

Impact of Foot Reflexology Technique on Pain intensity, Sleep Quality, and Fatigue among Children undergoing Surgical Procedures

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Abstract

Background: Pain was experienced by children undergoing surgery, low sleep quality, and Fatigue. Foot reflexology appears to be useful in reducing Pain intensity, sleep quality, and Fatigue, among Children undergoing surgical procedures as a complementary care that is becoming widely accepted and popular. **Aim:** This study aimed to evaluate the impact of foot reflexology technique on pain intensity, sleep quality, and fatigue among children undergoing surgical procedures. **Design:** A quasi-experimental research design was used to conduct this study. **Setting:** The study was carried out at the Pediatric Surgical Department at Sohag University Hospital. **Subjects and method:** The study included a purposive sample of 200 children undergoing surgical procedures from 6- to 12 years who were equally divided into two groups, the first was the control group and the second was the experimental group. **Tools:** Four tools were used to collect data: **Tool (I):** a structured interviewing questionnaire, **Tool (II)** A Visual Analogue Scale (VAS), **Tool (III)** Pittsburgh Sleep Quality Index (PSQI), and **Tool (IV)** Visual Analogue Scale for Fatigue (VAS-F). **Results:** The present study revealed that three-fifths of children undergoing surgical procedures in the experimental group had mild pain compared to only (7%) in the control group. Moreover, there were highly statistically significant differences in foot reflexology among the studied children undergoing surgical procedures regarding sleep quality and fatigue between the experimental and control groups. **Conclusion:** Foot reflexology affects reducing Pain intensity, improving sleep quality, and decreasing Fatigue among Children undergoing surgical procedures. **Recommendation:** Foot reflexology could be applied as a non-pharmacological strategy and complementary therapy along with routine care to manage Pain intensity, sleep quality, and Fatigue among Children undergoing surgical procedures.

Keywords: Children undergoing surgical procedures, Fatigue, Foot reflexology, Pain, Sleep quality

Introduction

Pain and fatigue are among the most common health issues that affect children, and when they arise under aberrant physiological settings, fatigue is thought to be the body's primary defense strategy. Many age-specific pain treatment tools and ratings have been developed since it can be challenging to evaluate children's pain. Children often experience pain after surgical procedures. Post-surgical procedures can worsen a child's perception of pain and fatigue, which can result in an unpleasant experience for many children who already feel fatigue and pain. Reducing pain and suffering is a vital duty of nurses caring for children because pain has certain long-term detrimental effects (Lee et al., 2019).

Reflexology therapy is a form of noninvasive and non-pharmacological complementary and alternative methods to managing pain and fatigue. It is considered a way to prevent the unfavorable side effects of analgesic drugs (Van et al., 2019). Reflexology is the science of studying human health through certain specific reflexology areas quantized on feet, hands, and ears. According to the reflexology hypothesis, the skin on the feet, hands, and ears serve as a representative of the target body parts, and impulses generated on the reflexology areas by the external stimulations of definite intensities arrive at the target body parts through the neural pathways or hormone-like activities. Additionally, it is accompanied by easy acceptance between children and parents, increases the patient's ability to adapt and reduce their anxiety, and

can be easily used by children (**Ghaljaei and Jalalodini 2021**).

One of the most popular types of reflexology therapy is foot reflexology which is simple and less expensive. The theory is that foot reflexology helps the body to restore its balance naturally. Since touching the skin can cause the release of endogenous endorphins of the body that would reduce the stress; therefore, with stress reduction, the pain would consequently have decreased. As well as can also relieve fatigue and anxiety due to applying pressure on hands or feet activates large-diameter fibers to close the pain gate, thereby inhibiting the transmission of pain (**EL-Fekey 2018**). Through the stimulation of cutaneous mechanoreceptors, foot reflexology stimulates large primary afferents that discharge Gamma-Aminobutyric Acid GABA and endorphins (**Jazayeri et al., 2021**). Moreover, the benefits of foot reflexology include increased circulation, which makes the body feel more energized and relaxed this reduces pain perception and anxiety by impacting the cardiovascular, neurological, and locomotor systems as well as the nervous system and also eases muscle tension and pain, which enhances general health and well-being (**Chanif et al., 2019**).

By applying pressure on reflexive points on the foot that correlate to each area of the body, reflexology helps to restore the body's balance and enhance comfort. According to reflexologists, applying pressure to particular reflex points on the sole during disease is believed to break up calcium and uric acid crystals deposited in nerve endings, unblock nerve pathways, and improve blood flow throughout the body (**Ballard et al., 2019**). Numerous research has confirmed the benefits of reflexology, such as reducing postoperative pain and anxiety (**Öztürk et al., 2018**), reducing fatigue and pain, and improving the quality of sleep in patients with lymphoma (**Rambod 2019**) also, Nurses may utilize foot reflexology as an addition to standard intensive critical care unit care to reduce anxiety and stabilize physiological parameters in patients undergoing coronary artery bypass graft surgery (**Abbaszadeh et al., 2018**).

