Research Article

THJPH

Reduction of Knee Pain from Osteoarthritis with Thai Massage and Thai Herbal Poultice in Government Hospitals, Thailand

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Received: April 2 2025; Revised: June 17 2025; Accepted: July 8 2025

Abstract

Objectives: This randomized controlled trial (RCT) aimed to assess the efficacy of Thai massage combined with a Thai herbal knee poultice in alleviating knee pain associated with osteoarthritis.

Methods: A total of 308 adults aged 44 years and older with clinically diagnosed knee osteoarthritis were recruited from 27 primary care clinics across four public health sectors in Thailand. In this two-arm, parallel-group randomized controlled trial, participants were randomly assigned to one of two groups: (1) a control group receiving Thai massage alone, or (2) an intervention group receiving Thai massage combined with a Thai herbal knee poultice applied every other day for five sessions, followed by five weekly maintenance sessions. Outcome measures were assessed at baseline and at week 5 using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) to evaluate pain, joint stiffness, and physical function. Knee radiographs were also obtained to support clinical assessment.

Results: At week 5 the intervention group experienced significantly greater reductions in resting pain ($p = 0.023$). Stiffness improved markedly—both on first arising and later in the day ($p = 0.001$). Physical function gains were superior in the intervention group, including the ability to stand ($p = 0.001$), rise from a chair ($p = 0.001$), walk on level ground ($p = 0.002$), get in and out of a car ($p = 0.001$), shop, and put on trousers or a sarong (both $p = 0.001$). No radiographic progression was detected in either group.

Conclusion: A five week regimen of Thai massage augmented with a Thai herbal knee poultice produced clinically and statistically significant improvements in pain, stiffness and physical

function compared with massage alone. These findings warrant confirmation in a larger, longer term clinical trial.

Keywords: Court-type traditional Thai massage, Knee osteoarthritis, Randomized controlled trial, Herbal knee poultice, WOMAC

What was Known

- Point 1: Thai massage and herbal poultices have been traditionally used and reported as effective therapies for reducing pain and improving joint function in elderly patients with knee osteoarthritis.
- Point 2: Previous studies on these interventions included a broad age range (43–78 years) but lacked rigorous randomized controlled trials assessing combined use of Thai massage and standardized Thai Herbal Poultice in a real-world clinical setting.

What's New and Next

- Point 1: This a study with random assignment to control and intervention groups is the first to evaluate the combined use of Thai massage and Thai Herbal Poultice knee masks in adults aged 44 and older, demonstrating feasibility, adherence, and significant pain reduction at rest.
- These findings support the scalability of the intervention in larger clinical trials and suggest a potential role for integrating traditional Thai therapies into evidence-based care pathways for managing knee osteoarthritis in aging populations.

Introduction

Knee osteoarthritis (OA) is the most common form of arthritis that affects the elderly in the world. It is a leading cause of disability and has a formidable societal and public health impact [1,2]. The prevalence of symptomatic knee OA is estimate 14.6% of the China adults over 40 yr. of age[3]. Osteoarthritis (OA) is a chronic disease occurring in different parts of the body; it is characterized by cartilage destruction, subchondral bone sclerosis, and arthritic bone hyperplasia[4]. Knee OA, the main type of OA, is ranked as the 11th highest contributor to global disability and 38th highest in disability-adjusted life years[5]. The development of knee OA have a number of factors may contribute including prior joint injury, obesity, sex, and anatomical factors related to joint shape and alignment6. Symptoms of OA, radiographic OA, and self-reported OA are the definitions of the most commonly used cases[7]. OA cases are defined as symptomatic when both radiographic and joint symptoms related to the pathology are present[8].

About $86 billion is spent annually in U.S. for direct costs of medical care for back/neck pain, with particularly burgeoning costs for back pain in older Americans[9]. By 2020, more than 50 million Americans will have OA[10, 11] which is the most frequently reported chronic condition in the elderly population[2, 12] For OA, conventional treatments include pain medication (nonsteroidal anti-inflammatory drugs and cyclooxygenase-2 inhibitors), exercises[13], hot and cold therapy, corticosteroid injections, and, eventually, surgery to repair the joint2. Despite of OA conventional treatment is often progressive and frequently leads to chronic pain and disability[14].

Massage therapy has been shown to alleviate symptoms in various musculoskeletal conditions by enhancing local circulation, improving muscle tone, increasing joint flexibility, and reducing pain[15]. Although massage therapy is widely used, to date, no rigorous study has specifically evaluated the effectiveness of traditional Thai massage for OA [16, 17]. Therefore, we conducted a five-week randomized controlled trial to investigate the effects of Court-type traditional Thai massage combined with herbal poultices on knee pain relief in individuals with knee OA.

