Original Article

The Effects of Usage Anti-Fatigue Mat and Foot Bath on Fatigue and Lower Extremity Pain Among Operating Room Nurses

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Abstract

Bacground and aim: Prolonged standing at work is associated with several health problems. This study was conducted to investigate the impact of using anti-fatigue mats and footbaths on fatigue and lower extremity pain among operating room nurses.
Materials and methods: This study used a single-group prospective quasi-experimental design and involved 32 operating room nurses. Two different interventions were implemented on the nurses at a one-month interval: footbaths and anti-fatigue mats. Before and after the interventions, the severity of foot pain was assessed using the Visual Analog Scale (VAS), and fatigue was evaluated using the Visual Analogue Fatigue Scale (VAS-F).
Results: After using footbaths, a significant reduction in weekly pain intensity was observed in both the right and left feet ($p < 0.001$; Cohen's $d > 0.8$). There was no significant decrease in the nurses' fatigue levels in the first week after the footbath ($p > 0.05$). However, after using anti-fatigue mats, there was a significant and clinically meaningful decrease in the weekly pain intensity in both feet from moderate to mild (Cohen's d: 0.2-0.5). Additionally, weekly fatigue levels significantly and clinically decreased ($p<0.001$; Cohen's $d \geq 0.8$).
Conclusions: Although there was no statistically significant difference between the two interventions, all measurement parameters showed favorable results after the footbath application.

Keywords: Pain, Lower Extremity, Operating Room Nurse, Foot Bath, Fatigue, Anti-Fatigue Mat

Introduction

Operating rooms are indeed high-stress and high-risk environments, where patients undergo various interventional procedures using cutting-edge technologies. It's not uncommon for life-threatening events and situations requiring urgent decision-making to occur in this setting (Bakhtiari et al., 2020; Zakhary and Ender, 2018). Factors such as the complexity of surgery, conflicts with surgeons, intra-team issues, and surgical complications can lead to fatigue and stress among operating room nurses (Apple and Letvak, 2021).

According to the Association of Perioperative Registered Nurses (AORN), operating room nurses encounter various ergonomic stressors daily. One of these stressors is related to prolonged standing. Many operating room nurses must stand for extended periods, which carries the risk of various health problems, such as extremity pain and cardiovascular abnormalities (Apple and Letvak, 2021). Operating room nurses stand for one to eight hours during most shifts. In a cross-sectional study, the prevalence of musculoskeletal disorders among operating room staff was reported as 64.2%. It was found that anesthetists had a prevalence of 69.4%, surgeons 57.3%, and nurses 72.9% (ILO, 2023). Globally, a high prevalence of musculoskeletal disorders has been observed among operating room personnel, particularly in the back, neck, shoulders, ankles, and feet

(Chung et al., 2013; Dexter, 2016; Asghari et al., 2019).

The highest prevalence rate was reported in the ankles and feet, following back issues (57.06%) (Asghari et al., 2019). The CDC highlights that musculoskeletal disorders are associated with high costs for employers, such as absenteeism, decreased productivity, increased healthcare services, disability, and worker compensations (Tavakkol et al., 2020). Therefore, to mitigate the adverse effects of prolonged standing, the use of fatigue-reducing mats, sit-stand stools, compression stockings, and similar options is recommended (Clari et al., 2021).

According to AORN's Ergonomic Tool 4, ergonomic intervention is required when an individual needs to stand for more than two hours or remain in the same position for over 30% of the workday (Apple and Letvak, 2021). AORN's "Guideline 8 for Safe Patient Handling and Movement" recommends the use of fatigue-reducing mats in the operating room environment to counteract the effects of prolonged standing (Hughes et al., 2011).

In addition to ergonomic considerations, one cost-effective method that has a positive impact on reducing fatigue and lower extremity pain, along with improving ergonomic conditions, is foot baths (Aghamohammadi et al., 2020).

A limited number of studies were found in the literature review that individually assessed the effectiveness of both interventions in operating room nurses. However, study results comparing the clinical superiority of these two interventions have not been found.

This study was conducted to investigate the impact of using anti-fatigue mats and foot baths on lower extremity pain and fatigue among operating room nurses.

Materials and methods

Study design and participants This single-group prospective quasi-experimental study was conducted with operating room nurses working in the operating rooms of a university and two state hospitals in the Western Black Sea Region of Turkey. There are 55 operating room nurses working in the state and university hospitals. The sample size was determined as 27 nurses using G Power 3.1.9.7 software, assuming an effect size of 0.6, alpha: 0.05, and power: 85% (Lee et al., 2014). The study included 32 operating room nurses who met the inclusion criteria: (i) were working as a sterile nurse in the operating room, (ii) being a volunteer, (iii) owning a smartphone, (iv) not having hearing and visual impairments, (v) not having diagnosed health problems in the lower extremities, (vi) working as a sterile nurse in the operating room for at least 4 consecutive hours a day, (vii)not using compression stockings, and (viii) not being pregnant. A total of 23 operating room nurses were excluded from the study process, including 18 who were unwilling to participate, three responsible nurses who did not work as sterile nurses, a nurse who experienced health problems during the application, and a nurse who changed units.

