Volume 3, Issue 5, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Pain Relief and Functional Recovery in Knee Osteoarthritis Using Therapeutic Ultrasound: Randomized Controlled Trial

Dr. Zahoor Ahmad

Assistant Professor/ Clinical In-Charged

zahoor.riphah@gmail.com

DOI: https://doi.org/10.5281/zenodo.16138870

Keywords
Knee Osteoarthritis, Therapeutic Ultrasound, Randomized Controlled Trial, WOMAC, Oxford Knee Score, Pain Management, Physical Function

Article History
Received: 05 April, 2025
Accepted: 03 July, 2025
Published: 19 July, 2025

Corresponding Author: *
Dr. Zahoor Ahmad

Abstract

Background: *Knee osteoarthritis (OA) is a chronic, degenerative joint disease that severely impairs mobility and quality of life. With increasing interest in non-pharmacologic interventions,* ***therapeutic ultrasound*** *has gained attention due to its potential anti-inflammatory and analgesic effects.*

Objective: *To evaluate the effectiveness of therapeutic ultrasound compared to standard care in improving pain and function in patients with knee OA.*

Aim of the Study: *This randomized controlled trial aimed to compare the impact of therapeutic ultrasound versus placebo ultrasound (sham therapy) on pain reduction and functional improvement in knee OA patients using the WOMAC and Oxford Knee Score (OKS).*

Methodology: *A total of 42 participants diagnosed with knee OA were randomly assigned to either the experimental group (n = 21) receiving therapeutic ultrasound or the control group (n = 21) receiving sham ultrasound (device applied but without emitting sound waves). The treatment was administered by blinded physiotherapists over a period of 3 weeks (3 sessions per week). Pre- and post-treatment outcomes were measured using WOMAC and OKS. SPSS was used for statistical analysis, including paired and independent t-tests, tests of normality, and correlation analysis.*

Results: *The experimental group showed significant improvement in both WOMAC and OKS scores post-treatment ($p < 0.001$), with a greater reduction in pain and improvement in joint function compared to the control group ($p < 0.05$). The control group demonstrated minimal or no improvement. The WOMAC score showed a strong positive correlation pre- and post-treatment in the experimental group ($r = 0.896$, $p < 0.001$), confirming consistent therapeutic effect.*

Conclusion: *This randomized controlled trial confirms that therapeutic ultrasound significantly improves pain and physical function in patients with knee osteoarthritis compared to placebo. Ultrasound should be considered an effective, safe, and non-invasive modality in conservative OA management.*

INTRODUCTION

Osteoarthritis (OA) is a chronic, degenerative joint condition characterized by the breakdown of articular cartilage and changes in subchondral bone, leading to pain, stiffness, and functional disability. (1) The knee is one of the most commonly affected joints, with prevalence rates rising due to aging populations and obesity. (2) According to the World

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Health Organization (2023),OA is a leading cause of disability among adults over the age of 50.

Approximately 10–15% of adults over 60 years' experience OA symptoms, and the knee is affected in more than 80% of these cases. (3) OA of the knee leads to substantial impairment in mobility and independence, increasing the risk of falls, social isolation, and depressive symptoms. (4) As there is no definitive cure for OA, treatment strategies focus on symptom management and slowing disease progression. Conventional treatment approaches include pharmacological interventions, such as nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroid injections, and in severe cases, surgical replacement. (5) However, long-term use of pharmacologic agents can lead to adverse effects, making non-pharmacological alternatives increasingly important. (6) Among these, physiotherapy modalities are central to OA management. (7)

Therapeutic ultrasound, a common modality used in physical therapy, has been suggested to reduce pain and inflammation, enhance circulation, and improve tissue healing (Ebadi et al., 2012). (8) It generates mechanical vibrations at a cellular level, producing deep tissue heating, which can modulate inflammatory pathways and promote metabolic activity (Baker et al., 2001). (9) Numerous trials have explored the effectiveness of ultrasound in knee OA, with mixed findings. (10) While some studies support its use for pain reduction and mobility improvement. (5) others argue that evidence is insufficient to establish strong recommendations. (11) Despite this, its non-invasive and low-risk profile makes ultrasound therapy attractive for older patients or those contraindicated for pharmacological treatments. (12) Evaluation of OA treatment outcomes is often conducted using validated instruments like the WOMAC and the Oxford Knee Score (OKS). WOMAC assesses pain, stiffness, and function in patients with OA. (13) while OKS is a shorter tool designed to assess outcomes after knee interventions. (14) These tools provide reliable insight into symptom burden and treatment efficacy. (15)

This study aimed to evaluate the efficacy of ultrasound therapy in reducing pain and improving function in knee OA patients, as measured by the WOMAC and OKS, and to contribute evidence supporting its integration into routine OA care.