Materials and Methods

Study design and participants

The research areas in the four regions were selected from hospitals that had applied to serve as pilot clinics, in collaboration with the Department of Thai Traditional and Alternative Medicine, for the care of elderly patients with knee osteoarthritis based on the principles of Thai traditional medicine. The quality control method for the production of herbal knee packs was carried out by the Division for Development of Medicinal Plants and Thai Traditional Medicine. A randomized controlled study was conducted at 27 pilot clinics operated by the Department of Thai Traditional and Alternative Medicine, Ministry of Public Health, Thailand. A total of 308 participants who met the inclusion criteria were recruited from four sectors of the national public healthcare system.

Participants were elderly patients aged 40–75 years who met the orthopedic doctor's diagnostic criteria for lom-jub-pong-hang-khoa (a traditional Thai diagnosis for knee osteoarthritis) or clinically defined knee osteoarthritis. (i.e.,x-ray, pain, stiffness and functional ability of the knee joint). Additionally, participants were required to report at least moderate pain intensity (total score level 2 on a 20-29 numerical rating scale) and exhibit minor knee osteoarthritis, defined by X-ray as Kellgren-Lawrence Grade 2 (minimal: definite osteophytes and possible joint space narrowing).

Participants were excluded if they presented with complicated knee osteoarthritis, defined as co-existing conditions such as atopic dermatitis, cancer, pestilence, gout, paralysis, rheumatoid arthritis, knee tumors, or inflammatory joint pain. Additional exclusion criteria included a history of knee injury (e.g., from football, falls, or direct impact), prior knee surgery, or possible cognitive impairment (indicated by a score of >2 on the 6-item Callahan screener). We also excluded individuals if they had a known allergy to any of the ingredients in the Thai Herbal Poultice (THP) for the knee mask (i.e., *Zingiber zerumbet* (L.) Roscoe ex Sm., *Mallotus repandus* (Willd.) MÜll.Arg., *Gloriosa superba* L., *Cryptolepis buchanani* Roem. & Schult., *Cleome viscosa* L.).

This traditional knee poultice formula is used to relieve knee pain caused by a local syndrome known in Thai traditional medicine as "lom-jub-pong-hang-khoa", which corresponds to degenerative osteoarthritis. The herbal components of this formula can be classified into four principal pharmacological groups based on their therapeutic actions:

1. **Anti-inflammatory, analgesic, anti-swelling, and musculoskeletal relaxant herbs**: These herbs alleviate pain, reduce inflammation, relieve muscle tension, and diminish swelling:
    - *Crinum asiaticum* (Plub Plueng leaf)
    - *Zingiber montanum* (Phlai)
    - *Zingiber officinale* (Ginger)
    - *Cleome viscosa* (Phak Sian Phee)
    - *Acorus calamus* (Sweet Flag)
    - *Gloriosa superba* (Dong Deung)

    Curcuma aromatica (Golden Root Turmeric / Wan Ron Thong)

2. Circulatory stimulants:These herbs promote blood flow and enhance circulation around the affected area:
    - *Piper retrofractum* (Long Pepper / Phrik Thai Lon)
    - *Citrus hystrix* peel (Makrut Lime Peel)

3. Antimicrobial and infection-related anti-inflammatory herbs

These herbs address inflammation caused by infection and have antimicrobial actions:
    - *Plumbago indica* (Jetmoolpleng Daeng)
    - *Alpinia galanga* (Galangal)
    - *Curcuma zedoaria* or *Curcuma aromatica* (Wan Nang Kham)

4. Detoxifying and diaphoretic herbs (promote excretion through the skin and pores)

These herbs support detoxification through the skin and enhance elimination via sweat glands:

- *Tamarindus indica leaves* (Tamarind Leaf)

Acacia concinna leaves (Soap Pod Leaf / Som Poi Leaf)

In this study, quality control measures were applied to both the production site and manufacturing processes. The original traditional formula, particularly the fermented herbal liquid component (*nam mak ya*), was modified to improve the overall quality, ensure standardization, and enhance user convenience. To ensure consistent quality, the researcher outsourced the production of the herbal poultice to a certified facility that complies with Good Manufacturing Practice (GMP) standards. The product was developed in the form of **single-use**

vacuum-sealed sachets, each containing:

- A **cotton pad soaked with the traditional herbal knee poultice formulation**, and
- A **gauze wraps** for securing the poultice in place over the knee.

All raw materials underwent **laboratory testing** for **contaminants and heavy metals** prior to use. Each sachet was vacuum-packed to preserve freshness and stability at room temperature. For application, the user simply opens the sachet and applies the cotton pad directly to the knee. One sachet is intended for **single use only**.

We recruited patients through electronic health records who had visited primary care providers for knee osteoarthritis. These recruitment efforts were supplemented with multiple strategies, including posters displayed at Thai Traditional Medicine clinics and outpatient department (OPD) clinics. Our goal was to recruit 308 participants, distributed across 28 cohorts, with a target of 154 participants in the intervention group and 154 in the control group. While we initially planned a direct comparison between the intervention and control, our funders requested the inclusion of an attention control. Given our skepticism about developing an effective attention control, we instead utilized post-intervention X-ray films from all 308 participants to confirm osteoarthritis diagnoses and conducted evaluations using the WOMAC scale and adverse reaction-based safety assessments.

