



Healthcare service utilization and work-related productivity in reflexology intervention for advanced breast cancer women

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Abstract

Purpose This project's purpose was to determine the effects of a home-based reflexology intervention on symptom-related use of health services and work-related productivity during the 11-week study.

Methods A total of 256 patients were randomized to four weekly reflexology sessions (each lasting 30 min, delivered by lay caregivers who received two training sessions by a professional reflexologist) or attention control. The Conventional Health Service and Productivity Costs Form was used to collect information on health service utilization and out-of-pocket expenditure of symptom management. The Health and Work Performance Questionnaire was used to measure workplace performance for patients during the study period. We used weighted and unweighted logistic and linear regression analyses.

Results Patients in the reflexology group were less likely to have hospital visits compared to the control group in the weighted unadjusted (odds ratio [OR] = 0.49; 95% confidence interval [CI] = [0.25, 0.97]), unweighted adjusted (OR = 0.35; 95% CI = [0.16, 0.75]), and weighted adjusted (OR = 0.30, 95% CI = [0.13, 0.66]) logistic regressions. Compared to attention control, patients in the reflexology group had lower relative absenteeism in the unweighted adjusted (−0.32; 95% CI = [−0.60, −0.03]) linear regressions and less absolute presenteeism (15.42, 95% CI = [0.87, 29.98]) in the weighted unadjusted analysis.

Conclusion The reflexology intervention delivered by lay caregivers reduced hospital visits and increased workplace productivity in a short-term period, which has potential for cost saving for health care systems and employers.

Trial registration [NCT01582971](https://www.clinicaltrials.gov/ct2/show/study/NCT01582971)

Keywords Breast cancer · Reflexology · Health service utilization · Health service expenditure, absenteeism, presenteeism

Introduction

Recent estimates projected that cancer care in the United States (U.S.) would cost \$157 billion annually by 2020, with a 27% increase in medical costs, of which prostate and breast cancer will have the greatest increase during the continuing phases of care [1]. Cancer care costs typically are highest in the first 12 months following diagnosis [2]. Breast cancer is

the most common cancer diagnosed among women. According to American Cancer Society, 255,180 persons in the U.S. were diagnosed with breast cancer and 41,070 died in 2017 [3].

Breast cancer patients with surgical treatment experience different levels of pain [4], and chemotherapy treatment gives rise to multiple additional symptoms [5]. Hospitalizations contribute to the increase in medical costs during breast cancer treatment. Evidence suggests that reductions in symptoms may be associated with fewer unscheduled health services [6, 7]. The purpose of this report was to evaluate the effects of a symptom management intervention on health services utilization, health care expenditures, and productivity using data from a recently completed randomized controlled trial of reflexology for managing symptoms among women with advanced breast cancer undergoing chemotherapy, targeted and/or hormonal therapy [8].

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Over 80% of women with breast cancer chose complementary and integrative health (CIH) therapies for at least a component of their symptom management after surgical intervention [9]. Reflexology was reported to be one of the commonly used CIH therapies for symptom management [10]. It involves applying a walking thumb pressure to particular points on the feet that are referred to as reflexes. Reflexology can be considered a supportive treatment used in combination with standard medical care. It is carried out by trained providers to help cancer patients receiving active therapy manage their symptoms and maintain their quality of life [11]. Currently, there is no established mechanism of action for how reflexology works to reduce symptoms. One physiologic theory is that reflexology activates receptors to release oxytocin for its positive effects on well-being [12]. A second theory is that applying pressure improves circulation, which in turn eliminates toxins and supports immune, nervous, and glandular systems [13]. A third theory is that the benefits are derived through activation of the relaxation response [14, 15]. A final theory proposes that reflexology reduces symptoms through the complex inputs and processing in the neuromatrix of the central nervous system [16, 17].

While an agreed upon mechanism of action is yet to be determined, the efficacy of reflexology in mitigating symptoms has been established [18–22]. Our previous studies showed both safety and efficacy of reflexology on improvements in physical function, dyspnea, and fatigue [23]. Our work also established that reflexology could be delivered successfully to patients by friends or family caregiver in the home, who were trained by a certified reflexologist [24], and caregiver-delivered reflexology was efficacious in reducing cancer symptom severity [8].

To date, few studies have examined the effect of reflexology on patient health care service utilization and employment productivity [25]. The aim of this paper was to determine the difference in symptom-related use of health services and employment productivity at study week 11 between women in treatment for advanced breast cancer in a randomized controlled trial who received either (1) four weekly sessions of home-based reflexology delivered by a trained friend or family lay caregiver; or (2) attention control. We hypothesized that women receiving reflexology compared to women in attention control would use fewer health service for symptom management and maintain higher employment productivity over the 11-week study.

