarding their biosocial 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		**1**
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	**0.192**
▪ Rural	10	33.3	15	50	
Neonate's weight at birth/ grams:					
▪ 1000: < 3000g	22	73.3	25	83.3	**0.345**
▪ ≥ 3000g	8	26.7	5	16.7	
• **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	

Chi-square test

Table (2): Presents percentage and frequency distribution of the studied neonate's regarding their biosocial data. It was founded that no statistically significant difference was found between the studied neonates regarding their biosocial data. Also, findings revealed that half (50%) of the study group were female and another half were male, compared to more than two third (66.7%) of the control group were female and one third (33.3%) of them were male. Regarding neonate's age/ day, the majority (80%- 83.3% respectively) of the study group and control group were between neonatal age 1:< 7 day. Also, more than two third (66.7%) of the study group were from urban areas, compared to half (50%) in the control group. According to neonate's weight at birth, more than two third (73.3%) of the study group were between 1000:< 3000g, compared to (83.3%) in the control group. Finally, it was also observed that more than one third (36.7%) of the study group were the third birth order, compared to one third (33.3%) in the control group.

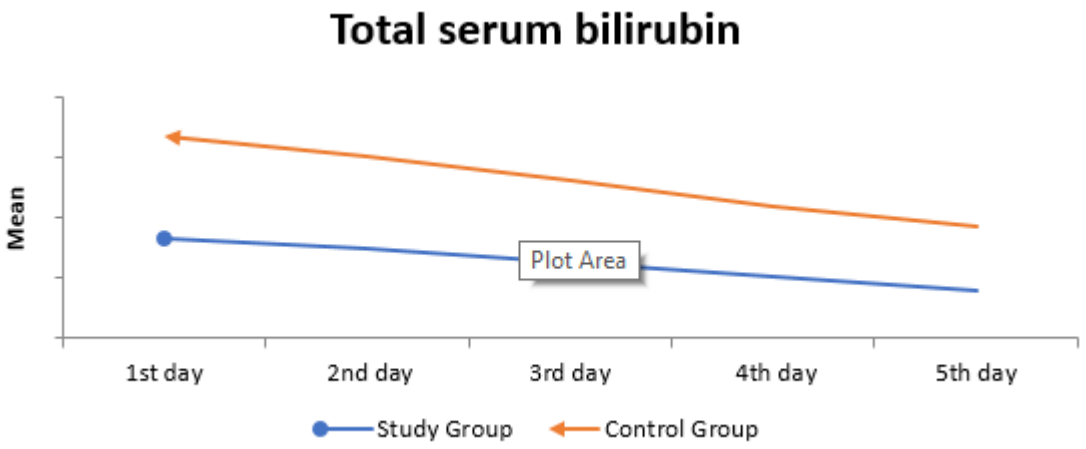

Figure (1): Effect of foot reflexology on the mean of total serum bilirubin for five consecutive days

Chi-square test
(**) highly statistically significant difference (p-value <.001)

Figure (1): Effect of foot reflexology on the mean of total serum bilirubin for five consecutive daysfoot reflexology interventions and mean of total serum bilirubin (P. Value= <.001**). According to the first day, the mean of total serum bilirubin over the study group was 16.7 mg/dl and over the control group was 17.0 mg/dl. While, on the fifth day, the mean of total serum bilirubin over the study group was 7.9 mg/dl and over the control group was 10.6 mg/dl.

Table (3): Effect of foot reflexology on the studied neonates' mean frequency of defecation/ day (N= 60)

Frequency of defecation /day	Study Group (N=30)	Control Group (N=30)	P value
The First Day	1.63±0.71	1.10±0.305	**0.001***
The Second Day	2.13±0.77	1.23±0.43	**0.001***
The Third Day	2.73±0.73	1.80±0.55	**<.001***
The Fourth Day	3.30±0.74	2.06±0.44	**0.001***
The Fifth Day	3.76±0.85	2.23±0.43	**<.001***

T test

(**) highly statistically significant difference (p-value <.001)

Table (3): Shows that there was a highly statistically significant difference between foot reflexology interventions and mean frequency of defecation/ day (P. Value= <.001**). As regard of the first day, the mean of frequency of defecation/ day over the study group was 1.63±0.71 and over the control group was only 1.10±0.305. While, on the fifth day, the mean of frequency of defecation/ day over the study group was 3.76±0.85 and over the control group was only 2.23±0.43.