Instruments: The data were collected using the following tools:

The survey form: This form consists of 16 questions. The first nine questions inquire about the participants' socio-demographic characteristics, including age, height, weight, body mass index, gender, marital status, educational level, working years in the same profession, and weekly working hours. The following four questions pertain to chronic illnesses, other medical history, Covid-19 history, and the last three questions assess regular exercise or physical activity, smoking, and alcohol usage (Clari et al., 2021; Li et al., 2021; Raake 2019).

Visual Analog Scale (VAS): The Visual Analog Scale (VAS) is a pain rating scale originally introduced by Hayes and Patterson in 1921. VAS is a unidimensional scale, typically presented horizontally or vertically, and measures 10 cm. It starts with "No Pain" at one end and "Worst Pain Imaginable". The distance from the lowest point on the VAS to the patient's mark is then measured using a ruler, and the numerical index of the patient's pain intensity is obtained in centimeters (cm) or millimeters (mm) (Unver and Makal Organ, 2023).

Visual Analog Scale for Fatigue (VAS-F): This scale was developed by Lee and colleagues in 1990, and comprises 18 items. Items 1, 2, 3, 4, 5, 11, 12, 13, 14, 15, 16, 17, and 18 are related to fatigue, while items 6, 7, 8, 9, and 10 pertain to energy sub-scales. The scale consists of rows with lines of 10 cm between them, with the most positive

expression at one end and the most negative at the other. As you move from one end to the other, the items on the fatigue sub-scale become progressively more negative, whereas the items on the energy sub-scale become more positive. A high score on the fatigue sub-scale indicates a higher level of fatigue, while a low score on the energy sub-scale suggests a lower level of energy. The scale's Turkish validity and reliability were established by Yurtsever and Beduk in 2003, with a Cronbach's alpha internal consistency coefficient of 0.90 for the fatigue sub-scale and 0.74 for the energy sub-scale (Yurtsever and Beduk, 2003).

Fatigue Monitoring Form: This form is used to record the VAS-F scores assessed over four weeks, both before and after each of the two interventions. It allows for the tracking and documentation of fatigue levels in the participants throughout the study.

Data collection: The data collection took place between December 2022, and January 2023. The data collection process began with the administration of footbaths. Sterile nurses who worked continuously for 4 hours without a break were asked to perform footbaths according to the steps specified in Box 1. This procedure was repeated for three consecutive days at the end of the fourth hour. To ensure a correct understanding of the procedure, we recorded a video demonstration of the footbath application. This video was sent to the nurses' smartphones. While delivering the necessary materials for footbaths, nurses were verbally instructed on the procedure in the resting room. Fatigue and pain assessments were conducted by the nurses before the first shift of the week, after the end of the third shift (post-operation), and 10 minutes following the footbath. The nurses obtained and recorded the measurements on the provided forms (Figure 1). Following the completion of the four-week foot bath application, there was a one-month hiatus. The break was taken to prevent any potential influence on the data collected regarding the use of anti-fatigue mats. During this month, operating room nurses continued their regular work without interruption in their respective units, ensuring they were not subjected to additional rest or special conditions (Figure 1). Following one month, anti-fatigue mats were introduced to the same group of nurses. In the nurse's resting room, verbal instructions were provided on the use and features of the anti-fatigue mats. These mats were placed on the hard floor next to the operating room tables.

Box 1 The foot bath procedure

- After the surgery completed, the necessary materials were prepared in the nurse's relaxation room.
- Water filled in the tub up to the ankle level.
- The water temperature was adjusted to reach 38-40°C.
- Both feet are immersed in the tub.
- For 20 minutes, soaking movements were performed for both feet in the water.
- The desired temperature is monitored and maintained using a water thermometer.
- At the end of the duration, the feet dried with a cotton towel and materials gather.

Nurses who worked 4 hours without rest between cases and three consecutive days were instructed to use the mats during the four weeks. The used mats were first cleaned by adding 200 grams of surface cleaning agent to 10 liters of water. Then, they were cleaned again using a mixture of 100 ml of sodium hypochlorite and 1 liter of water. After 4 hours of use, the anti-fatigue mats were removed from the operating room.

Fatigue and pain assessments were conducted throughout one month, just before the first shift of the week and immediately after the third shift, following mat usage, and 10 minutes after the end of each case. The measurements were obtained and recorded by the nurses (Figure 1).