Design

The study used a randomized clinical trial design [8]. Data were collected by telephone at baseline and week 11.

Participants

Women who had advanced breast cancer and were receiving chemotherapy, hormonal and/or targeted therapy were recruited from seven community-based medical oncology clinics and two comprehensive cancer centers in the Midwest. For the intervention arm, one of the patient's friend or family member (caregiver) who was willing to provide the 30-min protocol for four consecutive weeks also consented and enrolled. Patient inclusion criteria were age 21 or older, diagnosed with stage III or IV breast cancer, could perform basic activities of daily living, undergoing chemotherapy, targeted therapy, and/or hormonal therapy for breast cancer at enrollment, able to speak and understand English, able to hear normal conversation over the phone, and cognitively oriented to time, place, and person (determined by recruiters). Patient exclusion criteria were diagnosis of a major mental illness on the medical record and verified by the recruiter, residing in a nursing home, bedridden, currently receiving regular reflexology, or having symptoms of deep vein thrombosis or painful foot neuropathy.

Caregiver inclusion criteria were age 18 or older, able, willing to provide at least one 30-min protocol session per week for 4 consecutive weeks, could speak and understand English, had access to a telephone, able to hear normal conversations, and cognitively oriented to time, place, and person. Exclusion criterion was unwillingness to perform a return demonstration of the protocol according to training procedures. All the caregivers had two training sessions with a study reflexologist; however, the reflexologist did not work directly with study participants, but only with the caregiver.

Methods

Enrollment and randomization

Participants were enrolled in dyads (patient-caregiver) by trained recruiters, who were employed by the clinics and did not provide care to patients. Their study training included a script, didactic information, role-playing, problem cases, and return demonstration. Once consent was received at the clinic and the baseline interview was completed via telephone from the study office, the dyads were randomized into the reflexology group or the attention control group (weekly symptom calls only). A computerized minimization technique [26] was programmed by the team statistician to balance the groups on stage of breast cancer (III or IV), medical treatment (chemotherapy with or without hormonal therapy versus hormonal therapy alone), the recruitment location (oncology clinic) to control for any minor

variations in care between sites, and the severity of the most prevalent baseline symptom of fatigue. The project manager in the study office implemented the randomization to ensure location concealment.

Protocol

Women in the intervention group received four consecutive weekly reflexology sessions, each lasting 30 min, delivered by a friend or family caregiver, and completed weekly telephone symptom assessments by staff in the study office. A study reflexologist trained the friend/family caregiver during two home visits in weeks 1 and 2. Our previously validated cancer-specific protocol included nine locations on the foot referred to as reflexes [23]. This protocol consists of a thumb-walking pressure over each of the nine reflexes for 15 min per foot, totaling a 30-min session. On the first visit, the study reflexologist demonstrated the specific study protocol and trained the caregiver in stimulation of the nine reflexes, until 90% accuracy was achieved using a standard evaluation via a return demonstration on the reflexologist by the caregiver. The caregiver then performed session 1 on the patient while the reflexologist observed and coached. During session 2, the reflexologist observed and offered adjustments in techniques as the caregiver conducted the session on the patient. In the following 2 weeks, caregiver-patient sessions were conducted without the reflexologist present. Laminated instructions and the reflexologist's phone number were left with the dyad as a resource for weeks 3 and 4 of independent delivery of reflexology. Previous work established the minimum dose of reflexology was 4 weekly sessions [27].

Women in the attention control group only received the four weekly telephone symptom assessments. While the weekly symptom calls were part of data collection, they also provided a limited amount of attention and social interaction between the patient and the interviewer because the interview included inquiry about how the patient was doing. Weekly calls were conducted according to a standard script and lasted approximately 10–15 min each week for both groups. After the study, patients in the attention control group received a reflexology session or protocol training for a friend or family caregiver.

For a complete description of the trial, see [8]. The study was approved by the Michigan State University Institutional Review Board (IRB) and IRBs of the participating sites. All data were stored in a secure SQL server with firewalls.

Outcome measures

To measure the number of health services used and the amount of health service expenditure during the study period (11 weeks), the Conventional Health Service and

Productivity Costs Form (CHSPCF) was adapted [6]. It captures the number of times the patient visited an oncologist, emergency room, hospital, laboratory, and other providers (including primary care provider, social worker, psychologist, support group, and nurse) for symptom management. It also contains the total co-payment, deductibles, and out-of-pocket expenditure for each service type, in addition to medication, special supplies, and miscellaneous items. Because the utilization and expenditure data were highly skewed and many patients reported zero visits in some categories, data were dichotomized to capture use or no use of oncology, emergency care, hospital, and other services.