Non-pharmacological as well as pharmacological applications are frequently used to reduce postpartum symptoms and

support breastfeeding (**Domínguez-Solís et al., 2021; Wang et al., 2020**). Reflexology is one of the non-pharmacological applications that can be used to reduce postpartum symptoms and support breastfeeding (**Aksu & Palas Karaca, 2021; Basyouni et al., 2018; Çankaya & Ratwisch, 2020**). Reflexology is a manual method of applying complementary therapy. The practice involves applying pressure with specific finger movements to reflex points on the hands, feet, and ears that correspond to the glands, organs, and parts of the body. The applied pressure stimulates the nerve endings to generate electrochemical messages. Calcium crystals, lactic acid, and uric acid accumulated at the nerve endings are broken down. The pressure also enhances blood flow and accelerates the excretion of metabolites from the body. Although the duration of reflexology sessions varies according to disease and symptoms, each session should have a duration of 10 to 60 minutes and six to eight sessions are recommended once or twice a week to obtain therapeutic results (**Rambod et al., 2019**).

Nurses play a crucial and effective role in offering counseling, instruction, and advice to guarantee the success of the procedure and helping patients reduce their fatigue, and pain and get better sleep. So, nurses can use non-pharmacological and alternative therapies such as foot reflexology to control pain and fatigue because it is simple, inexpensive, and easy to use. Reflexology is one of the most significant complementary therapies employed by nurses as a nursing intervention. Additionally, increases the patient's ability to adapt and reduce their fatigue and can be easily used by older children (**Momeni et al., 2020**).

Nurses need to understand how children who have surgery may feel pain and exhaustion. To help children, nurses must understand what weariness and pain are as well as how kids express their dread and suffering. Children of all ages experience anxiety before having surgery, according to earlier studies. Not only are there risks associated with untreated pain, but treating pain can also result in earlier mobilization, shorter hospital stays, and cheaper costs, thus nurses should try to reduce a child's suffering (**Silverdale, et al., 2019**).

Significance of the study:

For Children who are fatigued and in pain, surgery is one of the scariest operations. In addition to being morally right, relieving children's pain and fatigue also helps to prevent negative short- and long-term consequences (Hosseinpour & Ahmadi, 2019). Children may decide not to receive medical care in the future as a result of traumatic experiences at a hospital or clinic. Fatigue and pain are common side effects of hospitalization for children undergoing surgery, and it can seriously hinder the physical, psychological, behavioral, cognitive, and academic growth of these young patients.

One of the most essential alternative therapies for pain relief is foot reflexology (Singh & Chaturvedi, 2019). For instance, the findings of (Amer et al. 2022) indicated that foot reflexology was an effective method to decrease pain and fatigue levels among patients. Moreover, Koraş et al., (2019) indicated that foot reflexology decreases postoperative pain and the use of analgesics, and causes reduce in fatigue levels. However, studies for evaluating pain and fatigue levels together after foot massage for children undergoing surgical procedures were limited. So, this study was conducted to evaluate the impact of the foot reflexology technique on pain intensity, sleep quality, and fatigue among children undergoing surgical procedures.

The study aimed to:

Evaluate the impact of foot reflexology technique on pain intensity, sleep quality, and fatigue among children undergoing surgical procedures through:

- Assessing pain levels among children undergoing surgical procedures pre and post-foot reflexology.
- Assessing sleep quality among children undergoing surgical procedures pre and post-foot reflexology.
- Assessing fatigue levels among children undergoing surgical procedures pre and post-foot reflexology.

Subjects and methods:**Research hypothesis:**

Children undergoing surgical procedures who receive foot reflexology are expected to experience little pain, fatigue, and improved sleep quality than those who do not.

Design:

A quasi-experimental research design was used to conduct this study.

Setting:

The study was carried out at the Pediatric Surgical Department at Sohag University Hospital.

Subjects:

The study included a purposive sample of 200 children undergoing surgical procedures from 6- 12 years who were equally divided into two groups, the first was the control group and the second was the experimental group. The randomization achieved by asking each child to pick cards with numbers one and two was given to the participants. Children who choose number one are assigned to the experimental group, while those who choose number two are assigned to the control group. The experimental group received foot reflexology in addition to routine care and the control group received only routine care from the department.

Sample size calculation:

The sample size was calculated based on considering the level of significance of power analysis of $0.95(\beta=1-0.95=0.5)$ at alpha .05 (one-sided) with a large effect size (0.5) as the significance, and 0.001 was used as the high significance.

Inclusion criteria included:

- Children aged 6-12 years
- From both sexes
- Agree to participate in this study

Exclusion criteria included:

- Children are suffering from any mental disease.
- Feet problems
- Local infection of the feet or recent lower limb surgery

Tools of data collection:

Tool (I): A structured interview questionnaire was developed by researchers in the study after reviewing the recent related literature and research studies. It included two parts:

Part (1): It included demographic data of children as age, gender, educational level, and residence.

Part (2): It included items related to the medical history of children as the child's diagnosis and previous hospitalization.