For the first cohort, 400 individuals registered and were screened; 92 were excluded, resulting in 308 remaining participants. In the second cohort, these 308 participants were then randomized in a 1:1 ratio to either the intervention group (n=154) or the control group (n=154) to

meet each group's sample size target. Prospective participants were initially screened by health staff. Those who passed then completed an in-person visit that included final eligibility questions, provided written informed consent, underwent two physical performance measurements, completed a self-administered baseline questionnaire, and were finally randomized and enrolled into the study. Participants in both cohorts were informed of their assigned intervention group.

Random assignment to control and treatment groups

The random allocation sequence for this study was generated using a computer program. This ensured that the staff responsible for participant randomization remained blinded to group assignments in advance.

Interventions

All participants had access to the health insurance provided by their plan. Control group, participants did not receive further interventions from the study they were received only Thai massage. The intervention group, participants received the Thai massage plus Thai Herbal Poultice for the knee mask, the intervention group received the intervention in once every twice days for five times (Table 1.). In addition, intervention participants received another 5 times of maintenance course massage: in each weekly for two days off in massage and used herbal knee pack for intervention group, in each weekly for two days off only massage for control group. Using the TIDier framework[19], Table 1 provides detailed descriptions of the interventions in, including the Thai massage, INTERVENTION government hospital practice, and assessments of adherence and fidelity. The herbal knee pack was recipes of herbal medicines for knee masks that need to be boiled for 22 types of medicines. All drugs are divided into 4 groups according to their therapeutic properties of osteoarthritis: the first group of herbs that have properties to relieve pain, cure inflammation, cure swelling, and cure tendons. The second group of herbs has properties that cause blood to flow. The third and fourth groups of herbs are effective in treating inflammation, infection and excretion of waste through the skin or hair follicles. For medicinal fermented water, consists of old glutinous rice (black and white rice), limewater and Thai traditional fermentation starter (Loog-Pang). The both material rice should be mixed with steamed until cooked and washed with clean water 3-7 times, aerate in the basket to dampen, then mix in 5 Loog-Pang and ferment the rice in a jar for 7 days, open the lid, pour 10 liters of lime water, leave it for 7 days, then filter the clear water to use for fermenting the drug.

Measuring instrument

The study outcomes were recruitment rates (at least 80%of target), massage intervention adherence, participant adherence to the interventions (massage/week, at least 70% of massage and for Thai massage at hospital twice/week), and follow-up for Monday, Wednesday/week of intervention group and Tuesday, Thursday/week of control group. We use outcome measures recommended by the Western Ontario and McMaster Universities Arthritis Index (WOMAC Scale)[20] for pain, stiffness, physical function which include X-ray imaging assessment of knee osteoarthritis for the prevalence of definite radiographic knee osteoarthritis was 30.0% and that of symptomatic knee osteoarthritis was 21.2%. We found that higher BMI, female sex, older age, and higher BMD were significantly associated with an increased risk for radiographic knee osteoarthritis[21]. Acceptability outcomes included data on the helpfulness of the interventions (0–5 scale), evaluation criteria for (0 – 14.6 score for healed, 14.7 – 29.3 score for pain but no knee osteoarthritis, 29.4 – 44.0 score for stage 1, 44.1 – 58.7 score for stage 2, 58.8 – 73.4 score for stage 3, 73.5 – 88.0 score for stage 4)[22, 23]. To assess intervention safety, we asked participants if there have anything in the Thai massage and Thai Herbal Poultice for the knee mask (swelling after massage, red rash) or the symptom that caused them significant discomfort or pain or that they felt was harmful. We appointment to participants before each follow-up time point to remind them for massage plus knee mask and answer the questionnaire would arrive the next week. We followed up by phone with participants who did not return the massage and doing questionnaire within a few weeks. After the 5 weeks for interviews, qualitative feedback on improving the recruitment and enrollment experience and suggestions for knee mask improvement was obtained from the Thai massage and Control group participants through 1-h focus groups. Participants were paid $5.6 for their time. Focus groups were re-corded and transcribed verbatim. In control group, similar feedback on logistics was obtained by self-administered questionnaire. We descriptively summarized participant's suggestions for improvement for use in a subsequent trial.

Sample size and statistical analyses

Calculating the appropriate sample size is critically important for our study, which aims to evaluate a novel knee poultice for the treatment of osteoarthritis. The primary objective is to demonstrate that the new poultice is non-inferior to standard treatment, rather than superior[24]. The sample size estimation is based on the patient population attending Thai traditional medicine clinics across 27 pilot hospitals, totaling 7,371 individuals. The clinically significant difference

was set at 80%, which served as the basis for determining the required number of participants. This represents the maximum acceptable difference where the new poultice could perform worse than the standard treatment, yet still be considered effective. This margin is set by clinicians based on what's clinically acceptable. Other key factors considered include of the primary outcome we're measuring, such as pain scores. Data variability, typically informed by previous studies.