Among the patients who were working, the World Health Organization Health and Work Performance Questionnaire (HPQ) (7-Day clinical trial version) was used to assess the effect of the intervention on the workplace performance for patients at baseline and at week 11 [28, 29]. Four main absenteeism and presenteeism outcomes were calculated based on the HPQ instruments. The absolute absenteeism was measured by the difference between the expected and actual hours worked in the past 7 days, with a negative lower bound if a woman worked more than expected and a positive upper bound equal to the expected hours worked. The relative absenteeism is the ratio between absolute absenteeism and the expected hours worked. It ranges between a negative number and one. Higher absenteeism scores indicated more absenteeism and more loss in productivity. The absolute presenteeism was based on self-rated performance in the past 7 days on a scale from 0 to 100, with a higher score indicating a lower amount of lost performance. The relative presenteeism was the ratio of her own performance and the usual performance of most workers in a job similar to hers. Following the instructions of the instrument's authors, the relative presenteeism was restricted between 0.25 to 2, where the highest performance is 200% of other works' performance [28, 29].

Baseline covariates

The number of comorbid conditions was assessed using the Bayliss tool that queries 20 conditions [30]. Data on cancer stage, recurrence, metastasis, and medical treatments were obtained from the medical records.

The M.D. Anderson Symptom Inventory (MDASI) [31] evaluates the severity of 13 symptoms experienced by cancer patients (i.e., pain, fatigue, nausea, disturbed sleep, distress, shortness of breath, difficulty remembering, decreased appetite, drowsiness, dry mouth, sadness, vomiting, numbness/tingling) on a scale from 0 = not present to 10 = as bad as you can imagine, and the interference of these symptoms with daily life on a scale from 0 = does not interfere to 10 = completely interferes. Reliability and validity of the instrument are

established [28]. Summed symptom severity and interference scores were derived from this instrument.

Physical functioning was measured using Patient Reported Outcomes Measurement Information System (PROMIS) 4-item short form, which has good evidence of reliability and validity [32, 33]. The *T* score rescales the raw score into a standardized score with a mean of 50 and a standard deviation 10 for the general population.

Quality of Life Index (QLI) reflects both satisfaction and importance regarding various aspects of life, using 30 items for each [34]. Importance ratings are used to weight satisfaction responses, so that scores reflect satisfaction with the aspects of life that are valued by the individual. The total QLI score summarizes four domains: health and functioning, psychological/spiritual, social and economic.

Statistical analysis

This secondary analysis used all available data from week 11. The baseline characteristics between patients lost to follow-up and remaining patients were compared using chi-square or *t* tests. Baseline characteristics of patients in the reflexology versus control group among those who remained by week 11 were similarly tested.

When the patients who remained in the study at week 11 had systematically different characteristics from those who were lost to follow-up or when the patients in the two treatment arms had differential loss to follow-up, analyses using only retained patients may suffer from selection bias. Therefore, the inverse probability weighting (IPW) was used to correct potential bias [35]. The weight was the inverse of the probability of remaining in the study by week 11, predicted by baseline characteristics. Unweighted and IPW-weighted logistic regressions were used to explore the effect of reflexology intervention on having specific health service utilization, controlling for baseline covariates. For HPQ analysis, weighted and unweighted linear regression models were used, also controlling for baseline covariates. The trial was powered to detect an adjusted effect size of 0.4 with power ≥ 0.80 in two-tailed tests at 0.05 significance level for the primary endpoint of symptom severity. This secondary data analysis used all available data by week 11. Data analysis was carried out using Stata (version 15; StataCorp LP, College Station, TX, USA).

Results

Out of the total 256 patients, 180 (70%) remained in the study at 11 weeks. There were some systematic differences in baseline characteristics between patients who were lost to follow-up and those who remained in the study. Patients who were lost were more likely to receive chemotherapy ($p = 0.006$),

unmarried ($p = 0.024$), had fewer comorbid conditions ($p = 0.014$), higher MDASI symptom severity score ($p = 0.009$), higher MDASI symptom interference score ($p = 0.001$), lower PROMIS physical function score ($p = 0.003$), and lower quality of life measure ($p = 0.029$) (For more details see Appendix Table 5). Thus, these variables were used for estimating the weights in the IPW estimation.

Among patients randomized, 89 out of 128 reflexology patients (70%) and 91 out of 128 control patients (71%) remained in the study. During the 11-week study period, 3 patients died (2 in reflexology group), 38 patients could not be reached (18 in reflexology group), and 35 patients dropped out due to other reasons (18 in reflexology group). For details about other reasons for attrition, see [8]. There was little systematic difference in baseline variables between the reflexology and control patients who remained in the study (Table 1). Between these two groups, only age had a significant difference at 5% level ($p = 0.042$).

