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E-mail: docritikkashwani@yahoo.com
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Effectiveness of foot reflexology on chemotherapy-related symptoms management: A randomized interventional study

P. Jega Juliet[1,*], Santhi Appavu[2], D. Sasikala[3], B. Joel Jebin Moses[4], Manju Sudhakar[3], Padmavathy Murugan[4], Anitha Ramalingam[5] & S. Madhubala[6]

[1]Department of Mental Health Nursing, Christian College of Nursing, Neyoor, India; [2]Department of Medical Surgical Nursing, Christian College of Nursing, Neyoor, India; [3]Department of Medical Surgical Nursing, Apollo College of Nursing, Chennai, India; [4]Department of MPT (Cardio-Respiratory), Christian College of Physiotherapy, Colachel, India; [5]Department of Medical Surgical Nursing, Government Medical College and Hospital, Omandurar, Chennai, India; [6]Department of Mental Health Nursing, St. Xavier College of Nursing, Kumbakonam, India; *Corresponding author

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Affiliation URL:
https://www.tnmgrmu.ac.in/

Author contact:
P. Jega Juliet - E-mail: julietjebin@gmail.com, jegajuliet@ccnneyyoor.edu.in
Santhi Appavu - E-mail: a_santhi67@yahoo.in
D. Sasikala - E-mail: sagasi143@gmail.com
B. Joel Jebin Moses - E-mail: joeljebin@gmail.com
Manju Sudhakar - E-mail: manjusudhakar660@gmail.com
Padmavathi Murugan - E-mail: padmavathy.murugan7@gmail.com
Anitha Ramalingam - E-mail: ani.ram86@yahoo.com
S. Madhubala - E-mail: madhubalasingaravel@gmail.com

Abstract:
Cancer-related symptoms such as pain, nausea, vomiting, anxiety and depression substantially impair the quality of life of patients receiving chemotherapy. Therefore, it is of interest to evaluate the effectiveness of foot reflexology in 250 cancer patients undergoing chemotherapy, with 125 patients receiving foot reflexology plus routine care and 125 receiving routine care alone. Symptoms of pain, nausea and vomiting, depression and anxiety were assessed before and after the intervention and the experimental group demonstrated significantly greater improvement than the control group ($p < 0.001$). Foot reflexology effectively reduced physical and psychological symptom burden when used as an adjunct to standard cancer care. Thus, data shows the integration of foot reflexology into routine nursing practice as a safe, non-pharmacological approach for improving symptom management and patient well-being during chemotherapy.

Keywords: Cancer, foot reflexology, pain, nausea and vomiting, anxiety, depression, chemotherapy, randomized interventional study

Background:
Cancer is one of the leading causes of morbidity and mortality worldwide and remains a major public health, societal and economic challenge in the 21st century. According to the Global Burden of Disease (GBD) 2023 Cancer Collaborators, cancer accounts for nearly one in six deaths globally, with the burden expected to increase substantially by 2050 **[1]**. The International Agency for Research on Cancer (IARC) estimated approximately 20 million new cancer cases and 9.7 million cancer-related deaths worldwide in 2022, with lung cancer the most commonly diagnosed cancer (12.4%) and the leading cause of cancer mortality (18.7% of all cancer deaths) **[2]**. In India, cancer has emerged as a significant health concern, with an estimated 1,461,427 new cancer cases in 2022 and a crude incidence rate of 100.4 per 100,000 populations; lung cancer is the most common cancer among males and breast cancer the leading cancer among females, with incidence projected to increase by 12.8% by 2025 compared with 2020 levels **[3]**. Chemotherapy remains one of the most commonly used treatment modalities and can provide cure, disease control, symptom relief and improved quality of life; however, it is frequently associated with distressing symptoms such as pain, nausea and vomiting, anxiety and depression that adversely affect patients' physical and psychological well-being **[4]**. Complementary and alternative therapies have gained increasing attention in cancer care for managing treatment-related symptoms and enhancing quality of life. Reflexology is a non-pharmacological therapeutic approach involving the application of pressure to specific reflex points on the feet or hands that correspond to various organs and systems of the body, believed to restore homeostasis, promote relaxation, improve circulation and reduce physical and emotional stress **[5]**. Several studies have reported that foot reflexology can reduce pain, alleviate anxiety, promote relaxation and improve overall well-being among patients with cancer **[6]**. Foot reflexology involves systematic massage and stimulation of reflex points on the feet, which may activate neural pathways, enhance blood circulation and facilitate relaxation responses throughout the body **[7]**. Proposed mechanisms include the breakdown of crystalline deposits in reflex zones, thereby improving physiological functioning, as well as the regulation of energy pathways similar to those described in complementary therapies such as acupuncture and therapeutic touch **[8]**. Therefore, it is of interest to evaluate the effectiveness of foot reflexology in reducing pain, nausea and vomiting, anxiety and depression among patients with cancer undergoing chemotherapy.