Participants aged 40–75 years, diagnosed by a Thai Traditional Medicine (TTM) doctor with knee pain due to lom-jub-pong-hang-khoa (osteoarthritis of the knee), were included. This information was sourced from the Ministry of Public Health's HDC system, reflecting individuals receiving services at 27 Thai Traditional Medicine clinics across hospitals. The sample size for this study is sufficient to provide a high likelihood of surfacing any important problems that may exist [25]. The research study was started after the approval from the Department of Thai Traditional and Alternative Medicine, Ministry of Public Health (COA. NO.10/2563) and approved by TCTR identification number is TCTR 20250619003. All participants provided consent for eligibility screening and study enrollment.

Our sample size of 308 was chosen based on practical considerations to provide ample opportunity to identify problems (Figure 1) with the study procedures, intervention protocols (including adherence), outcome measures, and follow-up rates. Descriptive data are presented as means, medians, and frequencies. Non-Parametric descriptive statistics (Chi-squared test, Repeated Measures ANOVA) were used for several with random assignment to control and treatment groups aims.

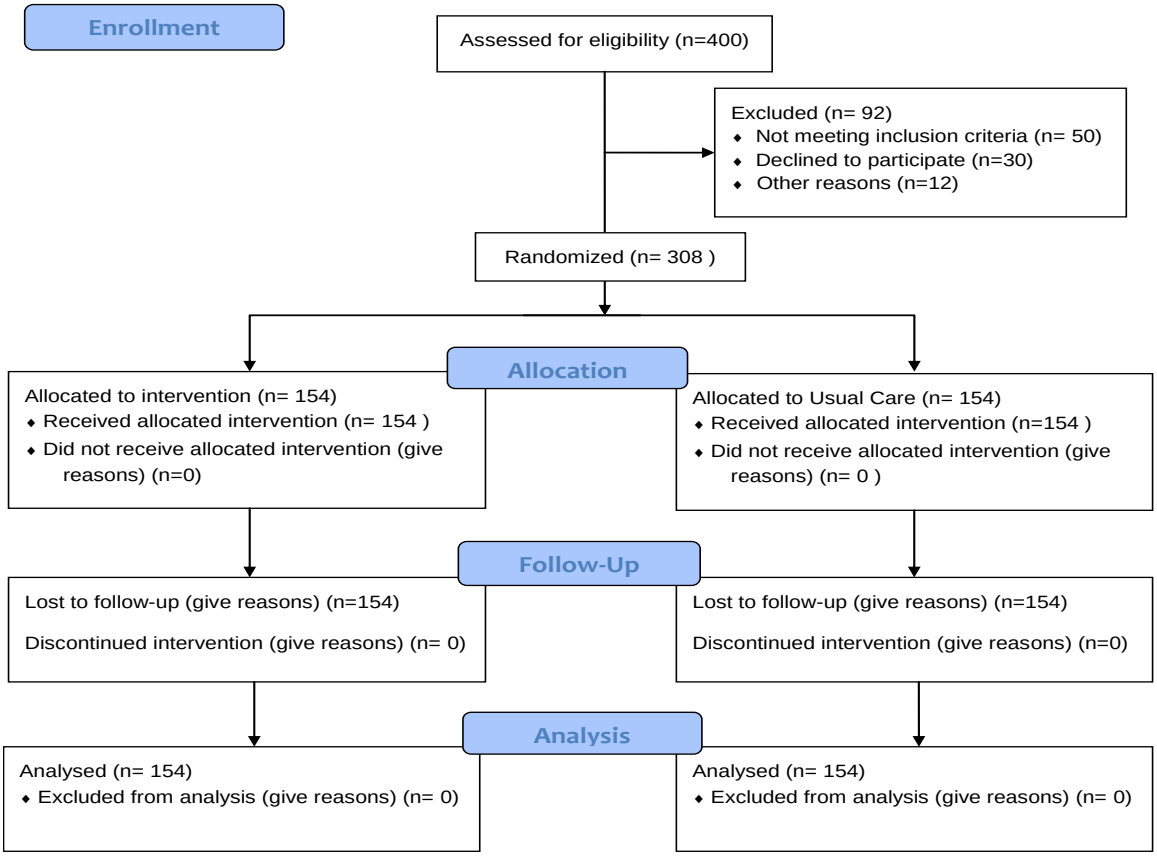

Figure1 Flow Diagram of the progression of participants through the phrase of the randomized control trial