Data analysis: Data was assessed using frequency distributions for categorical variables and descriptive statistics for numerical variables. To examine differences in measurements pre- and post-intervention, dependent samples t-tests, Wilcoxon, and Mann-Whitney U tests were used depending on the normality of the data distribution. To examine measurement differences across weeks, repeated measures analysis of variance (ANOVA) and the Friedman test were used based on the normality of the data distribution. For scale reliability, Cronbach's alpha coefficient was used. The differences in pain intensity and fatigue levels before and after the interventions were interpreted according to the effect size criteria of Cohen.

While Cohen's d of 0.2 is considered a small effect size, a value of 0.5 suggests a moderate effect size and a value of 0.8 is accepted as signifying a large effect size. The results were evaluated with a significance level of $p < 0.05$ and a 95% confidence interval.

Ethical Considerations: The ethical approval was obtained from the Social and Human Sciences Ethics Committee (Decision No: 10.07.2022/17). Subsequently, written permission was obtained from the hospitals. Permission was also obtained via email from the researcher who conducted the validity and reliability study of the VAS-F scale. Written informed consent was obtained from operating room nurses.

Results

Characteristics of nurses

The mean age of the operating room nurses was 37.94 ± 7.19, with an average Body Mass Index (BMI)of 26.12 ± 4.82. Moreover, 90.6% of the participants were female, 84.4% were married, and 62.5% held a bachelor's degree. Their average work experience was 11.41 ± 7.91 years, and the mean weekly working hours were 44.78 ± 6.11.

In addition, 9.4% reported having chronic illnesses, 75.0% had a history of COVID-19, 68.8% did not engage in sports or physical activities, and 28.1% were smokers, while 3.1% consumed alcohol (Table 1).

Pain intensity

The weekly pain intensity in both the right and left feet of operating room nurses was significantly lower after the foot bath compared to before ($p < 0.001$). After the foot bath, the mean pain intensity in both the right and left feet also decreased clinically significantly (Cohen's $d > 0.8$).

However, there was no statistically significant difference found between the averages of pain intensity in the right and left feet before and after the foot bath over four weeks ($p > 0.05$) (Table 2).

In operating room nurses, the average weekly pain intensity showed a statistically significant difference before and after the use of anti-fatigue mats ($p < 0.05$). After the use of anti-fatigue mats, the pain intensity in the right and left feet of operating room nurses decreased every week in a clinically small to medium effect size (Cohen's d: 0.2-0.5).

However, over four weeks, there was no statistically significant difference found between the averages of pain intensity in the right and left feet before and after using anti-fatigue mats ($p > 0.05$) (Table 2).

Fatigue severity

Based on Table 3, the average weekly fatigue scores of operating room nurses decreased, while the energy scores increased after a footbath. ($p < 0.001$). This indicates a significant decrease in weekly fatigue levels among operating room nurses after foot baths ($p < 0.001$).

The difference in fatigue levels was both statistically and clinically significant, with the exception of the 1st week (Cohen's d: ≥0.8). However, over four weeks, there was no statistically significant difference in fatigue levels before and after foot baths ($p > 0.05$).

After the use of anti-fatigue mats, the average weekly fatigue scores of operating room nurses decreased, and the energy score averages increased ($p < 0.001$). Therefore, in operating room nurses, weekly fatigue levels significantly decreased after the use of anti-fatigue mats ($p < 0.001$). This statistically significant difference in fatigue levels was also clinically significant in the fatigue subscale in the first three weeks (Cohen's d: ≥0.8).

In the energy subscale, the use of anti-fatigue mats had a moderate clinical effect in all weeks (Cohen's d: >0.5). However, over four weeks, there was no statistically significant difference found between fatigue levels before and after using anti-fatigue mats ($p > 0.05$) (Table 3).

Comparison of the effects of foot baths and anti-fatigue mat usage on fatigue and lower extremity pain

There was no statistically significant difference between the pain intensity in the right and left feet of operating room nurses before both implementations ($p>0.05$). After the implementation, the pain intensity in both feet of the nurses decreased from the first week to the end of the fourth week. The reduction in pain intensity was slightly higher in the right foot (mean 0.19 points) and left

foot (mean 0.22 points) after foot baths compared to after mat usage. However, this reduction was not statistically significant ($p>0.05$). When the weekly pain intensity was evaluated, it was lower after foot baths compared to mat usage. Nevertheless, the changes in weekly pain intensity did not show statistically significant differences ($p >0.05$) (Table 4).

The fatigue and energy scores of operating room nurses after foot baths increased less compared to the first week by the end of the fourth week. However, there was no statistically significant difference found between the effects of both implementations on the fatigue levels of operating room nurses ($p>0.05$) (Table 4).