Tool (II) A Visual Analogue Scale (VAS), developed by **Huskisson (1974)**, was used to assess the severity of pain participants were experiencing. The VAS consists of a 10-cm horizontal line labeled with *no pain* at the left end (0) and the *worst pain possible* at the right end (10). The individual is told to mark the point on this horizontal line that best expresses the intensity of bodily pain they are experiencing. Scores range from a minimum of 0 to a maximum of 10, with higher scores indicating more severe pain (**Eti Aslan, 2002**). VAS has been extensively validated and is considered a valid and reliable tool for assessing various subjective experiences (**Eti Aslan, 2002; Huskisson, 1974**).

Tool (III): Visual Analogue Scale for Fatigue (VAS-F): The severity of fatigue was measured using the Visual Analogue Scale for Fatigue (VAS-F), developed by **Lee et al. (1991)**. It was adapted to Turkish by **Yurtsever and Bedük (2003)**. VAS-F is a two-dimensional scale consisting of fatigue and energy dimensions. The total score is calculated separately for fatigue and energy. The scale consists of 18 items (**Lee et al., 1991; Yurtsever & Bedük, 2003**). For each item, the user marks how they feel along a 10 cm scale labeled with opposite extremes at each end (e.g., 0 = *not at all tired*, 10 = *extremely tired*). The item scores are added to obtain a total score. Scores range from 0 to 130 on the fatigue subscale and from 0 to 50 on the energy subscale of the VAS-F. The scale has no cut-off point. High scores in the fatigue subscale and low scores in the energy subscale indicate more severe fatigue. Cronbach's coefficients of

0.90 for the fatigue subscale and 0.74 for the energy subscale were reported in the adaptation study (**Yurtsever & Bedük, 2003**). In the present study, the Cronbach's coefficient of the VAS-F fatigue was 0.990 for all groups and all days, 0.966 for the intervention group on all days, and 0.942 for the control group on all days. The Cronbach's coefficient of the VAS-F energy in our study was 0.982 for all groups and all days, 0.935 for the intervention group on all days, and 0.958 for the control group on all days.

Tool (IV): Pittsburgh Sleep Quality Index (PSQI): Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). The PSQI was developed by **Buysse et al. (1989)** and it was adapted into Turkish by **Ağargün et al. (1996)**. The Cronbach's coefficient of the scale is 0.80 (**Ağargün et al., 1996**). It consists of a total of 24 items and has seven components. Scoring is based on 18 items in the seven components. Each component is rated and scored from 0 to 3 points. The sum of the component scores yields the PSQI global score, which ranges from a minimum of 0 to a maximum of 21. A PSQI global score of ≤ 5 indicates good sleep quality, and a score of > 5 indicates poor sleep quality (**Ağargün et al., 1996; Buysse et al., 1989**). In the present study, the Cronbach's coefficient of the PSQI was 0.825 for all groups and all days, 0.853 for the intervention group on all days, and 0.859 for the control group on all days.

Procedure:

Preparatory phase:

It involved developing data-gathering techniques by developing a review of relevant literature and theoretical understanding of different study components through books, papers, the internet, periodicals, and magazines. This contributed to the development of the testing tools as well.

Validity of Tools:

The instruments to examine the content validity were evaluated by five professors who have more than ten years of experience working in the field of pediatric nursing. By the experts' assessment of the tools' language structure, content suitability, and item order, no changes were made.

Pilot Study:

A pilot study was done on 10% of the sample (10 children undergoing surgical procedures) to test the feasibility and applicability of different items of the tool to establish the most practical and comprehensive way of obtaining necessary data. The participants in the pilot study were included in the main study sample.

Ethical considerations:

Before the research started, the Approval of the Ethical Research Committee of the Sohag Faculty of Nursing was obtained to conduct the study. The researchers met both medical and nursing directors of the selected setting to clarify the purpose of the study and obtain their approval. Oral consent was obtained from mothers and their children undergoing surgical procedures to gain their cooperation. Data collection was voluntary and confidential. The objective and methodology of the study for all children undergoing surgical procedures were explained by researchers. The right to refuse participation in the study was confirmed.

Fieldwork:

Data was gathered from July 2022 through November 2022. Two days of the week, from 9 a.m. to 12 p.m., were designated for the interview. It took each participant about twenty to thirty minutes to finish the questionnaire. The investigators employed Tools II, III, and IV before and following the intervention. There were three stages to the study's implementation: the assessment, implementation, and evaluation phases.

I- Assessment phase:

Before beginning to gather data, the researchers gave the kids an introduction before outlining the purpose of the study and its anticipated results. The researchers evaluated the children's clinical and demographic data. II, III, and IV were the pretest instruments that were employed in the data collection process. Pre-testing instruments were employed to evaluate children's levels of discomfort, exhaustion, and sleep.

II- Implementation phase:**Preparation for the study:**

The researcher has undergone special training in performing foot reflexology for two months under the supervision of a specialist trainer in the fields of physical medicine, rheumatology, and rehabilitation to determine the foot's reflection points correctly and learn how to apply pressure. So, the working method was approved. Then apply foot reflexology on volunteers, and some of her relatives before applying it on children.