In allocate, all participant received radiographic OA for diagnosis by orthopedic doctor in case confirm level of osteoarthritis. Stage 0 (L.0) of OA is classified knee health as “normal level” it means no symptom of OA and the joint functions without any impairment or pain. OA stage 1 (Minor: L.1) is showing very minor bone spur growth. However, if patient have a predisposition to OA or are at an increased risk, the doctor may recommend patient begin an exercise routine to help relieve any minor symptoms of OA and to try to slow the progression of the arthritis. Stage 2 (Mild: L2) of the knee is considered a mild stage of the condition. Several different therapies can help relieve the pain and discomfort caused by this mild stage of OA. These therapies are mainly nonpharmacological, which means patient don’t need to take medication for symptom relief. Stage 3 (Moderate: L3), in this stage, the cartilage between bones shows obvious damage, and the space between the bones begins to narrow. Glucocorticoids are types of corticosteroid drugs. Corticosteroids include cortisone, a hormone which has been shown to relieve OA pain

when injected into the affected joint. Stage 4 (Severe: L4), patients in this stage of the knee experience great pain and discomfort when they walk or move the joint. Available treatments for Stage 4 include surgery (Figure 2).

Radiographic OA L.0	Radiographic OA L.1	Radiographic OA L.2	Radiographic OA L.3	Radiographic OA L.4
				

Figure 2 Radiographic OA for inclusion criteria

To ensure consistent and reliable data collection, our research implemented a rigorous standardization protocol for all massage practitioners. This involved comprehensive, uniform training on both intervention techniques and assessment methods to minimize variability among individuals. Furthermore, we developed detailed Standard Operating Procedures (SOPs) that precisely outlined how to assess knee osteoarthritis inflammation, localize inflammation and bone tuberculosis using red lime paste (Table 1), and identify the exact target areas for massage. These measures were crucial for standardizing the intervention delivery and all associated assessments, ultimately ensuring high data integrity throughout the study.

Table 1 Detailed Description of Interventions in *Lom-jub-pong-hang-khoa*

Descriptors	Interventions	Implement	Control
Original Intervention	screening criteria for accepting patients for treatment,	Osteoarthritis screening form	Osteoarthritis screening form
Thai Traditional Diagnosis for Lomjubponghang khoa	check the general condition of the knee,		Check for warmth around the knee to measure inflammation.
	diagnosis with measurement of the heel,		This is the medical care that participants are entitled to by virtue of their insurance.
	Check the condition of knee deflection,		Insert the hand under the knee joint to examine or assess the condition of knee displacement or deflection
	knee patella,		Check the knee movement and prevent friction of the ligaments
	move the knee joint,		Check the flexibility of the knee joint.
	knee degree measurement,		The measurement of the knee joint range of motion, such as the angle of flexion or extension, which helps assess the flexibility and function of the knee joint
	Applying red plaster to the knee joint		Not Applying red plaster to the knee joint

Table 1 Detailed Description of Interventions in *Lom-jub-pong-hang-khoa* (Cont.)

Descriptors	Interventions	Implement	Control
knee poultice	herbal knee pack		Not Applying herbal knee pack to the knee joint
	Classes incorporated features of C-TTM that are known to be beneficial for reduce the pain of Lomjubponghangkoa : specific massage C-TTM enhance movements to enhance musculoskeletal strength and flexibility, efficient posture, heightened body awareness, herbal knee pack with applying on the knee joint reduce muscle stiffness and slack tendon, reduce inflammation of the knee joint	 C-TTM= Court-type traditional Thai massage	Provides a comparison of interventions that includes the treatments that participants of the study
Rational	Massage plus herbal knee pack	2x/week for 5 weeks and applying herbal knee pack on the knee joint	As desired by patient
Duration How practice	1.30 hour	Massage 1.30 h with Thai Traditional Medicine practices and applying herbal knee pack for 30 mins after finished the massage	
Where massage	C-TTM +herbal knee pack	Government hospital in the area of Thai Traditional Medicine Clinic	
Who provided	TTM practicing at government hospital	Thai Traditional Medicine professional with more than 5 years of experience practicing C-TTM	
Adherence Monitoring	Research Assistant (RA) took attendance. The RA contact participants who missed a massage both intervention and control group		

Result

Recruitment

We enrolled 308 participants out of our goal of 400 (75%), with 154 in each of Interventions and UC group. Among 400 individuals assessed for eligibility between Jan and Feb 2020 were randomized, 92 declined to participate and most others were ineligible (Figure 1). The most common reasons for eligibility were meeting our definition of chronic moderate [not chronic (n=54, 17.5%); minor (n=66, 21.4%)]; Mild (n=84, 27.3%) Moderate (n=78, 25.3%), and severe (n=26, 8.4%). The most successful method of recruitment was Poster announce at Thai Traditional Clinic at hospital enrollees who sought care for osteoarthritis (n=400) and the least successful was word of mouth in the community (n=0). All participants were finding diagnosis data from ICD 10 code from Hospital Information System.

Population

Participants ranged between 43 and 78 years of age (mean of 64.0 years; 8.1% were 40–49 years; 29.5% were 50-59 years; 36% were 60-69 years;26% were 70-79). Most participants (84.7%) were women. Virtually all participants (62.3 %) were finished primary school and most of the participants were agriculturist (44.8%), roughly 4 in 5 were retired and around more than half were married. The mostly participants used national health insurance (33.8%) and welfare for the elderly (30.8%) and have osteoarthritis of the knee in mild and moderate (27.3, 25.3%) in both sides.