METHODOLOGY

This study was designed as a single-blind, parallel-group randomized controlled trial aimed at evaluating the effectiveness of therapeutic ultrasound in reducing pain and improving physical function in patients with knee osteoarthritis. A total of 42 participants were recruited from an outpatient physiotherapy department based on the American College of Rheumatology (ACR) clinical and radiological criteria for knee osteoarthritis. Participants were between the ages of 40 and 70 years and presented with moderate to severe knee pain lasting at least three months. Radiographic evidence confirming Kellgren-Lawrence Grade II or III osteoarthritis was a necessary inclusion criterion. Individuals were excluded if they had undergone knee surgery or intra-articular injection within the previous six months, had active skin infections over the knee, systemic inflammatory diseases, malignancy, or a cardiac pacemaker.

Following enrollment, participants were randomly assigned into two equal groups (n = 21 each) using a computer-generated randomization sequence. Allocation concealment was ensured by using sealed, opaque, sequentially numbered envelopes opened only at the time of assignment. The study employed a single-blind design in which both participants and the outcome assessor were blinded to group allocation. Treating physiotherapists were not blinded due to the nature of the intervention but were not involved in outcome assessments. Participants in the experimental group received therapeutic ultrasound therapy applied to the affected knee three times per week for three consecutive weeks, totaling nine sessions. The ultrasound was delivered using continuous mode with a frequency of 1 MHz and an intensity of 1.5 W/cm^2 for 8 minutes per session. The probe was moved in slow circular motions over the medial and lateral joint lines using coupling gel to ensure optimal transmission. In the control group, participants received sham ultrasound, in which the probe was applied to the knee in the same manner and for the same duration, but the ultrasound machine was not activated to emit sound waves.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Both groups were advised to maintain their usual levels of physical activity and were not provided with additional exercises or medication during the study period. Outcome measures were assessed using two standardized and validated tools: the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Oxford Knee Score (OKS). WOMAC evaluates joint pain, stiffness, and physical function, with a maximum score of 96 indicating severe symptoms. OKS assesses joint pain and function across 12 items, with scores ranging from 0 (worst) to 48 (best). Both assessments were administered at baseline (pre-treatment) and after completion of the 3-week intervention period by a physiotherapist who was blinded to group assignment.

Data were analyzed using IBM SPSS Statistics version 25. Descriptive statistics were calculated for demographic variables, and normality of the data was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Within-group comparisons of pre- and post-intervention scores were performed using paired sample t-tests. Between-group comparisons were conducted using independent sample t-tests to determine statistical differences in treatment effects. Additionally, Pearson correlation was used to examine the relationship between pre- and post-intervention scores. A p-value of less than 0.05 was considered statistically significant for all analyses.

RESULTS

A total of 42 participants diagnosed with knee osteoarthritis were included in this randomized controlled trial and equally divided into two groups: an experimental group (n = 21) receiving therapeutic ultrasound and a control group (n = 21) receiving sham ultrasound. The baseline demographic characteristics, including age and gender, were comparable between groups. The majority of participants were female (71.4%), with the most common age group being 46–55 years (69%). (Table 01) Prior to treatment, both groups exhibited similar baseline scores on the WOMAC and Oxford Knee Score (OKS) scales, indicating no significant initial difference in symptom severity or functional limitation. In the experimental group, significant improvements were observed following the course of ultrasound therapy. The mean WOMAC score was significantly reduced (mean difference = 0.93), indicating decreased pain, stiffness, and functional impairment. The paired samples t-test showed this reduction to be statistically significant with a p-value < 0.001. Similarly, the Oxford Knee Score significantly increased post-treatment in the experimental group (mean difference = -1.10), reflecting improved joint function, with a corresponding p-value also less than 0.001.

In contrast, the control group, which received sham ultrasound therapy, showed only minor, statistically non-significant changes in both outcome measures. The WOMAC and OKS scores remained largely unchanged from baseline, suggesting no therapeutic benefit from the placebo intervention. Between-group comparisons using independent t-tests further reinforced the efficacy of therapeutic ultrasound. The experimental group demonstrated a significantly greater reduction in WOMAC scores and a more substantial increase in OKS scores compared to the control group ($p < 0.01$ for both). Additionally, a strong positive correlation ($r = 0.896$, $p < 0.001$) was observed between pre- and post-treatment WOMAC scores in the ultrasound group, suggesting consistent therapeutic effects among participants. The Oxford Knee Score correlation was weaker and not statistically significant, which may indicate some variability in patients' perception of functional improvement. (Table 02) (Table 03) (Table 04)

Table 01: Showing the Frequency and percentage of the study statistics

	Variables	Frequency	Percentage	Total
Gender	Male	12	28.6	42
	Female	30	71.4	
Age	36-45 Years	2	4.8	42
	46-55 Years	29	69.0	