All data were collected by the researcher through face-to-face interviews. The collection of data took an average of 15 to 20 minutes each week. The data were collected at the hospital in the 1st week and at the participants' homes in the following weeks. Descriptive information forms to determine the demographic characteristics of the participants were collected at the hospital, and then, at subsequent visits, they filled out the VAS to assess pain, VAS-F to assess fatigue, and PSQI to assess sleep quality. Pain was evaluated before and immediately after the application of the intervention or rest to evaluate the effectiveness of the application. Pain was reassessed 60 minutes after the intervention to determine whether pain changed with time.

Before the reflexology procedure, pain was assessed with the VAS, and fatigue was assessed using the VAS-F. Reflexology was then performed for 40 minutes by one of the researchers. Children in the control group received routine care according to the hospital protocol of care. While the diabetic children in the experimental group received routine care in addition to foot reflexology.

Each session lasted 40 minutes (20 minutes for each foot). Region-specific applications were performed three times to points on the feet related to pain, fatigue, and sleep by applying pressure in small circles or strokes (for approximately 30 seconds to 1 minute per point).

For the experimental group, before applying the foot reflexology, the researcher prepared the studied children and the environment as follows:

Prepare the warm, quiet, well-ventilated room for foot reflexology intervention.

Provide a full explanation of the foot

reflexology procedure as meaning, benefits, duration, and reflexology points for the studied children.

Ask the children to wash their feet with soap and warm water before intervention.

The researcher should keep her nails short and clean before touching the child. Then get a general overview of the feet, look at their color of, and feel their temperature and changes in skin texture Finally, move the feet to check for mobility and flexibility.

The participant was asked to lie in a supine position. A small pillow was placed under the knees to relax the participant's legs. Participants were instructed not to take any analgesic medication before the reflexology procedure. Four drops of petroleum jelly were applied to the participant's foot for lubrication. Two minutes of warming and relaxing exercises were performed on both feet at the same time. Then the procedure was started on the right foot. The reflex points where reflexology was applied on the right foot

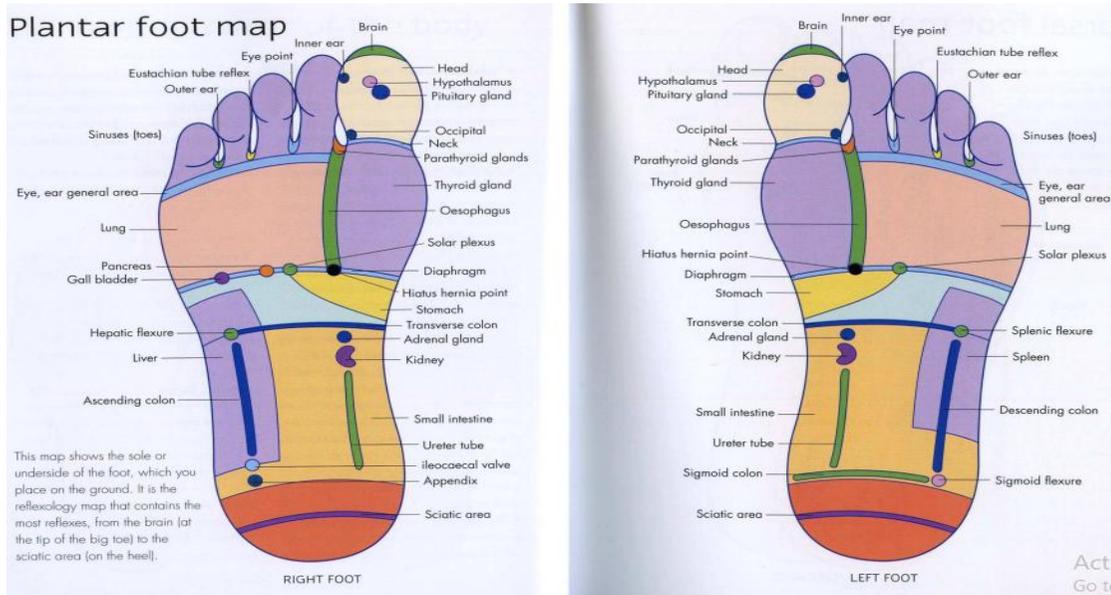
The selected points of foot reflexology:

The first one was the solar plexus point which is located in the distance between the upper and middle third of the sole. It is known as the relaxation point, this point communicates with the whole nervous system and can trigger a major relaxing effect as well as diminish fatigue. The second point was the brain point which is located at the tip of the big toe. It encourages optimal functioning of the parasympathetic nervous system which helps the body to cope with the effects of stress and anxiety also, it is used to reduce pain in the body and enhances the release of endorphins and enkephalins which are the body's natural pain relievers. The third point is an adrenal point which is located halfway between the diaphragm line and waistline just above the kidney point on the foot It assists in reducing pain as well as helping the body to cope with fatigue and the fourth one is a pituitary point that located in the middle of the big toe and helps to balance all body hormones by regulating and controlling their activities and aid to prevent low energy level of the body.