Table 2 Baseline Characteristics of Study Participants

Demographic characteristics	Control (n=154)	Interventions (n=154)	Total (n=308)
Age, Mean (SD), years in study	63.0(7.8)	65.1(8.2)	64.0(8.1)
Men, n (%)	29(18.7)	14(9.2)	4-3(14.0)
Women, n (%)	125(81.2)	140(90.9)	265(86.0)
Education, noncollege and college			
Did not study	15(9.7)	7(4.6)	22(7.1)
primary school	93(60.4)	99(64.3)	192(62.3)
secondary school	10(6.5)	8(5.2)	18(5.8)
high school	18(11.7)	17(11.0)	35(11.4)
diploma	3(1.9)	9(5.8)	12(3.9)
bachelor's degree	10(6.5)	11(7.1)	21(6.8)
master's degree	5(3.2)	1(0.6)	6(1.9)
Other degree	0(0.0)	2(1.3)	2(0.5)
Occupation			
civil servant	11(7.1)	12(7.8)	23(7.5)
Agriculturist	68(44.2)	70(45.5)	138(44.8)
Employee	23(14.9)	19(12.3)	42(13.6)
Self-employed	15(9.7)	15(9.7)	30(9.7)
Freelance	37(24.0)	38(24.7)	75(24.4)
Occupation			
Celibate	6(3.9)	10(6.5)	16(5.2)
Marry	118(76.6)	114(76.6)	232(75.3)
Widowed/divorced/separated	30(19.5)	30(19.5)	60(19.5)

Table 2 Baseline Characteristics of Study Participants (Cont.)

Demographic characteristics	Control (n=154)	Interventions (n=154)	Total (n=308)
Health insurance			
National Health Insurance	60(39.0)	73(47.4)	133(43.2)
Government or State Enterprise Officer	34(22.1)	18(11.3)	52(16.9)
Welfare for the elderly	41(26.6)	45(29.2)	86(27.3)
Social Security Scheme	2(1.3)	10(6.5)	12(3.9)
Other insurance	17 (11.0)	8(5.2)	25(8.1)
Osteoarthritis of the knee			
no symptoms of osteoarthritis	27(17.5)	27(17.5)	54(17.5)
Minor	35(22.7)	31(20.1)	66(21.4)
Mild	43(27.9)	41(26.6)	84(27.3)
Moderate	36(23.4)	42(27.3)	78(25.3)
Severe	13(8.4)	13(8.4)	26(8.4)
Number of knee joints with pain			
Pain in 1 knee	82(53.2)	82(53.2)	164(53.2)
Pain in both knees	72(46.8)	72(46.8)	144(46.8)
Number of knee joints with pain			
left side	37(24.0)	39(25.3)	76(24.7)
right side	44(28.6)	43(27.9)	87(28.2)
both side	73(47.4)	72(46.8)	145(47.1)
Causes of knee pain			
work hard	100(64.9)	101(65.6)	201(65.3)
sitting incorrectly	17(11.0)	8(5.2)	25(8.1)
overweight	13(8.4)	23(14.9)	36(11.7)
injurious food	2(1.3)	0(0.0)	2(0.6)
elderly	19(12.3)	20(13.1)	40(1.03)
heavy exercise	1(0.6)	0	1(0.3)
not specified	2(1.3)	1(0.6)	3(1.0)

Interventions acceptability

At 5 weeks, participants in the Interventions group reported feeling more comfortable in the resting position ($p = 0.023$). Joint stiffness improved, especially in the morning and occurred

later in the day ($p = 0.001$). Improvements in physical function were also observed, including better ability to stand ($p = 0.001$) and to rise from a seated position ($p = 0.001$). In addition, participants showed improved ability to walk on a flat surface ($p = 0.002$), get in and out of a car more easily ($p = 0.001$), go shopping, and put on trousers, sarong ($p = 0.001$) (Table 3).