Methodology:
Study design and setting:
A randomized interventional study was conducted at two cancer centres from January 2016 to January 2017. Ethical clearance was obtained from the Institutional Ethics Committee of Apollo College of Nursing, Chennai.

Sample size and participants:
The sample size was calculated using a power analysis method with a Type I error (α) of 0.05 and a power of 80% ($1-\beta = 0.80$). Based on a standard deviation of 6.71 and pre-test mean scores of 51.0 and 54.5 in the experimental and control groups respectively, the required sample size was estimated at 116 participants (58 per group). To enhance generalizability and

account for potential attrition, 254 cancer patients (127 per group) were initially recruited; following attrition, 250 participants (125 in the experimental group and 125 in the control group) were included in the final analysis. Participants were selected using a group randomisation method based on predefined eligibility criteria. Cancer patients aged 25-54 years who were undergoing chemotherapy and had a minimum hospital stay of 10 days were included; patients who were terminally ill, undergoing surgical procedures, had neurological disorders, or were severely debilitated were excluded.

Ethical considerations:
The purpose of the study was explained to all participants and written informed consent was obtained prior to data collection. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and Good Clinical Practice guidelines and confidentiality of all participant information was maintained throughout the study.

Data collection instruments:
Demographic and clinical data were collected using a structured questionnaire. Pre-test assessments of pain, nausea and vomiting, depression and anxiety were conducted using the Numerical Pain Rating Scale, Modified Rhodes Nausea and Vomiting Index, Modified Major Depression Inventory and Modified State-Trait Anxiety Scale, respectively. The reliability co-efficients of the instruments were satisfactory: pain (r=0.812), nausea and vomiting (r=0.862), depression (r=0.798) and anxiety (r=0.902).

Intervention protocol:
The intervention consisted of foot reflexology administered to participants in the experimental group for 30 minutes daily (15 minutes per foot) for 10 consecutive days in addition to routine care. The reflexology procedure involved stimulation of general reflex points followed by specific reflex points related to pain, nausea and vomiting, depression and anxiety. Participants in the control group received routine care alone.

Statistical analysis:
Data were analysed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including frequency, percentage, mean and standard deviation, were used to summarise the data. The Chi-square test was used to assess homogeneity of demographic and clinical variables between groups. Paired t-tests were used to compare pre-test and post-test scores within each group, while independent t-tests were used to compare post-test symptom scores between groups. A p-value of less than 0.05 was considered statistically significant.

Results:
The demographic characteristics revealed that the majority of participants in both the experimental (64.8%) and control (72.0%) groups were aged between 45 and 54 years. Females constituted 52.8% of the experimental group, while males accounted for 54.4% of the control group. Most participants were Christians, married, belonged to nuclear families and had a monthly income below ₹10,000. No statistically significant differences were observed between the groups with respect to demographic characteristics, indicating that both groups were comparable and homogeneous before the intervention **(Table 1)**. Regarding clinical characteristics, breast cancer was the most common diagnosis in both groups (40%), followed by head and neck cancers. The majority of patients had duration of illness below two years, were in Stage II of cancer, had undergone fewer than five previous hospitalisations and had no prior exposure to alternative therapies, indicating that the study groups were comparable at baseline **(Table 2)**. In the experimental group, the mean pain score decreased significantly from 2.5±0.6 during the pre-test to 0.3±0.5 during Post-test 2 ($t=43.9$, $p<0.001$), whereas no meaningful reduction was observed in the control group. The mean nausea and vomiting score decreased significantly from 25.8±4.3 in the pre-test to 3.9±2.6 in Post-test 2 among the experimental group ($t=62.84$, $p<0.001$), with no significant improvement in the control group. The mean depression score in the experimental group decreased from 37.0±3.3 before the intervention to 4.8±1.5 after the intervention ($t=112.7$, $p<0.001$) and anxiety scores decreased significantly from 62.5±3.6 to 34.9±2.6 ($t=73.2$, $p<0.001$); depression and anxiety scores remained almost unchanged in the control group. Full within-group comparisons across Pre-test, Post-test 1 and Post-test 2 are presented in **Table 3**. Comparison of Post-test 2 scores between the experimental and control groups further confirmed the effectiveness of the intervention. The experimental group showed significantly lower mean scores for pain (0.3±0.5 vs. 2.4±0.6), nausea and vomiting (3.9±2.6 vs. 25.2±4.3), depression (4.8±1.5 vs. 36.8±3.0) and anxiety (vs. 63.0±3.2) compared with the control group ($p<0.001$), as summarised in **Table 4**. Correlation analysis revealed no significant relationship between pain and nausea or vomiting scores, or between depression and anxiety scores, in either group throughout the study period **(Tables 5 and 6)**. Although symptom reduction occurred following the intervention, the improvements appeared to occur independently of one another.