Table (4): Effect of foot reflexology on the studied neonates' mean of amount of feeding cc/day (N= 60)

Amount of feeding cc/day	Study Group (N=30)	Control Group (N=30)	P value
The First Day	227.66±84.39	175.80±23.34	**0.002***
The Second Day	253.86±78.50	188.80±22.83	**<.001***
The Third Day	299.20±91.38	214.13±35.15	**0.001***
The Fourth Day	330.00±103.21	235.33±38.85	**<.001***
The Fifth Day	380.13±118.68	246.00±41.21	**<.001***

T test

(**) highly statistically significant difference (p-value <0.000)

Table (4): Presents that there was a highly statistically significant difference between foot reflexology interventions and mean of amount of feeding cc/day (P. Value= <.001**). Regarding of the first day, the mean of amount of feeding over the study group was 227.66±84.39 and over the control group was 175.80±23.34. While, on the fifth day, the mean of amount of feeding over the study group was 380.13±118.68 and over the control group was 246.00±41.21.

Table (5): Effect of foot reflexology on the studied neonates' mean of frequency of urination/day (N= 60)

Frequency of urination/day	Study Group (N=30)	Control Group (N=30)	P value
The First Day	3.13±0.57	2.66±0.54	**0.002***
The Second Day	3.86±0.68	2.86±0.43	**0.001***
The Third Day	4.50±0.90	3.43±0.72	**0.001***
The Fourth Day	5.63±0.99	3.86±0.81	**<.001***
The Fifth Day	6.00±1.05	4.00±0.83	**<.001***

T test

(**) highly statistically significant difference (p-value <0.000)

Table (5): Demonstrates that there was a highly statistically significant difference between foot reflexology interventions and mean of frequency of urination/day (P. Value= <.001**). According to the first day, the mean of frequency of urination over the study group was 3.13±0.57 and over the control group was 2.66±0.54. While, on the fifth day, the mean of frequency of urination over the study group was 6.00±1.05 and over the control group was 4.00±0.83.

Table (6): Effect of foot reflexology on the studied neonates' mean of weight daily (gm) (N= 60)

Weight daily (gm)	Study Group (N=30)	Control Group (N=30)	P value
The First Day	2.76±0.20	2.76±0.18	**0.315**
The Second Day	2.87±0.21	2.71±0.18	**0.042***
The Third Day	2.88±0.21	2.77±0.19	**0.003***
The Fourth Day	2.90±0.21	2.78±0.19	**0.024***
The Fifth Day	2.91±0.21	2.79±0.18	**0.025***

T test

(**) highly statistically significant difference (p-value <.001)

Table (6): Reveals that there was a highly statistically significant difference between foot reflexology interventions and mean of weight daily (gm) (P. Value= 0.025*). As regard of the first day, the mean of weight daily over the study group was 2.76±0.20 and over the control group was 2.76±0.18. While, on the fifth day, the mean of weight daily over the study group was 2.91±0.21 and over the control group was 2.79±0.18.