Table 2 shows the proportions of patients who used each category of health services, the median and interquartile range (IQR) for the number of visits and out-of-pocket expenditure for each category of services, and the productivity measures at week 11 by treatment groups. The numbers of employed women were 28 and 30 in the reflexology and control groups at week 11, respectively. These differed only slightly from the numbers of employed women at baseline (29 and 32, respectively). A lower proportion of reflexology patients had hospital visits (26% versus 40%, $p = 0.050$). No other service utilization, expenditure, or productivity measures differed between the two groups. While not statistically significant, the control group patients had higher absenteeism (less productive) and lower absolute presenteeism (less productive).

Table 3 presents the odds ratios (ORs) for the effect of reflexology on the utilization of each type of health care services using unweighted/weighted unadjusted/adjusted logistic regressions. Patients who received the reflexology intervention were less likely to have hospitalizations comparing to the control group during the study period in the weighted/unadjusted analysis (OR = 0.49; 95% CI [0.25, 0.97]), the unweighted/adjusted analysis (OR = 0.35; 95% CI [0.16, 0.75]), and the weighted/adjusted analysis (OR = 0.30; 95% CI [0.13, 0.66]). There were no other significant differences in utilization between the two groups.

Table 4 shows the unweighted/weighted unadjusted/adjusted absenteeism and presenteeism least squares regression results. In weighted/unadjusted models, the reflexology group had higher absolute presenteeism, i.e., better productivity, compared to controls ($\beta = 15.42$; 95% CI [0.87, 29.98]). In unweighted/adjusted models, the reflexology had lower relative absenteeism scores, i.e., less productivity loss, than control group ($\beta = -0.32$; 95% CI [-0.60, -0.03]).

Table 1 Baseline characteristics for patients

	All patients (<i>N</i> = 256)		Patients remained at week 11 (<i>N</i> = 180)		<i>p</i> value ^a
	Reflexology <i>N</i> = 128, <i>n</i> (%)	Control <i>N</i> = 128, <i>n</i> (%)	Reflexology <i>N</i> = 89, <i>n</i> (%)	Control <i>N</i> = 91, <i>n</i> (%)	
Metastatic cancer					
No	48 (37.5)	47 (36.7)	37 (41.6)	35 (38.5)	0.670
Yes	80 (62.5)	81 (63.3)	52 (58.4)	56 (61.5)	
Recurrent cancer					
No	87 (68.0)	93 (72.7)	60 (67.4)	67 (73.6)	0.361
Yes	41 (32.0)	35 (27.3)	29 (32.6)	24 (26.4)	
Therapy treatment					
Chemo/hormonal therapy	105 (82.0)	105 (82.0)	70 (78.7)	70 (76.9)	0.780
Hormonal therapy only	23 (18.0)	23 (18.0)	19 (21.3)	21 (23.1)	
Race					
White	105 (82.7)	107 (84.3)	74 (84.1)	79 (87.8)	0.772 ^{b,c}
Black or African American	13 (10.2)	13 (10.2)	8 (9.1)	6 (6.7)	
Other	9 (7.1)	7 (5.5)	6 (6.8)	5 (5.6)	
Marital status					
Never married	14 (10.9)	13 (10.2)	6 (6.7)	7 (7.7)	0.960
Married	89 (69.5)	87 (68.0)	65 (73.0)	65 (71.4)	
Divorced/separated/widowed	25 (19.5)	28 (21.9)	18 (20.2)	19 (20.9)	
Relationship to caregiver					
Spouse or partner	70 (54.7)	71 (55.5)	53 (59.6)	52 (57.1)	0.405
Child or stepchild	21 (16.4)	21 (16.4)	16 (18.0)	13 (14.3)	
Friend	11 (8.6)	17 (13.3)	6 (6.7)	13 (14.3)	
Other	26 (20.3)	19 (14.8)	14 (15.7)	13 (14.3)	
Employment					
Employed (full/part-time)	38 (29.7)	50 (39.4)	29 (32.6)	32 (35.6)	0.691 ^d
Retired	40 (31.2)	29 (22.8)	30 (33.7)	25 (27.8)	
Other	50 (39.1)	48 (37.8)	30 (33.7)	33 (36.7)	
Education					
High school degree/some HS	29 (22.8)	29 (22.7)	20 (22.7)	15 (16.5)	0.478 ^d
Some college/2-year degree	35 (27.6)	38 (29.7)	23 (26.1)	29 (31.9)	
4-year college graduate	30 (23.6)	33 (25.8)	20 (22.7)	26 (28.6)	
More than 4-year degree	33 (26.0)	28 (21.9)	25 (28.4)	21 (23.1)	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	<i>p</i> value ^e
Age, years	58.1 (11.6)	54.8 (10.3)	59.0 (11.0)	55.7 (10.5)	0.042
Number of comorbid conditions	4.4 (2.9)	4.4 (3.0)	4.6 (3.0)	4.7 (3.1)	0.814
MDASI symptom severity	44.5 (24.4)	42.5 (22.6)	41.4 (24.8)	40.7 (21.8)	0.846
MDASI symptom interference	22.3 (16.0)	22.5 (15.7)	20.1 (16.1)	20.3 (14.6)	0.955
PROMIS physical function	41.2 (7.6)	41.2 (8.1)	42.3 (7.0)	42.0 (8.1)	0.805
Quality of life index	21.7 (4.3)	21.1 (4.7)	22.3 (4.3)	21.4 (4.7)	0.169
	Median (IQR)	Median (IQR)	Median (IQR)	Median (IQR)	<i>p</i> value ^f
Absolute absenteeism in past 7 days	0 (0, 20)	5 (0, 20)	0 (−4, 10)	4 (0, 20)	0.270
Relative absenteeism in past 7 days	0 (0, 0)	0 (0, 0)	0 (0, 0)	0 (0, 0)	0.141
Absolute presenteeism in past 7 days	80 (70, 90)	80 (70, 90)	80 (65, 90)	80 (60, 90)	0.833
Relative presenteeism in past 7 days	1 (1, 1)	1 (1, 1)	1 (1, 1)	1 (1, 1)	0.347