Table 1: Frequency and percentage distribution of demographic variables in the experimental and control groups of patients with cancer

Demographic Profile	Components	Experimental n=125 f (%)	Control n=125 f (%)	χ^2 (df)	P value
Age (years)	25-34	14 (11.2)	5 (4.0)	4.737 (2)	P=0.094
	35-44	30 (24.0)	30 (24.0)		
	45-54	81 (64.8)	90 (72.0)		
Gender	Male	59 (47.2)	68 (54.4)	1.295 (1)	P=0.255
	Female	66 (52.8)	57 (45.6)		
Religion	Christian	59 (47.2)	68 (54.4)	2.706 (2)	P=0.258
	Hindu	57 (45.6)	53 (42.4)		
	Muslim	9 (7.2)	4 (3.2)		

Marital status	Married	107 (85.6)	112 (89.6)	5.400 (2)	P=0.145
	Unmarried	12 (9.6)	4 (3.2)		
	Widowed	6 (4.8)	9 (7.2)		
Education	High School	36 (28.8)	39 (31.2)	0.751 (3)	P=0.861
	Higher Secondary	39 (31.2)	41 (32.8)		
	Graduate	40 (32.0)	38 (30.4)		
	Post Graduate	10 (8.0)	7 (5.6)		
Income (₹ '000)	<5	25 (20.0)	69 (55.2)	33.624 (3)	P=0.000*
	10-May	72 (57.6)	42 (33.6)		
	15-Oct	19 (15.2)	11 (8.8)		
	15+	9 (7.2)	3 (2.4)		
Type of family	Nuclear	87 (69.6)	92 (73.6)	0.492 (1)	P=0.483
	Joint	38 (30.4)	33 (26.4)		
Occupation	Unemployed	40 (32.0)	44 (35.2)	12.008 (2)	P=0.000*
	Labourer / Daily wage	41 (32.8) / 30 (24.0)	22 (17.6) / 50 (40.0)		
	Professional	14 (11.2)	9 (7.2)		
Hobbies	TV watching	73 (58.4)	81 (64.8)	1.536 (3)	P=0.674
	Reading / Music	26 (20.8) / 16 (12.8)	25 (20.0) / 12 (9.6)		
	Keeping pets	10 (8.0)	7 (5.6)		

** Statistically significant (p < 0.05).*

Table 2: Frequency and percentage distribution of clinical variables in the experimental and control groups of patients with cancer

Clinical Variables	Components	Experimental n=125 f (%)	Control n=125 f (%)	χ^2 (df)	P value
Cancer site	Head & Neck	30 (24.0)	60 (24.0)	0.0005 (5)	P=1.00
	GI Tract	19 (15.2)	19 (15.2)		
	Respiratory Tract	12 (9.6)	12 (9.6)		
	Uterus	6 (4.8)	6 (4.8)		
	Breast	50 (40.0)	50 (40.0)		
	Cervix	8 (6.4)	8 (6.4)		
Duration of illness	Below 2 years	95 (76.0)	90 (72.0)	0.5201 (1)	P=0.471
	2-4 years	30 (24.0)	35 (28.0)		
Stage of cancer	Stage I	22 (17.6)	22 (17.6)	0.0003 (3)	P=1.00
	Stage II	46 (36.8)	46 (36.8)		
	Stage III	41 (32.8)	41 (32.8)		
	Stage IV	16 (12.8)	16 (12.8)		
Duration of treatment	Less than 2 years	102 (81.6)	99 (79.2)	0.2281 (1)	P=0.633
	3-4 years	23 (18.4)	26 (20.8)		
No. of chemotherapy cycles	2nd-3rd	24 (19.2)	13 (10.4)	6.3855 (5)	P=0.271
	4th	38 (30.4)	33 (26.4)		
	5th	29 (23.2)	35 (28.0)		
	6th	24 (19.2)	28 (22.4)		
	7th	10 (8.0)	16 (12.8)		
No. of previous hospitalisations	Below 5 times	85 (68.0)	63 (50.4)	10.5622 (2)	P=0.005*
	5-10 times	34 (27.2)	44 (35.2)		
	More than 10 times	6 (4.8)	18 (14.4)		
Exposure to alternative therapy	Acupressure	6 (4.8)	11 (8.8)	9.9176 (6)	P=0.042*
	Acupuncture	4 (3.2)	3 (2.4)		
	Herbal medicine	10 (8.0)	11 (8.8)		
	Siddha	13 (10.4)	2 (1.6)		
	No exposure	92 (73.6)	98 (78.4)		
Duration of exposure	No exposure	96 (76.8)	101 (80.8)	1.0563 (3)	P=0.590
	Below 6 months	25 (20.0)	19 (15.2)		
	6-12 months	4 (3.2)	5 (4.0)		