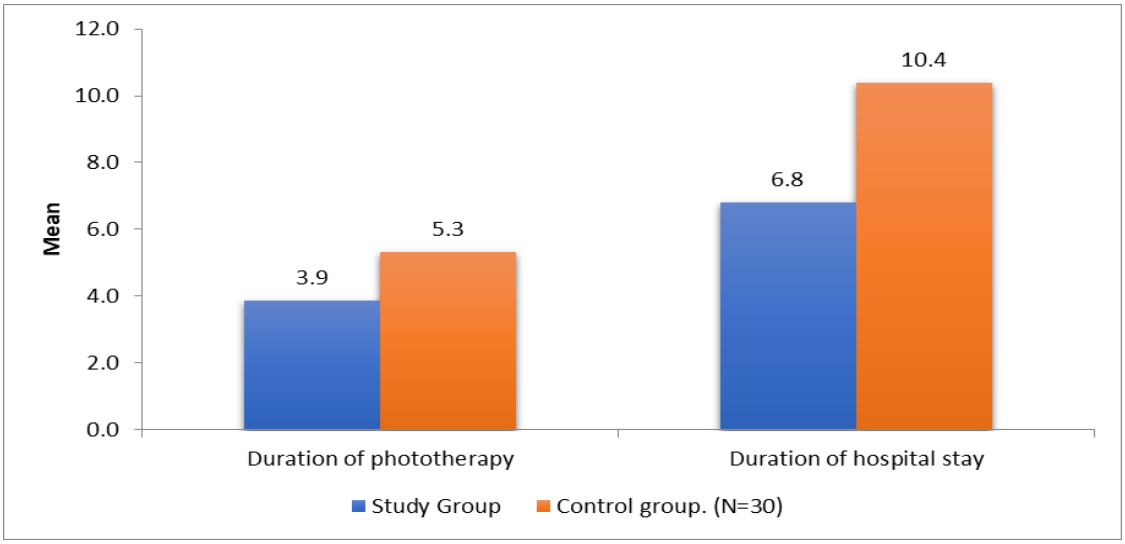

Figure (2): Effect of foot reflexology on the mean of duration of phototherapy and duration of hospital stayChi-square test

(**) highly statistically significant difference (p-value <.001)

Figure (2): Represents that there was a highly statistically significant difference between foot reflexology interventions and the mean of duration of phototherapy and hospital stay (P. Value= <.001**). Findings revealed that, the mean of duration of phototherapy over the study group was 3.9 days and over the control group was 5.3 days. As regard of mean of duration of hospital stay, the study group was 6.8 days and over the control group was 10.4 days. So that, neonates in the study group stayed less in the hospital than those in the control group.

Table (7): Correlation between the studied neonates' different parameters and their clinical outcomes: Pearson correlation test

Items		Neonate's weight / grams		Total serum bilirubin	
		Study group	Control group	Study group	Control group
Duration of phototherapy	r	-.546	-.233	.470	.408
	p	0.002*	0.215	0.009*	0.025
Duration of hospital stay	r	-.395	-.280	.476	.430
	p	0.031*	0.134	0.008*	0.018

Table (7): Reveals that there was a statistically significant positive correlation between neonate's weight at birth and duration of phototherapy & duration of hospital stay in the study with p value (0.002*, 0.031*, respectively) compared to the control group. Also, there was a statistically significant positive correlation between the total serum bilirubin and duration of phototherapy & duration of hospital stay in the study with p value (0.009*, 0.008* respectively) compared to the control group.

DISCUSSION:

Neonatal hyperbilirubinemia is a common benign problem among neonates that may cause serious complications such as kernicterus if left untreated. Therefore, it requires immediate interventions such as foot reflexology to reduce duration of phototherapy and is used as adjuvant treatment for phototherapy (Badr & Ibrahim, 2023).

The results of the current study revealed that, more than half of mothers in the study group and more than two-third of the control group were delivered by caesarean section. These results might be due to the passage of neonates through the vagina during birth helps to stimulate milk production in the mother's body, that early lead to decrease in amount of reabsorption of unconjugated bilirubin. Moreover, the caesarean method of delivery was overused in Egypt.

These results were in the same line with Garosi et al. (2019) who found that, the majority of mothers in the study group were delivered by caesarean section and the method of delivery could be linked to neonatal hyperbilirubinemia and its severity. While these results were disagreed with Tavakolizadeh et al. (2020) who referred that, the method of delivery was not associated with the incidence of neonatal hyperbilirubinemia.

The present study found that, the incidence of neonatal hyperbilirubinemia was higher in female neonates than male, while half of control group and more than two third of the study group were from urban. These findings explained by the testosterone hormone stimulates the production of red blood cells, which leads to an increase in daily bilirubin production.

This finding matched with Elsabel et al. (2022) who found that, two thirds of the study and control groups were females and majority of neonatal hyperbilirubinemia was among urban areas than rural. While this finding was disagreement with Acharya & Paneru, (2021) who showed that, the incidence of neonatal hyperbilirubinemia was higher in male neonates than in female neonates.

The current study referred that, the range of gestational age for the study and control group was between 37- 40 weeks, while more than one third of control group were the second birth order and more than one third of the study group were the third birth order. These were the same results reached by Karatas & Dalgic (2021) who demonstrated that, the mean range of gestational age for the control group and study group was between 36-40 weeks and the high percentage of neonates in the two groups were the second birth order.