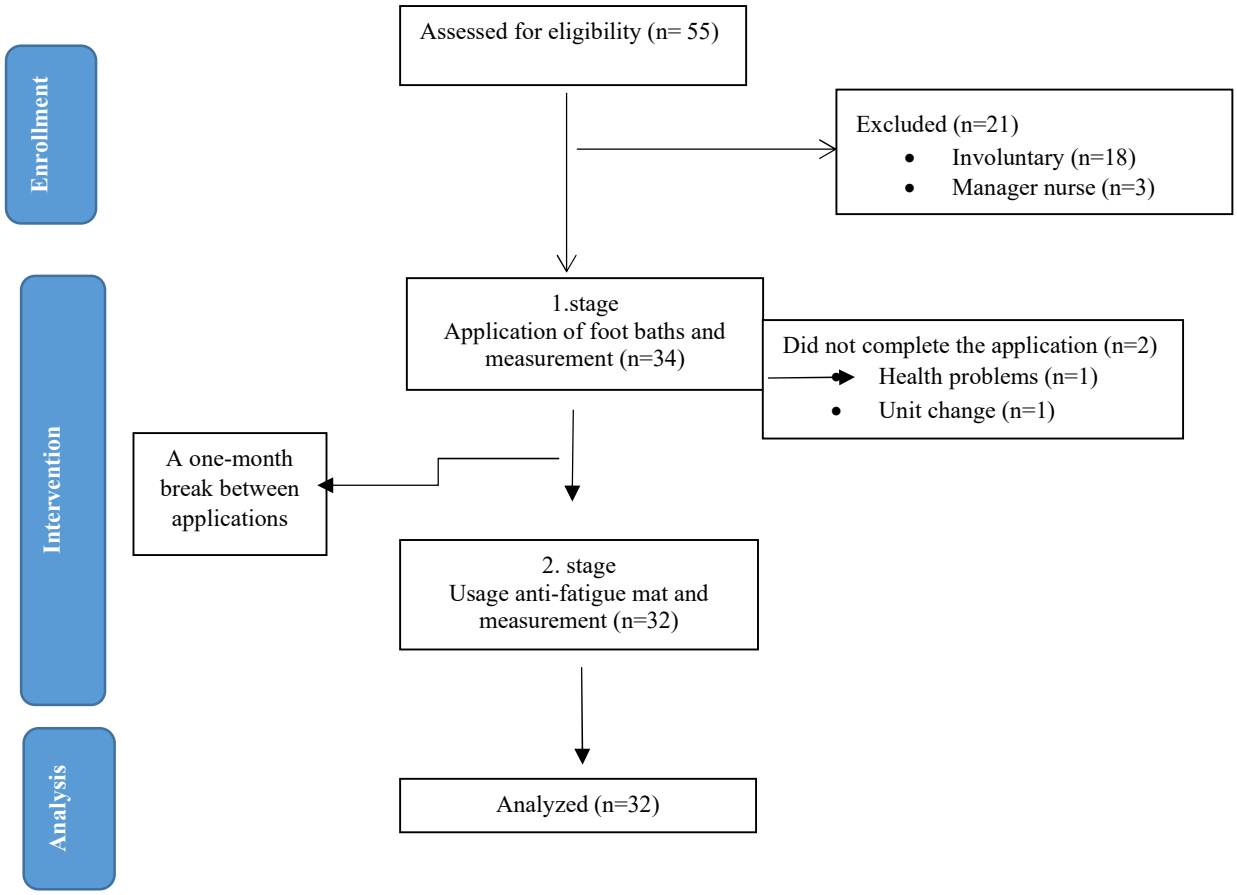

Fig 1. Follow Diagram Of The Study

Table 1. Characteristics of Nurses

		Mean (SD)	Min-Max.
Age		37.94 (7.19)	22-47
BMI		26.12 (4.82)	20-39.6
Work experience (year)		11.41 (7.91)	1-29
Weekly working hours		44.78 (6.11)	40-56
		n	**%**
Gender	Female	29	90.6
	Male	3	9.4
Marital status	Married	27	84.4
	Single	5	15.6
Educational background	Associate Degree	6	18.8
	Bachelor's Degree	20	62.5
	Postgraduate	6	18.8
Chronic illness	Yes	3	9.4
	No	29	90.6
Type of chronic illness	Hypertension	2	66.7
	Hashimoto's Thyroidis	1	33.3
Covid 19 history	Yes	24	75.0
	No	8	25.0
Physical activity	Yes, I do it regularly	2	6.3
	Yes, but I do it regularly	8	25.0
	No, I don't do it	22	68.8
Smoking	Yes	9	28.1
	No	23	71.9
Alcohol use	Yes	1	3.1
	No	31	96.9

SD: Standard Deviation *Min: Minimum* *Max: Maximum*

Table 2.Comparison of Right and Left Foot Pain Intensity Before And After Implementations