** Statistically significant (p < 0.05).*

Table 3: Comparison of mean and standard deviation of pain, nausea and vomiting, depression and anxiety within the experimental and control groups across Pre-test, Post-test 1 and Post-test 2

Variable	Comparison	Group	Level I (Mean±SD)	Level II (Mean±SD)	Paired t	df	P value
Pain	Pre-test vs Post-test 1	Experimental	2.5±0.6	1.5±0.5	40.3	124	P=0.000*
	Post-test 1 vs Post-test 2	Experimental	1.5±0.5	0.3±0.5	27.6	124	P=0.000*
	Pre-test vs Post-test 2	Experimental	2.5±0.6	0.3±0.5	43.9	124	P=0.000*
	Pre-test vs Post-test 1	Control	2.5±0.6	2.48±0.6	2.7	124	P=0.008*
	Post-test 1 vs Post-test 2	Control	2.5±0.6	2.4±0.6	3.46	124	P=0.001*
	Pre-test vs Post-test 2	Control	2.5±0.6	2.4±0.6	4.57	124	P=0.000*
Nausea & vomiting	Pre-test vs Post-test 1	Experimental	25.8±4.3	12.2±4.0	51.25	124	P=0.000*
	Post-test 1 vs Post-test 2	Experimental	12.2±4.0	3.9±2.6	32.82	124	P=0.000*
	Pre-test vs Post-test 2	Experimental	25.8±4.3	3.9±2.6	62.84	124	P=0.000*
	Pre-test vs Post-test 1	Control	25.3±4.3	25.3±4.3	1.93	124	P=0.05
	Post-test 1 vs Post-test 2	Control	25.3±4.3	25.2±4.3	1.45	124	P=0.149
	Pre-test vs Post-test 2	Control	25.3±4.3	25.2±4.3	1.86	124	P=0.065
Depression	Pre-test vs Post-test 1	Experimental	37.0±3.3	13.6±1.6	92.5	124	P=0.000*

	Post-test 1 vs Post-test 2	Experimental	13.6±1.6	4.8±1.5	61.4	124	P=0.000*
	Pre-test vs Post-test 2	Experimental	37.0±3.3	4.8±1.5	112.7	124	P=0.000*
	Pre-test vs Post-test 1	Control	36.7±3.1	36.8±3.0	1.23	124	P=0.223
	Post-test 1 vs Post-test 2	Control	36.8±3.0	36.8±3.0	0	124	P=1.000
	Pre-test vs Post-test 2	Control	36.7±3.1	36.8±3.0	1.1	124	P=0.275
Anxiety	Pre-test vs Post-test 1	Experimental	62.5±3.6	37.6±3.0	73.4	124	P=0.000*
	Post-test 1 vs Post-test 2	Experimental	37.6±3.0	34.9±2.6	13.7	124	P=0.000*
	Pre-test vs Post-test 2	Experimental	62.5±3.6	34.9±2.6	73.2	124	P=0.000*
	Pre-test vs Post-test 1	Control	62.8±3.4	63.0±3.2	2.3	124	P=0.012*
	Post-test 1 vs Post-test 2	Control	63.0±3.2	63.0±3.2	0	124	P=1.000
	Pre-test vs Post-test 2	Control	62.8±3.4	63.0±3.2	2.3	124	P=0.012*

** Statistically significant (p < 0.05).*

Table 4: Comparison of mean, standard deviation and independent t-test values for Post-test 2 pain, nausea and vomiting, depression and anxiety scores between the experimental and control groups