The researcher sat in a fully comfortable and relaxed position in front of the children. Then the patient was instructed to lie down in a comfortable, usually supine position A pillow was placed under the patient's foot. Firstly, the patient's feet were examined for pain and sensitivity. Then the researcher put a tiny amount of non-therapeutic baby lotion on her hand to facilitate massaging starting with the right foot. A general massage of the feet is performed after that to warm up the feet. Also, with just one hand's palm and fingers of the researcher, the sole, back, and toes of the leg of the child were massaged, and these movements were repeated several times. This technique is used to relax the feet and legs and help for preparation of the child for specific reflexology. It took two minutes.

Then the pressure was applied to points on the feet that correspond to the pain and fatigue in the body. These points are four important foot reflexology points which include the solar plexus, pituitary, adrenal, and brain. The rotating thumb technique was used as the researcher put four fingers on the dorsal aspect of the patient's foot and kept the thumb free to work on the sole. Bend the thumb from the first joint to between a 75 and 90-degree angle and the angle must ensure that the thumbnail doesn't dig into the flesh then apply firm pressure with the tip of the thumb to the point to be worked on with rotate the thumb, clockwise., then lift the thumb, move to the next point and repeat the procedure so, the basic movement is, press in, rotate, lift and move. Reflexology was performed by the researcher for 8 minutes on each foot. The cycle of foot reflexology was applied in the second foot as the first foot for 20 minutes and a total of 40 min for both. After completing the procedure on the right foot, the practitioner switched to the left foot. The reflex points where reflexology was applied on the left foot. After completing the left foot, the procedure was completed by performing relaxing strokes on both feet.

Control Group: The participants in the control group did not receive the reflexology intervention.



Louise Keet. (2008): The Reflexology Bible: The Definitive Guide to Pressure Point Healing. 1st ed. Octopus Publishing Group Ltd 2008. Pp 96-174.

Evaluation:

Re-evaluate the impact of foot reflexology technique on pain intensity, sleep quality, and fatigue among children undergoing surgical procedures was done using the same pretest tools Tool (II) A Visual Analogue Scale, Tool (III): Visual Analogue Scale for Fatigue, Tool (IV): Pittsburgh Sleep Quality Index on both groups and were scaled for children by the researcher. For the experimental group before and after received foot reflexology for 40 minutes (20 min for each foot) in addition to routine care whereas, for the control group it was estimated before and after received routine care only. Finally, the mean of the data was compared between the study and control groups.

Administrative design:

Administrative permission was obtained through an issued letter from the Dean of the Faculty of Nursing, Sohag University Hospital to the directors of the surgical pediatric wards.

Statistical analysis:

SPSS version 19 (Statistical Package for Social Science) was used for both data entry and analysis. The numbers, percentages, means, medians and standard deviations of the data were displayed. Qualitative variables were

compared using the Fisher exact test and the Chi-square test. The quantitative variables between the two groups were compared using the Mann-Whitney test. P-values less than 0.05 are regarded as statistically significant.

Results:

Table (1): Illustrated that the age of the studied children in the experimental group (58%) and children in the control group (54%) were 9 to 12 years old, with $M \pm SD$ (9.22 ± 3.33 and 9.12 ± 3.00 respectively). in the experimental and control groups (60 % and 58 %, respectively) were boys. Concerning **Educational level**, (50 % and 52 %, respectively) were in the third level. in The experimental and control groups. Regarding residence, 74% were from rural areas in the experimental group compared to 70% in the control group. Concerning demographic data, there was no statistically significant difference between the animated stories intervention group and the control group.

Table (2) shows that in the experimental group, 50% of the children were undergoing Tonsillectomy & Adenectomy, compared to in the control group, 46.0% of the children were undergoing Tonsillectomy & Adenectomy, followed by those exposed to

different types of accident (36.0%). Regarding previous hospitalization, (78% and 80%, respectively) of studied children in the experimental group and control group had no history of previous hospitalization.

Table (3): Demonstrates the mean pain scores of among the children undergoing surgical procedures pre and post-foot reflexology in the two groups. As shown post-foot reflexology intervention, there was a difference between the mean scores **pre and post-foot reflexology** among children undergoing surgical procedures regarding the level of pain in the experimental group was statistically significant at $p < 0.05$ level.

Figure (1): Revealed that during the pretest (80% and 85%) of the children undergoing surgical procedures had a moderate level of pain in both experimental and control groups respectively. However, during the posttest, all of the post-children undergoing surgical procedures (100) had mild levels of pain in the experimental compared to 70% in the control group who had mild levels of pain.

Table (4): illustrates the mean **fatigue** scores of among the children undergoing surgical procedures pre and post-foot

reflexology in the two groups. As shown post-foot reflexology intervention, the results indicated a highly statistically significant reduction and differences in the **fatigue** scores among the two studied groups ($P = < 0.001$).

Table (5): illustrates the mean **sleep quality** scores of among the children undergoing surgical procedures pre and post-foot reflexology in the two groups. As shown post-foot reflexology intervention, there was statistically significant improvement detected between the mean scores **pre and post-foot reflexology** among children undergoing surgical procedures regarding sleep quality in the experimental group at $p < 0.05$ level.