MDASI, M.D. Anderson Symptom Inventory; PROMIS, Patient Reported Outcomes Measurement Information System; MSPSS, Multidimensional Scale of Perceived Social Support; SD, standard deviation; IQR, interquartile range (25th, 75th quantile)

^aBased on Chi-squared test

^bData missing for two patients

^cBased on Fisher exact test

^dData missing for one patient

^eBased on *t* test with unequal variance

^fBased on Wilcoxon rank-sum test

Discussion

It is important for breast cancer survivors (defined as individuals from the time of diagnosis to end of life

[34]) to enjoy all facets of life including accomplishing their social roles at their workplace and in society [1]. Results of this study point to reflexology delivered by friend or family caregivers as an intervention that can

Table 2 Health services utilization and expenditure at week 11 ($N = 180$)

	Reflexology $N = 89, n$ (%)	Control $N = 91, n$ (%)	p value ^a
Had oncology visits	76 (85.4)	81 (89.0)	0.467
Had emergent care visits	15 (16.9)	20 (22.0)	0.385
Had hospital visits	23 (25.8)	36 (39.6)	0.050
Had other service visits ^c	64 (71.9)	73 (80.2)	0.191
	Median (IQR)	Median (IQR)	p value ^b
Number of oncology visits	4 (2, 6)	4 (2, 8)	0.605
Number of emergent care visits	0 (0, 0)	0 (0, 0)	0.314
Number of hospital visits	0 (0, 1)	0 (0, 2)	0.060
Number of other service visits ^c	2 (0, 7)	3 (1, 11)	0.054
Oncology expenditure	0 (0, 80)	0 (0, 100)	0.653
Emergency care expenditure	0 (0, 0)	0 (0, 0)	0.692
Hospital expenditure	0 (0, 0)	0 (0, 0)	0.323
Other service expenditure ^c	210 (7, 720)	279 (60, 829)	0.114
	Reflexology $N = 28$	Control $N = 30$	p value ^b
Absolute absenteeism in past 7 days	0 (0, 6)	2 (0, 10)	0.582
Relative absenteeism in past 7 days	0 (0, 0)	0 (0, 0)	0.365
Absolute presenteeism in past 7 days	90 (75, 95)	80 (60, 90) ^d	0.087
Relative presenteeism in past 7 days	1 (1, 1)	1 (1, 1) ^e	0.161

IQR, interquartile range (25th, 75th quantile)

^a Based on Chi-squared test

^b Based on Wilcoxon rank-sum test

^c Other service visits include laboratory visits, primary care provider visits, social worker visits, psychology visits, support group visits, and nurse visits. Other expenditure in addition includes out-of-pocket expense for medication, personal care, special supplies, and miscellaneous expense related to cancer care