Foot/	W e e k	Before Footh Bath	After Foot Bath	t/p	Effect Size
		Mean±SD	Mean±SD		
Right	1 st week	4.22±1.72	2.72±1.84	5.568/ 0.000*	-1.019
	2nd week	4.06±1.74	2.72±1.46	4.946/ 0.000*	-0.813
	3rd week	4.34±1.66	2.59±1.74	6.588/ 0.000*	-1.192
	4 th week	3.81±1.64	2.34±1.70	5.379/ 0.000*	-0.968
	F/p	1.936/ 0.146	1.723/ 0.184		
Left	1 st week	4.19±1.75	2.69±1.79	4.926/ 0.000*	-0.879
	2nd week	4.16±1.85	2.69±1.40	4.824/ 0.000*	-0.770
	3rd week	4.34±1.84	2.56±1.72	6.141/ 0.000*	-1.053
	4 th week	3.81±1.65	2.25±1.50	5.311/ 0.000*	-0.900
	F/p	2.022/ 0.133	2.432/ 0.085		
Foot/	**Week**	**Before Usage of Mat**	**After Usage of Mat**	**t/p**	**Effect size**
		Mean±SD	**Mean±SD**		
Right	1 st week	3.66±1.58	2.94±1.41	2.589/ 0.015*	-0.436
	2nd week	3.56±1.37	3.00±1.48	2.119/ 0.042*	-0.388
	3rd week	3.66±1.60	2.72±1.49	2.955/ 0.006*	-0.506
	4 th week	3.56±1.68	2.75±1.39	2.714/ 0.011*	-0.442
	F/p	0.149/ 0.929	0.616/ 0.610		
Left	1 st week	3.59±1.58	2.91±1.47	2.438/ 0.021*	-0.412
	2nd week	3.56±1.41	3.00±1.55	2.119/ 0.042*	-0.392
	3rd week	3.63±1.56	2.81±1.60	2.430/ 0.021*	-0.439
	4 th week	3.59±1.83	2.69±1.26	2.844/ 0.008*	-0.436
	F/p	0.038/ 0.990	0.925/ 0.441		

*SD: Standard Deviation t: Dependent Sample t-test F: Repeated Measures Analysis of Variance * p < 0.05*

Table 3. Comparison of VAS-F Scores Before and After Implementations

Subscale/Week		Before Foot Bath Mean±SD	After Foot Bath Mean±SD	t/p	Effect size
Fatigue	1 st week	55.13±21.21	46.28±17.83	2.494/ 0.018*	-0.410
	2nd week	64.09±18.99	47.16±15.57	5.784/ 0.000*	-0.946
	3rd week	65.44±23.22	50.34±17.66	5.830/ 0.000*	-0.972
	4 th week	61.97±20.94	47.59±16.71	4.789/ 0.000*	-0.781
	F/p	2.574/ 0.073	1.142/ 0.349		
Energy	1 st week	25.69±6.47	28.59±6.04	-2.592/ 0.014*	0.443
	2nd week	23.75±6.32	29.69±5.79	-5.568/ 0.000*	0.947
	3rd week	23.84±7.37	29.63±6.34	5.107/ 0.000*	0.849
	4 th week	24.31±5.90	29.59±6.66	-4.222/ 0.000*	0.798
	F/p	0.934/ 0.437	0.384/ 0.765		

Subscale/Week		Before Usage of Mat Mean±SD	After Usage of Mat Mean±SD	t/p	Effect size
Fatigue	1 st week	63.16±1480	45.72±15.97	5.716/ 0.000*	-1.052
	2nd week	65.81±14.48	43.78±15.00	6.731/ 0.000*	-1.212
	3 rd week	63.75±17.49	47.75±15.08	5.093/ 0.000*	-0.844
	4 th week	63.25±18.09	49.22±16.11	4.439/ 0.000*	-0.745
	F/p	2.574/ 0.073	0.506/ 0.681		
Energy	1 st week	24.06±5.71	28.06±5.81	-3.933/ 0.000*	0.702
	2nd week	23.78±5.68	29.81±6.82	-3.848/ 0.001*	0.752
	3 rd week	24.00±6.48	27.31±6.54	-2.501/ 0.018*	0.444
	4 th week	23.97±6.24	29.47±7.31	-3.830/ 0.001*	0.739
	F/p	0.934/ 0,437	0.038/ 0.990		

*SD: Standard Deviation t: Dependent Sample t-test F: Repeated Measures Analysis of Variance * p < 0.05*

Table 4. Comparison of VAS-F Scores and Pain Intensity in The Feet Before and After Implementations