Figure (2): Revealed that in the pretest all of the post-children undergoing surgical procedures (100 and 100) had poor sleep patterns in both experimental and control groups respectively. Also, the same figure demonstrated that in the posttest, (93%) of the post-children undergoing surgical procedures had good sleep quality in the experimental group and poor sleep quality in the control group was among all children undergoing surgical procedures.

Table (1): The studied children distribution in experimental and control groups regarding their demographic data

Demo graphic data	Experimental group (n= 100)		Control group (n= 100)		P-value
	No	%	No	%	
Age: (years)					
6 - < 9	42	(42.0%)	46	(46.0%)	0.514
9 - ≤ 12	58	(58.0%)	54	(54.0%)	
Mean ± SD	9.22 ± 3.33		9.12 ± 3.00		0.335
Gender:					
Boys	60	(60.0%)	58	(58.0%)	0.664
Girls	40	(40.0%)	42	(42.0%)	
Educational level:					
- First	8	8.0	10	10.0	2.40
- Second	10	10.0	18	18.0	
- Third	50	50.0	52	52.0	
- Fourth	22	22.0	10	10.0	
- Fifth	5	5.0	6	6.0	
- Sixth	5	5.0	4	4.0	
Residence:					
-Rural	74	74.0	70	70.0	2.0
-Urban	26	26.0	30	30.0	

Table (2): The studied children distribution in experimental and control groups regarding their clinical data

Clinical data	Experimental group (n=100)		Control group(n=100)		P-value
	No	%	No	%	
Medical diagnosis					
Tonsillectomy & Adenectomy	50	(50.0%)	46	(46.0%)	0.896
Accident	32	(32.0%)	38	(38.0%)	
Hernia	9	(9.0%)	8	(8.0%)	
Intestinal Obstruction	4	(4.0%)	4	(4.0%)	
Others	3	(3.0%)	4	(4.0%)	
Previous hospitalization					
Yes	22	(22.0%)	20	(20.0%)	0.987
No	78	(78.0%)	80	(80.0%)	

Table (3): Comparison between mean pain score pre- and post between both children undergoing surgical procedures in experimental and control groups

Mean pain score	Experimental group (n=100)	Control group (n=100)	t-test	P-value
	Mean ±SD	Mean ±SD		
Pre-foot reflexology	7.9 ± 1.1	7.4 ± 0.6	0.447	0.660
Post-foot reflexology	3.1 ± 0.9	7.2 ± 1.2	6.67	<0.001 *

NS=Non significant, *= significant at p<0.05 level

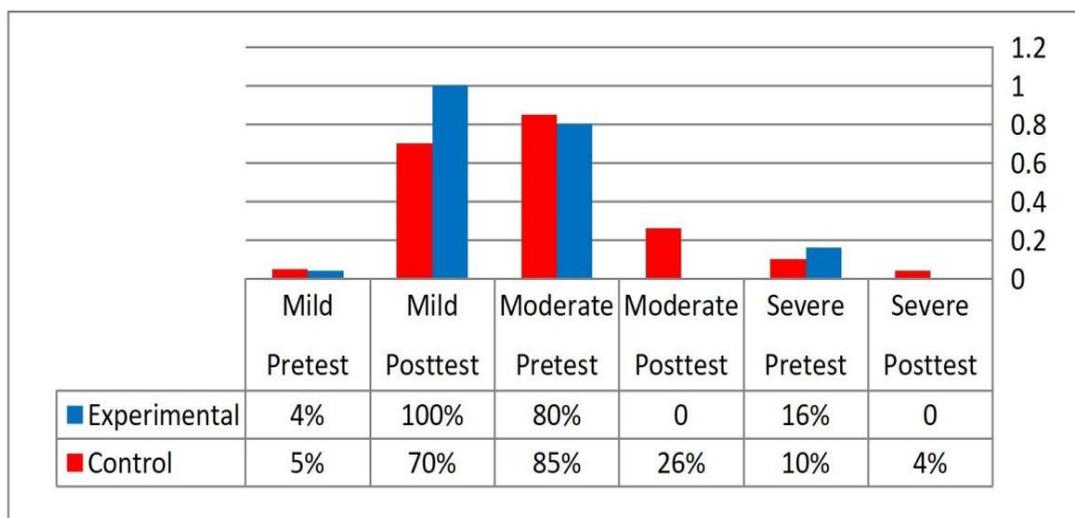


Figure (1): Children undergoing surgical procedures distributed in experimental and control groups according to pain level pretest and posttest (N=200).