^d Data missing for three patients

^e Data missing for four patients

reduce hospitalizations and increase workplace productivity (lower absenteeism and higher presenteeism) in a short-term period. These findings complement earlier results on the efficacy of reflexology on patient quality of life and symptom management [8, 23], and are consistent with reports that reductions in symptoms are associated with lower unscheduled health services use [6, 36] and less productivity loss [37]. Studies using cross-sectional survey data for the comparison of healthcare utilization and productivity cost may suffer from confounding bias. Our study is the first that we know of to examine the effect of reflexology on healthcare utilization and productivity loss in a randomized controlled trial for advanced breast cancer patients. This study is also the only one that used the Health and Work Performance Questionnaire (HPQ) to measure productivity for advanced breast cancer patients. The HPQ is the only validated questionnaire to measure all three types of workplace consequences of illness: sickness absence, presenteeism, and critical incidents [28, 29]. Productivity loss was reduced for both absenteeism and presenteeism in our study.

We did not conduct a full cost-effectiveness analysis because the intervention was delivered by friend or family

caregivers, the time frame was short, and the direct healthcare costs across settings (e.g., academic versus non-academic) were difficult to ascertain from a societal perspective [38]. However, the findings have implication for economic evaluations of CIH therapies in three ways. First, hospitalization is the largest driving force for escalating healthcare costs. Since reflexology can be taught to friend or family caregivers who can deliver it in the patient's home setting, it represents a promising avenue for curbing the increased medical costs.

Second, the burden of cancer includes not only medical costs but also losses in productivity [37]. Being able to participate fully in the social life is an important part of the survivorship [39], particularly for younger breast cancer survivors [40]. No U.S. studies were found that examined the impact of a specific CIH therapy on cancer survivor's workplace productivity. The present finding supports the potential efficacy of reflexology on reducing societal cancer costs in lost productivity.

Finally, coping with the diagnosis and treatment of breast cancer is stressful and complicated by fear, anxiety, and other emotional issues [1]. Having the support of family and friends is a critical and most beneficial ingredient to coping [39]. It is possible that reflexology

Table 3 Effect of reflexology on having specific health services at week 11 ($N = 180$)^a

	Unweighted, unadjusted		Weighted, unadjusted ^b	
	Reflexology vs. control (ref)		Reflexology vs. control (ref) ^c	
	OR	95% CI	OR	95% CI
Oncology visits	0.72	[0.30,1.74]	0.96	[0.35,2.61]
Emergent care visits	0.72	[0.30,1.51]	0.68	[0.30,1.52]
Hospital visits	0.53	[0.28,1.00]	0.49*	[0.25,0.97]
Other service visits ^d	0.63	[0.32,1.26]	0.80	[0.37,1.70]
	Unweighted, adjusted ^e		Weighted, adjusted ^{b,e}	
	Reflexology vs. control (ref) ^c		Reflexology vs. control (ref) ^c	
	OR	95% CI	OR	95% CI
Oncology visits	0.74	[0.27,2.06]	0.75	[0.24,2.34]
Emergent care visits	0.71	[0.30,1.68]	0.67	[0.27,1.69]
Hospital visits	0.35**	[0.16,0.75]	0.30**	[0.13,0.66]
Other service visits ^d	0.59	[0.25,1.37]	0.70	[0.32,1.52]

OR, odds ratio; CI, confidence interval; ref, reference. * $p < 0.05$; ** $p < 0.01$

^a Outcomes were dichotomized as zero versus one or more visit

^b Inverse probability weighting with the probability for remaining in the study by week 11 estimated by logistic regression using baseline covariates in Table 1

^c Baseline data missing for four patients

^d Other service visits include laboratory visits, primary care provider visits, social worker visits, psychology visits, support group visits, and nurse visits

^e Adjusted by baseline covariates in Table 1

delivered by friend/family caregivers had the added benefit of improving the women's mental health and keeping their mind off their illness. Such benefits cannot be monetized in economic evaluations of any intervention. In our

study, both the intervention and control groups received minimal social interaction with the interviewer each week on the phone, thus the effect of reflexology was not due to a Hawthorne effect [41].