Selected Symptom	Test	Experimental (Mean±SD)	Control (Mean±SD)	Independent t	df	P value
Pain	Post-test 2	0.3±0.5	2.4±0.6	29.03	248	P=0.000*
Nausea & vomiting	Post-test 2	3.9±2.6	25.2±4.3	47.51	248	P=0.000*
Depression	Post-test 2	4.8±1.5	36.8±3.0	106.9	248	P=0.000*
Anxiety	Post-test 2	34.9±2.6	63.0±3.2	74.98	248	P=0.000*

** Statistically significant (p < 0.05).*

Table 5: Correlation between pain and nausea/vomiting symptoms at Pre-test, Post-test 1 and Post-test 2 among the experimental and control groups

Test	Physiological Symptoms	Experimental rs	Experimental P value	Control rs	Control P value
Pre-test	Pain with Nausea & Vomiting	-0.034	P=0.672	-0.088	P=0.349
Post-test 1	Pain with Nausea & Vomiting	0.154	P=0.209	-0.082	P=0.394
Post-test 2	Pain with Nausea & Vomiting	0.122	P=0.159	-0.121	P=0.199

Table 6: Correlation between depression and anxiety symptoms at Pre-test, Post-test 1 and Post-test 2 among the experimental and control groups

Test	Psychological Symptoms	Experimental r	Experimental P value	Control r	Control P value
Pre-test	Depression and Anxiety	-0.033	P=0.716	-0.156	P=0.082
Post-test 1	Depression and Anxiety	0.002	P=0.983	-0.152	P=0.090
Post-test 2	Depression and Anxiety	0.116	P=0.199	-0.137	P=0.127

Discussion:

The present study was conducted to assess the effectiveness of foot reflexology on selected symptoms among cancer patients undergoing chemotherapy. The findings showed that foot reflexology significantly reduced pain, nausea and vomiting, depression and anxiety among cancer patients receiving chemotherapy, whereas no meaningful change was observed in the control group. The significant reduction in pain observed in the experimental group is consistent with the study by Stephenson *et al.*, who reported that reflexology significantly reduced pain intensity and improved comfort among cancer patients receiving treatment **[9]**. The beneficial effect may be attributed to stimulation of specific reflex points that promote relaxation and activate endogenous pain-relieving mechanisms. Nausea and vomiting are among the most distressing side effects experienced by patients undergoing chemotherapy. Murat-Ringot *et al.*, who found that foot reflexology effectively, reduced chemotherapy-induced nausea and vomiting and improved patient comfort during treatment **[10]**. Psychological symptoms also showed significant improvement following the intervention. These findings are in agreement with Rajabzadeh *et al.*, who reported that foot reflexology significantly reduced depression among patients and was more effective than conventional relaxation measures **[11]**. Furthermore, Wang *et al.* and Chen *et al.* concluded that foot reflexology is an effective complementary intervention for reducing anxiety, depression and other psychological symptoms while improving overall well-being **[12, 13]**. Comparison of Post-test 2 scores between the experimental and control groups further confirmed the effectiveness of the intervention, with the experimental group showing substantially lower scores for all four symptoms ($p<0.001$), indicating that foot reflexology produced meaningful improvements in both physical and psychological symptoms among cancer patients undergoing chemotherapy. Although symptom reduction occurred following the intervention, correlation analysis indicated that improvements in pain, nausea and vomiting, depression and anxiety appeared to occur independently of one another rather than as a unified response. Overall, the findings suggest that foot reflexology is a safe, non-invasive, economical and effective complementary nursing intervention for reducing pain, nausea and vomiting, depression and anxiety among cancer patients receiving chemotherapy and that it can be incorporated into routine oncology nursing care to improve symptom management and enhance patients' quality of life.

Conclusion:

Foot reflexology may serve as an effective complementary nursing intervention for alleviating selected symptoms in patients undergoing chemotherapy. It reduced pain, nausea, vomiting, depression and anxiety compared with standard care, with potential benefits for physical and psychological well-being. Its safety, simplicity and affordability support its integration into routine oncology nursing practice to improve symptom management and quality of life.

Limitations:

The study was limited to two cancer centres and a 10-day intervention period, which may restrict the generalisability of the findings to other settings and longer treatment courses.

Future perspectives:
Foot reflexology may provide an additional non-pharmacological intervention for adults suffering from depression, anxiety or sleep disturbance. High-quality, rigorously designed randomized controlled trials in specific populations, with larger numbers of participants and longer-term follow-up, are recommended to strengthen the evidence regarding the long-term benefits of foot reflexology and to support its wider implementation in cancer care settings.

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Ethical approval:
Ethical clearance was obtained from the Institutional Ethics Committee of Apollo College of Nursing, Chennai, prior to data collection. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and Good Clinical Practice guidelines and written informed consent was obtained from all participants.

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