Table 3 Acceptability of Interventions for reduce pain of OA patient

Measure	Control [mean, SD]	Interventions [mean, SD]	*p-value*
Pain			
Walking	1.58(0.50)	1.50(0.49)	0.174
Stair Climbing	1.87(0.33)	1.78(0.41)	0.032
Nocturnal	1.57(0.49)	1.51(0.50)	0.309
Rest	1.43(0.49)	1.31(0.46)	0.023*
Weight bearing	1.70(0.45)	1.64(0.48)	0.243
Stiffness			
Morning stiffness	1.66(0.47)	1.48(0.50)	0.001*
Stiffness occurring later in the day	1.73(0.44)	1.59(0.49)	0.009*
Physical Function			
Descending stairs	1.87(0.33)	1.81(0.39)	0.148
Ascending stairs	1.86(0.35)	1.84(0.36)	0.732
Rising from sitting	1.64(0.48)	1.51(0.50)	0.001*
Standing	1.75(0.47)	1.61(0.57)	0.001*
Walking on flat surface	1.48(0.53)	1.37(0.51)	0.002*
Getting in / out of car	1.71(0.42)	1.62(0.45)	0.001*
Going shopping	1.65(0.49)	1.52(0.50)	0.001*
Putting on trousers, sarong	1.88(0.34)	1.76(0.47)	0.001*
Lying in bed	1.60(0.49)	1.54(0.50)	0.258
Taking off socks	1.81(0.39)	1.75(0.43)	0.248
Standing shower	1.23(0.41)	1.27(0.44)	0.392
Sitting	1.54(0.50)	1.48(0.50)	0.307
Getting on/off toilet	1.60(0.49)	1.56(0.49)	0.431
Light domestic duties	1.65(0.48)	1.59(0.49)	0.306
Heavy domestic duties	1.72(0.49)	1.66(0.47)	0.273

** Chi-square test or Fisher's exact test*

At the 5-week, Interventions group participants the massage mixed Thai Herbal Poultice for the knee mask (Follow up 1-5) rated and interview the helpfulness of this model can reduce the pain level in joint pain/knee pain while resting (Table 4, Figure 3). For control group, the researcher does not interfere with the treatment process and at the end of the research the control group will receive a massage mixed the knee mask.

Table 4 Overall effect of massage and knee mask for improved symptoms

Variables	*df*	SS	MS	Control		Interventions		95% CI		F	Sig
				Mean	SE	Mean	SE	Lower Bound	Upper Bound		
Pain Level											
Joint pain/knee pain while resting (stay still)											
Intercept	1	447.89	447.89							5591.24	0.000
Baseline				1.45	0.50	1.42	0.50	1.38	1.49	0.87	0.351
Follow up 1				1.42	0.50	1.31	0.47	1.31	1.42	13.49	0.000
Follow up 2				1.24	0.43	1.16	0.37	1.16	1.25	11.13	0.001
Follow up 3				1.17	0.38	1.08	0.27	1.09	1.16	27.86	0.000
Follow up 4				1.10	0.31	1.02	0.14	1.04	1.09	43.15	0.000
Follow up 5				1.08	0.27	1.02	0.14	1.03	1.07	24.18	0.000

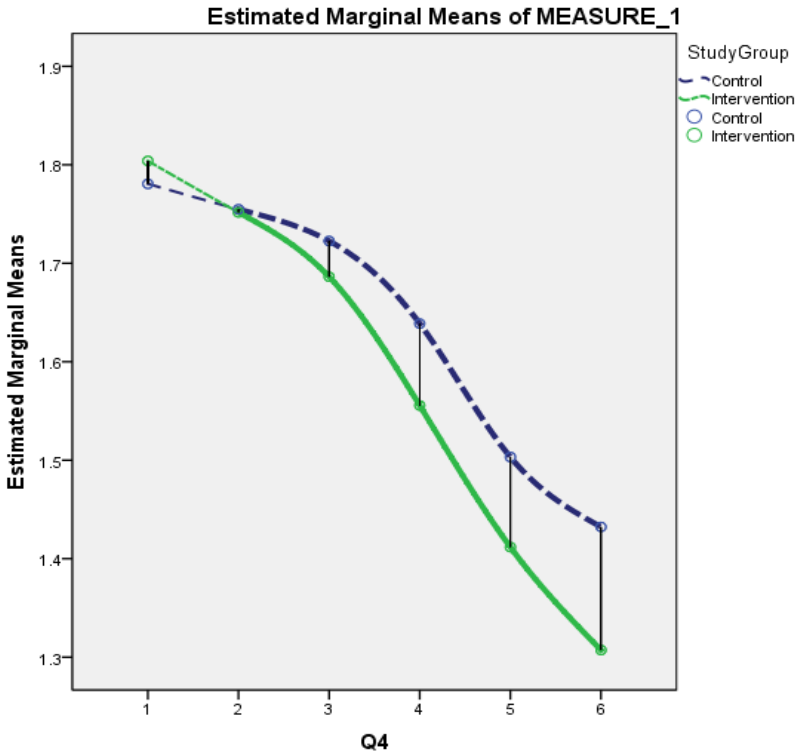

Figure 3 Estimated marginal means of measure pain level

Discussion

In this study, both groups demonstrated significant improvements in their primary and secondary outcomes. The observed similarity in improvements between the groups, along with narrow confidence intervals, suggests that the addition of Thai Herbal Poultice to traditional Thai massage for pain reduction in knee osteoarthritis may differ in effectiveness when using the Thai Herbal Poultice. Future studies are needed to definitively confirm this. Based on these results, we can reject the null hypothesis that the Thai Herbal Poultice provides additional benefits to the outcomes when combined with traditional Thai massage.