Table 4 Effect of reflexology on absenteeism and presenteeism at week 11 ($N = 58$)^a

	Unweighted, unadjusted		Weighted, unadjusted ^b	
	Reflexology vs. control		Reflexology vs. control	
	Coefficient	95% CI	Coefficient	95% CI
Absolute absenteeism in past 7 days	-2.23	[-9.41, 4.95]	-4.72	[-13.4, 3.94]
Relative absenteeism in past 7 days	-0.13	[-0.35, 0.08]	-0.19	[-0.42, 0.04]
Absolute presenteeism in past 7 days ^c	10.62	[-0.53, 21.78]	15.42*	[0.87, 29.98]
Relative presenteeism in past 7 days ^d	0.11	[-0.06, 0.28]	0.16	[-0.04, 0.36]
	Unweighted, adjusted ^e		Weighted, adjusted ^{b,e}	
	Reflexology vs. control (ref)		Reflexology vs. control (ref)	
	Coefficient	95% CI	Coefficient	95% CI
Absolute absenteeism in past 7 days	-8.63	[-18.7, 1.42]	-9.19	[-22.3, 3.91]
Relative absenteeism in past 7 days	-0.32*	[-0.60, -0.03]	-0.31	[-0.66, 0.05]
Absolute presenteeism in past 7 days ^c	10.82	[-1.75, 23.4]	13.93	[-0.90, 28.77]
Relative presenteeism in past 7 days ^d	0.16	[-0.07, 0.38]	0.19	[-0.01, 0.40]

CI, confidence interval; ref, reference. * $p < 0.05$

^a Ordinary least squares estimation of linear regression. $N = 58$ for those employed at week 11

^b Inverse probability weighting with the probability for remaining in the study by week 11 estimated by logistic regression using baseline covariates in Table 1

^c Data missing for three patients

^d Data missing for four patients

^e Adjusted by baseline covariates in Table 1

Limitation

To reduce interview burden, this study only assessed the health service utilization and expenditure at the end of the study and the study period was short (11 weeks). This timeframe is not long enough to fully evaluate the economic impact of the intervention. However, one difficulty in advanced cancer patient research is that attrition can potentially introduce bias in estimation of the intervention effects. To account for the 30% attrition rate in this study, inverse probability weighting was used to mitigate the potential selection bias, and the fact that the weighted and unweighted estimates lead to the same conclusion is reassuring in terms of the robustness of findings. The 7-day clinical trial version of the HPQ was the only measure used to estimate the loss in productivity, due to the relatively short study period. However, the 7-day version of the instrument has been advocated and evaluated by the instrument developers [29]. In a longer-term study, say 1 year, we can use the 28-day version of the questionnaire to evaluate how productivity changes over time.

Conclusion

The reflexology intervention delivered by friend or family caregivers can reduce some health service utilization and increase workplace productivity in a short-term period. The technique can be learned by friend and family caregivers, which has potential for reflexology to be an accessible means for cost savings to the health care system and employers. Longer-term evaluations would enhance the real-world applicability of the intervention on reducing costs and burden of cancer.

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Compliance with ethical standards

Conflict of interest The authors declared that there is no conflict of interest.

Appendix

Table 5 Demographic characteristics for patients retained versus lost by reflexology and control group

	By follow-up status (N=256)			Reflexology (N=128)			Control (N=128)		
	Retained N=180, n (%)	Lost N=76, n (%)	p value	Retained N=89, n (%)	Lost N=39, n (%)	p value ^a	Retained N=91, n (%)	Lost N=37, n (%)	p value ^a
Metastatic cancer									
Yes	108 (60)	53 (70)	0.141	52 (58)	28 (28)	0.150	56 (62)	25 (68)	0.521
No	72 (40)	23 (30)		37 (42)	11 (72)		35 (38)	12 (32)	
Recurrent cancer									
Yes	53 (29)	23 (30)	0.896	29 (33)	12(31)	0.839	24 (26)	11 (30)	0.699
No	127 (71)	53 (70)		60 (67)	27(69)		67 (74)	26 (70)	
Therapy treatment									
Chemotherapy w/ or w/o hormonal therapy	140 (78)	70 (92)	0.006	70 (79)	35 (90)	0.210 ^b	70 (77)	35 (95)	0.021 ^b
Hormonal therapy only	40 (22)	6 (8)		19 (21)	4 (10)		21 (23)	2 (5)	
Race									
White	153 (86)	59 (78)	0.153 ^{b,c}	74 (84)	31 (79)	0.748 ^{b,c}	79 (88)	28 (76)	0.109 ^{b,c}
Black or African American	14 (8)	12 (16)		8 (9)	5 (13)		6 (7)	7 (19)	
Other	11 (6)	5 (7)		6 (7)	3 (8)		5 (6)	2 (5)	
Marital status									
Never married	13 (7)	14 (18)	0.024	6 (7)	8 (21)	0.071	7 (8)	6 (16)	0.275
Married	130 (72)	46 (61)		65 (73)	24 (62)		65 (71)	22 (59)	
Divorced/separated/widowed	37 (21)	16 (21)		18 (20)	7 (18)		19 (21)	9 (24)	
Relationship to caregiver									
Spouse or partner	105 (58)	36 (47)	0.312	53 (60)	17 (44)	0.122 ^b	52 (57)	19 (51)	0.723 ^b
Child or stepchild	29 (16)	13 (17)		16 (18)	5 (13)		13 (14)	8 (22)	