Table (4): Comparison between mean fatigue score pre- and post between both children undergoing surgical procedures in experimental and control groups

Mean fatigue score	Experimental group (n= 100)	Control group (n= 100)	t-test	P-value
	Mean \pm SD	Mean \pm SD		
Pre-foot reflexology	114.6 \pm 9.8	111.5 \pm 15.3	0.289	0.660
Post-foot reflexology	94.7 \pm 11.3	105.5 \pm 10.6	16.43	<0.001 *

*Statistically significant level at P < 0.001

Table (5): Comparison between sleep quality index mean scores pre- and post between both children undergoing surgical procedures in experimental and control groups

Mean sleep quality index score	Experimental group (n= 100)	Control group (n= 100)	t-test	P-value
	Mean \pm SD	Mean \pm SD		
Pre-foot reflexology	14.3 \pm 1.7	14.1 \pm 2.6	0.530	0.598
Post-foot reflexology	11.4 \pm 2.2	13.1 \pm 1.3	9.49	<0.001 *

NS=Non significant, *= significant at p<0.05 level

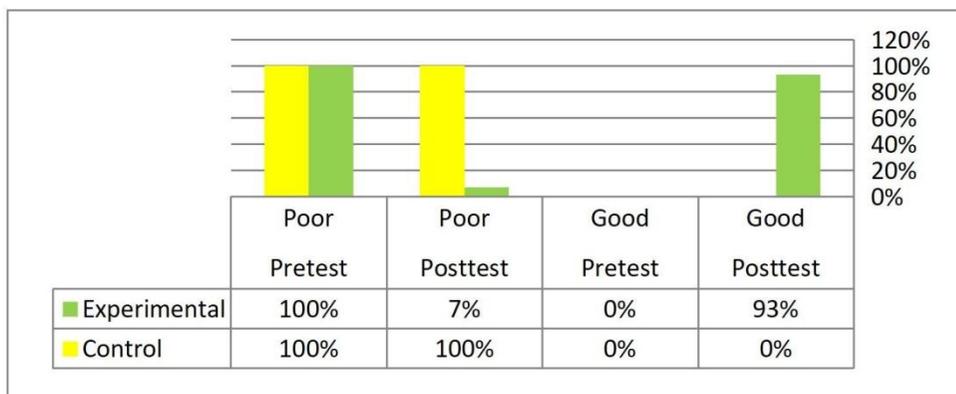


Figure (2): children undergoing surgical procedures distributed in experimental and control groups according to sleep quality pre and post-foot reflexology (n=200).

Discussion:

The study was conducted to evaluate the impact of foot reflexology technique on pain intensity, sleep quality, and fatigue among children undergoing surgical procedures, which meets the research hypothesis. The results of the present study showed that foot reflexology alleviated pain and fatigue and improved the quality of sleep after surgical procedures. The effects of foot reflexology on pain, fatigue, and quality of sleep were clinically important.

The results of this investigation showed that there were no differences in the demographic or clinical data between the two groups. As per the researchers' perspective, this outcome indicates that both groups had similar baseline levels of pain, fatigue, and sleep quality.

The results of this demonstrated that there was a difference between the mean scores **pre and post-foot reflexology** among children undergoing surgical procedures regarding the level of pain in the experimental group was statistically significant at p<0.05

level. According to the researchers, demonstrate the benefits of applying foot reflexology intervention to patients, since they help them reduce pain. The study "A Quasi-Experimental Study to Evaluate the Effects of Foot Massage on Pain in Post-Surgery Patients Admitted to Selected Hospitals in Hoshiarpur, Punjab" conducted by **Farrokhian et al., (2021)** and **Ghaljaei & Jalalodini, (2021)** also reports similar findings.

This result was supported by the finding from a study done by **Bakir et al., (2018)** who showed that foot reflexology applied to rheumatoid arthritis patients is effective in reducing their pain symptoms. Also, this result was in agreement with another study carried out by **Gökmetin et al., (2021)** who concluded that foot reflexology significantly reduced pain mean scores in leukemic children after receiving 20 min foot reflexology. Moreover, the result of the present study was in the same line as those of the previous study of **Taheri et al., (2019)**, who investigated pain in patients after appendectomy and indicated a positive effect of foot reflexology on pain relief. Reflexology has favorable impacts on lowering pain and anxiety, in the researcher's opinion as vital energy flows along the paths of the feet to all parts of the body. Stimulation of reflexology can break these barriers in the canal flow and release energy in each foot, inactivating the pain paths by secreting morphine-like compounds (**Robison, & Smith, 2019**)

The results of the current study revealed that in the posttest all of the post-children undergoing surgical procedures had mild levels of pain in the experimental compared to less than three quarters in the control group who had mild levels of pain, indicating the efficacy of the foot reflexology applied. Similarly, long-term reflexology was found to be useful in reducing pain among populations with chronic pain and was quite successful in lowering pain (**Dikmen & Terzioğlu, 2019**). I.e. Based on the hypothesis of gate control, the brain stem blocks the transmission of pain stimuli when an individual experiences an adequate or excessive level of sensory stimulation. More pain is seen when there are low sensory inputs because pain stimuli are not blocked

(**Rambod et al., 2019**). According to several theories (**Rambod et al., 2019; Yağcı & Saygın, 2019**), reflexology might enhance sensory stimulation through the skin, speed up mobilization, promote comfort and relaxation, and make it easier for metabolites to be excreted by increasing blood circulation. Similarly, **Karamisefat et al., (2021)** found the same results.