In the group that received massage combined with a Thai Herbal Poultice, there were significant improvements in both primary and secondary outcomes. This suggests a difference in effectiveness, which warrants further investigation in future studies. According to the study protocol, both groups received traditional Thai massage, while the Interventions group additionally received with Thai Herbal Poultice applied to specific knee points for 30 minutes. It is well-established that Thai massage helps reduce knee pain, and importantly, this study demonstrates additional benefits from the Thai Herbal Poultice within the traditional Thai

massage regimen[25, 29]. Our use of an herbal knee compress containing Zingiber montanum for pain management aligns with the findings of Worasing, K. et al. (2023). Their research indicates that the Zingiber montanum herbal compress is significantly more effective at reducing pain compared to a placebo. However, they also reported no significant difference in pain reduction when compared to non-steroidal anti-inflammatory drugs (NSAIDs), although these results showed substantial heterogeneity[30]. A recent finding aligns with the results of a randomized controlled trial by Koonrung sesomboon et al., which investigated the effectiveness of Thai medicinal plant-4 (TMP-4) cream against diclofenac gel for symptomatic knee osteoarthritis. The study revealed that both treatments led to significant improvements in pain and joint function[27]. Crucially, the TMP-4 cream was found to be as effective as diclofenac gel, with no serious adverse effects reported in either group. This suggests that TMP-4 cream is a safe and effective alternative to conventional Western pharmacological treatments, offering comparable benefits for individuals with knee osteoarthritis.

Our study revealed statistically significant differences in both primary and secondary outcomes when comparing the control and Interventions groups during the first five treatment sessions (sessions 1-5). The mean differences between the groups, along with the upper limit of the 95% confidence interval, were sufficiently large at both the mid-point and the end of the Interventions to conclude that these differences were clinically significant. During the initial treatment period, both groups showed a trend towards increased pain reduction; however, the overall difference between the two groups was more than 1 on the WOMAC scale. Our results are highly compelling because the study was conducted as a randomized controlled trial, featuring independent group allocation and employing an intention-to-treat methodology. This study boasted a high compliance rate, adequate sample size, and high follow-up rates. Furthermore, the intra-reliability of all outcomes was tested and found to have high degrees of correlation. However, this study did have limitations. First, the study lacked a second observer, which precluded the examination of the inter-observer reliability of our outcome measures. Second, the use of multiple Thai traditional medicine assistants for massage meant that the pressure applied by each individual could not be perfectly controlled. This might have influenced the characteristics of the treatment for Lom-jub-pong-hang-khoa (knee osteoarthritis), despite efforts to standardize the procedure through training and the implementation of a Standard Operating Procedure (SOP). Finally, it was not ascertained if participants had sought care from other providers. However, further research should compare three groups: one receiving

conventional Western medicine, another receiving traditional Thai massage alone, and a third receiving traditional Thai massage combined with Thai Herbal Poultice. Such studies should also consider participant satisfaction, assess if additional Thai Herbal Poultice applications are preferred, and investigate if these additions can diminish or prevent side effects.

Conclusion

We believe that modified Court-type Traditional Thai Massage (Interventions) and Thai Herbal Poultice (THP) for knee mask interventions are worth testing in a full-scale trial. Before undertaking such a study, further work is needed to improve recruitment processes, refine the interventions, optimize the Thai Herbal Poultice (THP) for the knee mask, and prepare for the production of herbal medicines. Additionally, creating comprehensive training programs for Court-type Traditional Thai Massage (Interventions) and other facilitators, along with establishing an interventions workshop to offer to the control groups at the conclusion of the study, is essential. Enhancing fidelity to both interventions also warrants further investigation.

Ethical Approval Statement

This study was conducted in accordance with the *Belmont Report* and approved in accordance with the *Declaration of Helsinki* by the Committee on Human Research in Traditional Thai Medicine, Department of Thai Traditional and Alternative Medicine, Ministry of Public Health (COA.NO.10/2563). Participation was voluntary. Participants were informed about the study's objectives and informed consent to participate was obtained from all participants in the study before the interview. All methods were carried out under relevant guidelines and regulations.

Author Contributions

Study design and data collection: VS, TK

Data analysis and interpretation: VS, TK, YJ

Writing and/or critical review of the content: VS

Final approval of the manuscript: All authors

Acknowledgments

Thai traditional medicine team at the following hospitals: Khun Han Hospital, Bang Pa-in Hospital, Thatpanom Crown Prince Hospital, Denchai Crown Prince Hospital, Choeng Thale Health Promoting Hospital, Phrae Hospital, Sisaket Hospital, Loei Hospital, and Uttaradit Hospital, for practices in C-TTM, Herb and Thai Traditional Medicine Department in the product

of Thai Herbal Poultice (THP)for the knee mask, all staff of Division of Protection and Promotion of Thai Traditional and Indigenous Medicine assistance with the study.

Source of Funding

This Project was supported by Thai Science Research and Innovation (TSRI), Project code 10-2563. The contents are the sole responsibility of the authors and do not necessarily reflect the official view of TSRI.

Conflicts of Interest

None of the authors report any conflicts of interest.

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