Table 5 (continued)

	By follow-up status (<i>N</i> = 256)			Reflexology (<i>N</i> = 128)			Control (<i>N</i> = 128)		
	Retained <i>N</i> = 180, <i>n</i> (%)	Lost <i>N</i> = 76, <i>n</i> (%)	<i>p</i> value	Retained <i>N</i> = 89, <i>n</i> (%)	Lost <i>N</i> = 39, <i>n</i> (%)	<i>p</i> value ^a	Retained <i>N</i> = 91, <i>n</i> (%)	Lost <i>N</i> = 37, <i>n</i> (%)	<i>p</i> value ^a
Friend	19 (11)	9 (12)		6 (7)	5 (13)		13 (14)	4 (11)	
Other	27 (15)	18 (24)		14 (16)	12 (31)		13 (14)	6 (16)	
Employment									
Employed (full- or part-time)	61 (34)	27 (36)	0.098 ^d	29 (33)	9 (23)	0.171	32 (36)	18 (49)	0.089 ^{b,c}
Retired	55 (31)	14 (18)		30 (34)	10 (26)		25 (28)	4 (11)	
Other	63 (35)	35 (46)		30 (34)	20 (51)		33 (37)	15 (41)	
Education									
High school graduate or some HS	35 (20)	23 (30)	0.289 ^d	20 (23)	9 (23)	0.81	15 (16)	14 (38)	0.073 ^c
Some college or 2-year degree	52 (29)	21 (28)		23 (26)	12 (31)		29 (32)	9 (24)	
4-year college graduate	46 (26)	17 (22)		20 (23)	10 (26)		26 (29)	7 (19)	
More than a 4-year college degree	46 (26)	15 (20)		25 (28)	8 (21)		21 (23)	7 (19)	
	Mean (SD)	Mean (SD)	<i>p</i> value	Mean (SD)	Mean (SD)	<i>p</i> value ^d	Mean (SD)	Mean (SD)	<i>p</i> value ^d
Age, years	57.3 (10.9)	54.4 (11.4)	0.057	59.0 (11.0)	56.1 (12.8)	0.219	55.7 (10.5)	52.6 (9.5)	0.109
Number of comorbid conditions	4.7 (3.1)	3.7 (2.6)	0.014	4.6 (3.0)	3.9 (2.5)	0.209	4.7 (3.1)	3.5 (2.6)	0.028
MDASI symptom severity	41.0 (23.3)	49.4 (23.1)	0.009	41.4 (24.8)	51.6 (22.0)	0.022	40.7 (21.8)	47.0 (24.2)	0.173
MDASI symptom interference	20.2 (15.4)	27.7 (15.8)	0.001	20.1 (16.1)	27.3 (14.8)	0.017	20.3 (14.6)	28.1 (16.9)	0.016
PROMIS physical function	42.1 (7.6)	38.9 (8.0)	0.003 ^d	42.3 (7.0)	38.6 (8.3)	0.021 ^c	42.0 (8.1)	39.2 (7.8)	0.070
Quality of life index	21.8 (4.5)	20.5 (4.4)	0.029 ^d	22.3 (4.3)	20.4 (4.2)	0.022 ^c	21.4 (4.7)	20.6 (4.7)	0.391
Health and Productivity Questionnaire									
Absolute absenteeism in past 7 days	0 (15.0)	7.5 (26.5)	0.068	5.9 (17.5)	15.1 (14.0)	0.061	10.2 (18.5)	11.3 (26.1)	0.453
Relative absenteeism in past 7 days	0 (0.4)	0.4 (0.9)	0.031	0.1 (0.4)	0.5 (0.4)	0.017	0.3 (0.4)	−0.6 (3.5)	0.569
Absolute presenteeism in past 7 days	80.0 (30.0) ^g	80.0 (10.0) ^h	0.835	73.2 (23.7)	71.1 (17.6)	0.494	75.2 (20.3)	80.0 (15.8)	0.687
Relative presenteeism in past 7 days	1.0 (0.3) ^k	1.0 (0.1) ^h	0.579	1.0 (0.4)	1.0 (0.2)	0.833	1.3 (1.7)	1.0 (0.1)	0.567

^a Based on Chi-squared test^b Base on Fisher exact test^c Data missing for one patients^d Based on *t* test with unequal variance^e Data missing for two patients^f Based on Wilcoxon rank-sum test^g Data missing for seven patients^h Data missing for six patients^j Data missing for four patients^k Data missing for eight patients

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