In addition, this result was supported by **Imani et al., (2020)** who conducted a randomized controlled trial to determine the effect of foot reflexology on postoperative pain in patients undergoing tibia plating surgery and found that the baseline pain scores in the intervention and control groups were reported 8.1 ± 0.9 and 8.4 ± 0.9 , respectively but, after performing foot reflexology for 10 minutes, one hour before surgery the pain score in these groups was reduced to 6.9 ± 1.1 and 8.1 ± 1.0 , respectively. Besides that, **Ozturk et al., (2018)**, were congruent with the present study as they reported that the average pain score of the experimental group was statistically lower than that of the control group at 30 and 60 min after applying the reflexology with significant differences found between pain score averages on the postoperative pain first, second and third days when reflexology was administered to the patients in the experimental group. From the perspective of the researchers, the effectiveness of the foot reflexology intervention is suggested and this result supports the study's central hypothesis by demonstrating the beneficial benefits of foot reflexology on patients' pain levels.

Concerning the mean **fatigue** scores among the children undergoing surgical procedures pre and post-foot reflexology in the two groups. As shown post-foot reflexology intervention, the results indicated a highly statistically significant reduction and differences in the **fatigue** scores among the two studied groups.

Previous studies on the effect of reflexology on fatigue and their findings suggest that reflexology reduces fatigue (**Bastani et al., 2019**). In the present study, it was determined that reflexology reduced fatigue and increased energy levels over time.

The mechanism through which reflexology reduces fatigue may be explained by the energy and lactic acid theories. Pressure applied to nerve endings in the foot acts as a sensor for certain parts of the body, increasing blood circulation, boosting energy, and promoting relaxation. Because toxins such as calcium, lactate, and uric acid accumulate in the reflex zones of the feet, applying pressure to these points promotes the excretion of these toxins, thus accelerating the detoxification process. As a result, reflexology improves blood circulation by relieving tension in muscles, facilitating oxygen and nutrient transport to cells, and reducing fatigue by increasing energy (Rambod et al., 2019). The reduction in perceived fatigue following reflexology performed after surgery may be a result of increased comfort and relaxation. This supports the study hypothesis that reflexology reduces fatigue levels

The results of the current study illustrated the mean **sleep quality** scores of among the children undergoing surgical procedures pre and post-foot reflexology in the two groups. As shown post-foot reflexology intervention, there was a statistically significant improvement detected between the mean scores **pre and post-foot reflexology** among children undergoing surgical procedures regarding sleep quality in the experimental group. In the present study, participants who received reflexology had significantly improved sleep quality. Reflexology is thought to improve sleep quality via nerve stimulation and sympathetic/parasympathetic system activation. The sympathetic and parasympathetic nerves that regulate tissue and organ function terminate in the ears, hands, feet, and eyes. Stimulating the relevant points in these areas results in the activation of the sympathetic and parasympathetic nervous systems. In people with pain, stress, and anxiety, stimulating the parasympathetic nervous system through reflexology to the left foot provides relaxation. According to the nerve impulse theory, there are nerve receptors with many different properties in the skin, and neural interconnections in the spinal cord directly affect the muscles.

Stimulation of nerve receptors in the feet with reflexology is thought to result in regional activation in the spinal cord and brain due to signals generated by the opening of ion channels in the cellular plasma membranes (Feng et al., 2018; Yağcı & Saygın, 2019). This decreases muscle tension and improves sleep quality by providing relaxation of the body (Rambod et al., 2019). This supports the study hypothesis that reflexology increases sleep quality.

The results of the current study revealed that in the post-test, most of the post-children undergoing surgical procedures had good sleep quality in the experimental group. According to the researchers, this demonstrated the positive effects of foot **reflexology** on improving the quality of sleep. Few studies have examined the effect of reflexology on postpartum sleep quality. Improved sleep quality was reported by Deepshika (2019) with reflexology applied for 15 minutes once a day for the first 3 days, and by Li et al. (2019) with reflexology applied for 30 min once a day for the first 5 days. Manjuri and Latheef (2019) reported similar results. Long-term reflexology was also reported to increase sleep quality in different samples with chronic disorders (Dikmen & Terzioğlu, 2019; Unal & Balci Akpınar, 2019). In addition, reflexology duration and session number were positively correlated with sleep quality in two different meta-analysis studies (Wang et al., 2020).

Conclusion:

According to the findings of the current study, the current study concluded that Foot reflexology affects reducing Pain intensity, improving sleep quality, and decreasing Fatigue among Children undergoing surgical procedures. The results of the study showed that there was a statistically significant difference ($p < 0.05$) in the mean pretest and posttest scores for pain severity, fatigue, and sleep quality in the experimental group.

Recommendation:

In the light of the findings obtained from the current study, the following recommendations were suggested:

- Foot reflexology could be applied as a non-pharmacological strategy and complementary therapy along with routine care to manage Pain intensity, sleep quality, and Fatigue among Children undergoing surgical procedures.

- Replicating the current study with a broader sample of children undergoing surgery in different settings is necessary to generalize the findings.

- More research should be done to determine how well different non-pharmacological treatments work together to address children's pain and anxiety.

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