		Before Foot Bath	Before Usage of Mat	t/p	After Foot Bath	After Usage of Mat	t/p
		Mean±SD	Mean±SD		Mean±SD	Mean±SD	
Right Foot	1 st week	4.22±1.72	3.66±1.58	1.364/0.177	2.72±1.84	2.94±1.41	-0.534/0.595
	2 nd week	4.06±1.74	3.56±1.37	1.278/0.206	2.72±1.46	3.00±1.48	-0.764/0.448
	3 rd week	4.34±1.66	3.66±1.60	1.689/0.096	2.59±1.74	2.72±1.49	-0.309/0.758
	4 th week	3.81±1.64	3.56±1.68	0.603/0.549	2.34±1.70	2.75±1.39	-1.047/0.299
Left Foot	1 st week	4.19±1.75	3.59±1.58	1.423/0.160	2.69±1.79	2.91±1.47	-0.535/0.594
	2nd week	4.16±1.85	3.56±1.41	1.442/0.154	2.69±1.40	3.00±1.55	-0.848/0.400
	3 rd week	4.34±1.84	3.63±1.56	1.684/0.097	2.56±1.72	2.81±1.60	-0.603/0.549
	4 th week	3.81±1.65	3.59±1.83	0.502/0.618	2.25±1.50	2.69±1.26	-1.264/0.211
Fatigue	1 st week	55.13±21.21	63.16±14.80	-1.757/ 0.085	46.28±17.83	45.72±15.97	0.133/ 0.895
	2nd week	64.09±18.99	65.81±14.48	-0.407/ 0.680	47.16±15.57	43.78±15.00	0.883/ 0.381
	3 rd week	65.44±23.22	63.75±17.49	0.328/ 0.744	50.34±17.66	47.75±15.08	0.632/ 0.530
	4 th week	61.97±20.94	63.25±18.09	-0.262/ 0.794	47.59±16.71	49.22±16.11	-0.396/ 0.693
Energy	1 st week	25.69±6.47	24.06±5.71	1.065/ 0.291	28.59±6.04	28.06±5.81	0.359/ 0.721
	2 nd week	23.75±6.32	23.78±5.68	-0.021/ 0.983	29.69±5.79	29.81±6.82	-0.079/ 0.937
	3 rd week	23.84±7.37	24.00±6.48	-0.090/ 0.928	29.63±6.34	27.31±6.54	1.437/ 0.156
	4 th week	24.31±5.90	23.97±6.24	0.226/ 0.822	29.59±6.66	29.47±7.31	0.071/ 0.943

SD: Standard Deviation t: Dependent Sample t-test

Discussion

The limited number of studies conducted on several operating room nurses, different groups, and the literature was discussed under three headings.

Effects of foot baths

In a study, it was found that the pain intensity in the right and left feet of operating room nurses decreased significantly after weekly foot bath applications compared to before the foot baths ($p < 0.05$). However, during the follow-up results conducted over four weeks, although the pain intensity decreased in both feet compared to the first week, no statistically significant difference was observed ($p > 0.05$).

During surgery, sterile nurses need to work on a hard surface for a long time in a stressful environment, while keeping a certain distance from the surgeon. This can lead to muscle tension, fatigue, and pain in the back, waist, arms, hands, and legs (Hwang and Jun, 2015).

Warm foot baths can help by promoting the body's natural pain relief, getting rid of waste

products from the tissues, and improving blood flow. This, in turn, reduces tension in the tissues and eases joint and muscle pain (Devkate et al., 2016; Nagaich, 2016; Nakamura et al., 2018; Sarvinoz and Muzaffar, 2022).

In a study conducted by Han and colleagues (2022), nurses received foot baths with 0.5 ml of essential oils (grapefruit and mint mixed in water) for two consecutive days after their shifts. The study found that post-foot bath lower extremity pain significantly decreased compared to the control group.

Another experiment involving 30 elderly individuals examined the effect of foot baths on pain. Participants received a 15-minute foot bath at a temperature of 37-46°C for two weeks, and the study observed that foot baths were effective in reducing joint pain levels (Shruthi et al., 2018).

Celik et al., (2023) conducted a study with nursing students, where students participated in clinical practice sessions for four weeks, two days a week. After these sessions, the students were given a 20-minute foot bath in 40°C warm water 2 hours before bedtime.

Following this intervention, it was determined that the daily and four-week average pain intensity in the students' right and left feet significantly decreased both statistically and clinically. Although the sample group and the duration of observation may differ, the current study findings align with previous studies and the existing literature. These findings suggest that foot baths, which can be easily implemented by operating room nurses, may contribute to reducing pain and enhancing physiological well-being.

The study found that the weekly fatigue levels of operating room nurses decreased significantly after they received foot baths ($p<0.001$). Although there wasn't a significant reduction in fatigue levels during the first week, clinically significant reductions were observed in the following three weeks.

However, over the four weeks, there were no statistically significant changes in the nurses' fatigue levels ($p>0.05$).

The use of foot baths has been found to enhance gamma oscillations in both sides of the brain, contributing to the improvement of cognitive functions (Olanipekun et al., 2019).