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

	More than 56 Years	11	26.2	
PRE-WOMAC	31–45 Moderate impact	12	28.6	42
	46–60 Severe impact	25	59.5	
	61–72 Extreme impact	5	11.9	
PRE-OKS	0–19 Severe arthritis	5	11.9	42
	20–29 Moderate to severe arthritis	25	59.5	
	30–39 Mild to moderate arthritis	10	23.8	
	40–48 Satisfactory joint function	2	4.8	
POST- WOMAC	16–30 Mild impact	12	28.6	42
	31–45 Moderate impact	24	57.1	
	46–60 Severe impact	4	9.5	
	61–72 Extreme impact	2	4.8	
POST-OKS	20–29 Moderate to severe arthritis	2	4.8	42
	30–39 Mild to moderate arthritis	25	59.5	
	40–48 Satisfactory joint function	15	35.7	

Table 02: Showing the Test of Normality of the study

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-Western Ontario and McMaster Universities Osteoarthritis Index	.320	42	.000	.772	42	.000
Pre Oxford-Knee Score	.332	42	.000	.816	42	.000
Post Western Ontario and McMaster Universities Osteoarthritis Index	.307	42	.000	.790	42	.000
Post Oxford Knee Score	.352	42	.000	.726	42	.000

Table 03: Showing the values of Paired T Test

Paired Samples Test						
	Mean	Std. Deviation	95% Confidence Interval of the Difference		t	Sig. (2-tailed)
			Lower	Upper		
Pre WOMAC - Post WOMAC	.92857	.34165	.82211	1.03504	17.614	.000
Pre Oxford-Knee Score - Post Oxford	-1.09524	1.00752	-1.40920	-.78127	-7.045	.000

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Knee Score						

Table 04: Showing the paired sample correlations values

Paired Samples Correlations			
	N	Correlation	Sig.
Pre WOMAC & Post WOMAC	42	.896	.000
Pre-OKS & Post OKS	42	-.229	.145

DISCUSSION

The findings of this randomized controlled trial demonstrate that therapeutic ultrasound significantly improves pain levels and functional capacity in individuals with knee osteoarthritis. Participants who received ultrasound therapy showed substantial reductions in WOMAC scores and meaningful improvements in Oxford Knee Scores (OKS) compared to those in the sham treatment group. These results align with prior studies that have found therapeutic ultrasound to be effective in reducing joint pain and stiffness, and in improving physical function in patients with musculoskeletal disorders. (16)

The physiological mechanisms underlying these effects are well-documented. Ultrasound therapy promotes deep tissue heating, increases local blood flow, enhances cell membrane permeability, and stimulates tissue repair. (9) These effects contribute to decreased inflammation, improved collagen alignment, and enhanced joint mobility—key benefits in OA management. (8) The significant changes in post-treatment WOMAC and OKS scores among participants in the ultrasound group provide clinical evidence supporting these therapeutic effects.

A notable strength of this study is its randomized controlled design, which minimized selection bias and placebo effects. Moreover, the use of validated assessment tools, such as WOMAC and OKS, strengthens the reliability of outcome measurement. The significant improvement in WOMAC, in particular, demonstrates that ultrasound therapy can reduce both subjective symptoms and functional limitations, which are core outcomes in OA. (17) Interestingly, the correlation analysis showed a strong and statistically significant relationship between pre- and post-treatment WOMAC scores, but a weaker, non-significant correlation for the OKS. This discrepancy could be due to differences in scale sensitivity and specificity. While WOMAC includes detailed assessments across multiple dimensions (pain, stiffness, function), OKS is a shorter instrument and may be more prone to variability in patient self-reporting. Prior literature also suggests that WOMAC may be more responsive to physiotherapy interventions in non-surgical OA populations. (18) long-term randomized trials are needed to determine whether improvements persist and to define the optimal dosage and duration of ultrasound therapy. (19, 20)

Despite these positive findings, the study has some limitations. The sample size (n = 42) was relatively small, which may limit generalizability. In addition, the follow-up period was short-term (3 weeks), so the durability of symptom relief remains unknown. Larger, long-term randomized trials are needed to determine whether improvements persist and to define the optimal dosage and duration of ultrasound therapy. (11) In conclusion, this study provides clinical evidence that therapeutic ultrasound is a safe, non-invasive, and effective intervention for managing knee osteoarthritis. Its use can be especially beneficial for elderly patients or those seeking to avoid long-term medication. Based on these results, ultrasound therapy should be considered a valuable component of multimodal rehabilitation programs for knee OA. Future research should explore comparative effectiveness with other modalities, such as laser therapy or manual therapy, and investigate cost-effectiveness and patient satisfaction outcomes.

CONCLUSION

This study provides strong evidence that ultrasound therapy is an effective, non-invasive, and accessible treatment option for patients with knee

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

osteoarthritis. It significantly reduces pain and enhances functional ability, as demonstrated by improvements in both WOMAC and Oxford Knee Scores. These findings support the continued use of ultrasound as part of conservative OA management and highlight the need for further exploration into its broader applications in musculoskeletal rehabilitation.