The current results revealed that, the mean of total serum bilirubin level, duration of phototherapy over the study

period decreased significantly after the foot reflexology interventions than over the control group. Consequently, that reduce the length of hospital stay for those neonates. These findings interpreted by the valuable effects of the reflexology as in hemodynamic theory, which claims that the incitement of a point in an area of the foot can enhance blood supply to the relevant organ, activation of the parasympathetic system and increasing blood flow to the intestines due to stimulation of intestinal reflex points on the feet contributed to increase bowel movement. There by, led to increase bilirubin excretion, ultimately facilitating defecation, reducing enterohepatic circulation of bilirubin and increased bilirubin excretion.

This result was in agreement with Moghadam et al. (2021) who illustrated that, the total serum bilirubin level and duration of hospital stay decreased after the foot reflexology interventions than control group. While these findings were disagreement with Seyyedrasooli et al. (2021) who indicated that, no statistically significance difference between the total serum bilirubin level in two groups after interventions.

The results of the current study referred that, the studied neonates had a higher mean defecation frequency than the control group, with a highly statistically significant difference throughout the study period. These results attributed that, the fact of foot reflexology interventions had an improving effect on intestinal motility and faster stool excretion, also, improve the time, frequency of meconium excretion and feeding tolerance in neonates. These results were compatible with Valizadeh et al. (2022) who found that, the defecation frequency of neonates who received reflexology interventions was significantly higher than those in the control group.

The findings of these study demonstrated that, foot reflexology interventions had very beneficial effect on increasing the mean amount of feeding/ day and neonates' body weight over the study group compared with the control group over the study period. These findings attributed that, foot reflexology interventions stimulated the vagal nerve, improved gastrointestinal function and draw more nutrients. Furthermore, these findings may be related to the higher defecation frequency for neonates in the study group, which is expected to increase the frequency, amount of feeding and result in enhancement in neonates' body weight gain.

These findings were in agreement with Lin et al. (2020) who found that, amount of feeding/ day and body weight increased after reflexology interventions than the control group. While these results were inconsistent with Smith et al., (2021) who referred that, there was no statistically significant difference in weight gain between the study and control groups after reflexology interventions.

The present study indicated that, foot reflexology interventions had very effective in improving frequency of urination/ day and promoting weight gain for neonates with hyperbilirubinemia. There was a highly statistically significant differences between foot reflexology interventions and frequency of urination/ day, weight gain. These findings were supported by AL- Basiri et al. (2020) who showed that, reflexology had effective in improving frequency of urination, meconium excretion and nutrition tolerance in neonates. While these results were disagreement with Lee, (2019) who found that, there was no statistically significant difference between body weight in the study and control group after applying reflexology interventions for 4 weeks.

The current study denoted that, foot reflexology interventions had an observable effect on reduction duration of phototherapy, hospital stay and there was a highly statistically significant difference between foot reflexology interventions and duration of phototherapy and hospital stay. These results were the same results reached by Karbandi et al (2022) who indicated that, reflexology had an effect on reducing duration of phototherapy in neonates admitted to the NICU and thus, reducing length of hospital stay, readmissions and provide more robust evidence.

Finally, the results of the present study showed that, there was a statistically significant positive correlation between foot reflexology interventions and improving clinical outcomes of neonates with hyperbilirubinemia undergoing phototherapy. These findings were in agreement with Badr & Ibrahim (2023) who found that application of foot reflexology was effective in improving clinical outcomes for full-term neonates with hyperbilirubinemia undergoing phototherapy. Thus, this non-pharmacological method is recommended as a supplement treatment for neonates with hyperbilirubinemia beside phototherapy in NICU.

CONCLUSION:

Foot reflexology had an influential effect on reducing total serum bilirubin, duration of phototherapy, length of hospital stay and increasing amount of feeding intake, frequency of defecation, urination as well as enhancing neonates' weight gain during the study period. There was a statistically significant positive correlation between applying foot reflexology interventions and improving clinical outcomes of neonates with hyperbilirubinemia undergoing phototherapy with p- value (<.001). An in-service training and education programs for neonatal nurses should be conducted on a regular basis to teach them non-pharmacological strategies such as foot reflexology techniques.

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Conflict of Interest

The authors declare no conflict of interest.

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