Additionally, foot baths can have positive effects on prefrontal cortex activity and autonomic nervous system functions by reducing tension in the brain, leading to a relaxation effect for individuals (Seo et al., 2018; Maeda et al., 2023). In a study involving fifty operating room nurses, it was concluded that warm foot baths, when applied once daily for four days a week over four weeks, were effective in reducing stress and fatigue ($p<0.05$) (Lee et al., 2014).

In a study conducted among university students, it was reported that foot baths were not effective in reducing fatigue levels (Seo et al., 2017). The fatigue levels of individuals can be influenced by various factors such as gender, age, psychological issues, illness, medication use, standing duration, and workplace conditions. As a result, different results can be expected. However, based on the findings of the majority of studies and the physiological relaxing effects, it is believed that foot baths are effective in reducing the fatigue experienced by operating room nurses due to prolonged standing.

Effects of anti-fatigue mats

In this study, the use of anti-fatigue mats among operating room nurses led to a significant decrease in weekly pain intensity ($p<0.001$). Before using anti-fatigue mats, the nurses experienced moderate pain. However, after using the mats, they reported mild pain.

These changes in weekly pain intensity had a small to medium clinical effect. Nevertheless, during the four weeks of observations, the changes in pain intensity did not show statistically significant differences ($p>0.05$).

Anti-fatigue mats in the operating room environment are recommended to counteract the effects of prolonged standing (Apple and Letvak, 2021; Clari et al., 2021; Hughes et al., 2011). Prolonged standing increases the muscular load in the lower extremities, leading to pain.

The slight elevations on anti-fatigue mats prompt gentle movements in standing operating room nurses, stimulating lower extremity muscles, promoting blood circulation, and stabilizing plantar pressure

distribution (Hughes et al., 2011; Gabrielson et al, 2021).

In a study of 16 sterilization nurses working in an operating room, a single-group design with repeated measurements was used. The study assessed the discomfort levels of the nurses during sterilization procedures, both when standing on a steel footrest on a hard floor and after placing an anti-fatigue mat on the steel footrest.

The use of the anti-fatigue mat was found to be significantly associated with decreased discomfort levels ($p<0.001$) (Hwang and Jun, 2015). In a study by Unver and Makal Organ (2023) that involved operating room nurses, it was discovered that the postoperative pain levels of surgical team members were significantly lower when they used a mat during surgical procedures lasting at least two hours, compared to working without a mat ($p < 0.05$).

The impact of anti-fatigue mats on pain has been investigated in various groups, not just operating room nurses. A systematic review and meta-analysis by Stucky et al. found that static forces in surgeons caused musculoskeletal tension. Of the 5152 surgeons studied, approximately 50% experienced pain in different parts of their bodies, such as the arms, shoulders, back, and lower extremities. The study also mentioned various ergonomic methods, such as adjusting monitor height and using fatigue-reducing mats in the operating room, to reduce static forces for different groups (Stucky et al., 2018).

Winberg and colleagues (2022) conducted a study in a laboratory setting to investigate the effects of using anti-fatigue mats on lower back pain in students. The students spent 60 minutes standing on a hard floor and then on an anti-fatigue mat. The results demonstrated the effectiveness of anti-fatigue mats in reducing pain.

In several limited studies, the areas where participants experienced pain, often in their lower back, and the duration of standing varied. However, the current study's findings align with these previous studies. In a study by Voss and colleagues, surgeons who stood for 4 hours or most commonly reported muscle stiffness and back pain. The gel-based anti-fatigue mat to relieve these symptoms was found to have no effect ($p=0.69$) (Voss et al., 2017).

During a three-month study, weekly observations were conducted with the operating room team. The study reported that the use of anti-fatigue mats did not lead to a change in pain levels or pain reporting rates in the right and left feet before and after usage (Raake, 2019). The findings correspond with most previous studies, indicating that using anti-fatigue mats with small elevations can help prevent static postures and promote gentle movements for operating room nurses who stand for extended periods.

In a recent study, operating room nurses who used fatigue-reducing mats experienced a significant reduction in their weekly fatigue levels, both statistically and clinically ($p<0.001$). However, it was found that using the fatigue-reducing mats for four weeks did not effect fatigue levels ($p>0.05$).

While at work, at least 50% of employees who stand for a significant portion of their day are at risk of developing musculoskeletal disorders. Musculoskeletal disorders are associated with simultaneous muscle activity, blood pooling, fatigue, and individual factors. Soft-surfaced materials, such as anti-fatigue mats, are considered one of the ergonomic solutions to reduce fatigue.

The textured surface of anti-fatigue mats promotes micro-movements and stability in posture when used during standing. This leads to improved microcirculation and nutrient flow in muscles, reducing fatigue (Aghazadeh et al., 2015; Anderson et al., 2017; Alaqeel and Tanzer, 2020).