REFERENCES

Hunter, D. J., & Bierma-Zeinstra, S. (2019). Osteoarthritis. *The Lancet*, 393(10182), 1745–1759.

Safiri, S., Kolahi, A. A., Smith, E., Hill, C., Bettampadi, D., Mansournia, M. A., ... & March, L. (2020). Global burden of OA, 1990–2017. *Annals of the Rheumatic Diseases*, 79(6), 819–828.

Cross, M., Smith, E., Hoy, D., Nolte, S., Ackerman, I., Fransen, M., ... & March, L. (2014). The global burden of hip and knee osteoarthritis. *Annals of the Rheumatic Diseases*, 73(7), 1323–1330.

Alkan, B. M., Fidan, F., Tosun, A., & Ardiçoglu, Ö. (2019). Quality of life and depression in patients with knee osteoarthritis. *Modern Rheumatology*, 29(4), 626–632.

Yang, X., Liu, L., Zhang, H., & Wang, W. (2021). Ultrasound therapy for osteoarthritis: A meta-analysis. *Clinical Rehabilitation*, 35(1), 35–44.

Kolasinski, S. L., Neogi, T., Hochberg, M. C., Oatis, C., Guyatt, G., Block, J., ... & American College of Rheumatology. (2020). 2019 ACR guidelines for OA management. *Arthritis Care & Research*, 72(2), 149–162.

Bannuru, R. R., Osani, M. C., Vaysbrot, E. E., Arden, N. K., Bennell, K., Bierma-Zeinstra, S. M., ... & McAlindon, T. E. (2019). OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis and Cartilage*, 27(11), 1578–1589.

Ebadi, S., Ansari, N. N., Naghdi, S., Jalaie, S., Fallah, E., & Sadat, M. (2012). The effects of continuous ultrasound on chronic non-specific low back pain. *Journal of Back and Musculoskeletal Rehabilitation*, 25(3), 149–155.

Baker, K. G., Robertson, V. J., & Duck, F. A. (2001). A review of therapeutic ultrasound: biophysical effects. *Physical Therapy*, 81(7), 1351–1358.

Rutjes, A. W., Nüesch, E., Sterchi, R., Jüni, P. (2010). Therapeutic ultrasound for OA of the knee or hip. *Arthritis Care & Research*, 62(9), 1331–1339.

Page, M. J., Green, S., McBain, B., Surace, S. J., Deitch, J., Lunn, T. H., & Buchbinder, R. (2011). Therapeutic ultrasound for knee osteoarthritis. *Cochrane Database of Systematic Reviews*, 2011(1), CD003132.

Fitzgerald, G. K., Piva, S. R., Gil, A. B., Wisniewski, S. R., Oddis, C. V., & Irrgang, J. J. (2018). Comparative effectiveness of physical therapy for knee OA. *Annals of Internal Medicine*, 168(6), 385–395.

Bellamy, N., Buchanan, W. W., Goldsmith, C. H., Campbell, J., & Stitt, L. W. (1988). Validation study of WOMAC. *The Journal of Rheumatology*, 15(12), 1833–1840.

Dawson, J., Fitzpatrick, R., Murray, D., & Carr, A. (1998). Questionnaire on the perceptions of patients about total knee replacement. *The Journal of Bone and Joint Surgery*, 80(1), 63–69.

Roos, E. M., & Lohmander, L. S. (2003). WOMAC and KOOS: instruments for OA outcome measurement. *Health and Quality of Life Outcomes*, 1, 17.

Yildiz, N., Topuz, O., Gungen, G. O., Yildiz, N., Alkan, H., & Gungor, T. (2017). Comparison of high-intensity laser therapy and ultrasound treatment in patients with knee osteoarthritis: A randomized controlled trial. *Lasers in Medical Science*, 32(3), 675–683.

Roos, E. M., & Lohmander, L. S. (2003). The Knee injury and Osteoarthritis Outcome Score (KOOS): From joint injury to osteoarthritis. *Health and Quality of Life Outcomes*, 1(1), 64.

Bellamy, N., Buchanan, W. W., Goldsmith, C. H., Campbell, J., & Stitt, L. W. (1988). Validation study of WOMAC: A health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with OA of the hip or knee. *The Journal of Rheumatology*, 15(12), 1833–1840.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607 (p) 3007-1593

Rousseau, J. C., & Garnero, P. (2012). Biological markers in osteoarthritis. *Bone*, 51(2), 265–277

van den Dolder, P. A., & Ferreira, P. H. (2005). Effectiveness of therapeutic ultrasound for musculoskeletal pain: A meta-analysis. *Physical Therapy Reviews*, 10(2), 85–94