In previous years, studies conducted on surgical teams have reported the effectiveness of anti-fatigue mat usage in reducing fatigue in individuals ($p<0.05$) (Unver and Makal Organ, 2023; Hwang and Jun, 2015; Voss et al., 2017). Furthermore, in Voss and colleagues' study, 65% of surgeons reported having a positive experience with the mat. Additionally, 70% expressed their willingness to recommend the mat to a colleague (Voss et al., 2017).

A systematic review examined the fatigue levels of individuals standing for at least three hours, on both hard surfaces and hard surfaces

with added soft materials. The review found moderate evidence supporting the effectiveness of using soft materials, such as anti-fatigue mats, in reducing musculoskeletal discomfort and fatigue among employees who stand for extended periods during work (Speed et al., 2018).

In two recent studies involving healthy individuals, it was reported that using anti-fatigue mats reduced fatigue in measurements taken after standing for at least four hours, compared to working on a hard surface. This was observed in individuals who were not healthcare workers (Zhang et al., 2022; Lu et al., 2021). The results align with the weekly observations of the current study but are in contrast to the findings from the four-week follow-up. This difference could be attributed to variations in the monitoring duration in previous studies.

Advantages of foot bath and anti-fatigue mat usage

After both applications, the pain in the nurses' right and left feet decreased compared to the first week. The reduction in pain at the end of the fourth week after foot baths was greater compared to after using the mat. However, these reductions were not statistically significant ($p > 0.05$).

The literature review suggests that warm foot baths have been shown to reduce tissue tension and alleviate pain in joints and muscles. These findings are backed by various sample groups in previous studies (Devkate et al., 2016; Nagaich, 2016; Sarvinoz and Muzaffar, 2022; Han et al., 2022).

However, no studies examining their effectiveness on operating room nurses and their changes over both weekly and four-week periods were found. Anti-fatigue mats, on the other hand, are effective in reducing musculoskeletal disorders and fatigue by promoting slight movements in nurses through the small elevations on the mats, leading to increased blood circulation and venous return (Chung et al., 2013; Speed et al., 2018; Zhang et al., 2022; Pazouki et al., 2017).

Studies conducted in various industries and groups have highlighted the positive effects of using anti-fatigue mats on reducing pain in different areas (Unver and Makal Organ, 2023; Winberg et al., 2022; Hwang and Jun, 2015; Gabrielson et al., 2021; Aghazadeh et al., 2015). When evaluating the applications separately in the current study, the findings align with those of previous studies.

However, no study was found in the literature that compared the effectiveness of both interventions on the same group and examined the reduction in pain intensity in the right and left feet. In this study, although the superiority of foot baths could not be conclusively proven, it is believed that this simple and cost-effective method might be more beneficial for operating room nurses because it led to a greater reduction in pain intensity after foot baths.

In the study, the fatigue levels of operating room nurses increased at the end of the fourth week after both interventions. However, the average fatigue and energy score changes at the end of the fourth week after foot baths were less than those after anti-fatigue mat usage when compared to the first week. Nevertheless, these findings were not statistically significant ($p>0.05$).

In the literature, some studies conducted on patients have reported the effectiveness of foot baths in reducing fatigue (Lee et al., 2014; Sharma et al., 2016; Das et al., 2018), while other studies have reported no statistically significant effect of foot baths on fatigue levels (Seo et al., 2018; Seo et al., 2017).

Anti-fatigue mats are effective in reducing fatigue in studies (Hwang and Jun, 2015; Voss et al., 2017; Speed et al., 2018; Zhang et al., 2022; Lu et al., 2021). Therefore, the superiority of both interventions has not been conclusively established, and further study is needed with a similar design and sample group to determine their relative effectiveness.

Study limitations: This study has several limitations, including the use of a small group of operating room nurses. Other limitations involve nurses performing the interventions themselves and conducting their observations.

Conclusion: In this study, there was no significant difference in terms of the superiority of foot baths and anti-fatigue mat usage in reducing fatigue and lower extremity

pain. However, more favorable results were obtained in all measurement parameters after foot baths. Based on these findings, it is recommended to conduct studies aimed at increasing the use of foot baths as a comfortable and cost-effective method to alleviate the symptoms of lower extremity discomfort among operating room nurses. Additionally, since anti-fatigue mats, which are not widely used, are easy to use and clean, it may be beneficial to incorporate them into operating rooms to reduce the symptoms of lower extremity discomfort in operating room nurses.

The effects of foot baths and anti-fatigue mat usage on pain and fatigue among operating room nurses should be further studied. Studies should also be conducted comparing the effectiveness of foot baths at different water temperatures on lower extremity symptoms. Additionally, larger, longer-term, and a greater number of randomized controlled clinical trials with the same sample group are recommended to demonstrate the superiority of foot baths and anti-fatigue mat usage over each other.

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