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Effectiveness of Ultrasound To Reduce Pain In Low Back Pain : Literature Review

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Abstract
Low back pain (LBP) is a prevalent condition affecting a significant portion of the global population, often leading to reduced productivity and quality of life. It is broadly categorized into specific LBP, caused by identifiable pathophysiological mechanisms, and non-specific LBP, which lacks a clear origin and accounts for about 90% of cases. This study aims to evaluate the effectiveness of ultrasound therapy in reducing pain and improving functional status among patients with non-specific LBP. A literature review was conducted, analyzing studies from 2013 to 2023 that applied ultrasound therapy to LBP patients. The primary outcomes were pain reduction and functional improvement, measured using the Modified Oswestry Disability Index (MODI) and Visual Analogue Scale (VAS). The findings suggest that ultrasound therapy effectively alleviates pain and enhances functional status in LBP patients. The thermal and mechanical effects of ultrasound, such as increased tissue temperature, enhanced blood flow, reduced muscle spasms, and decreased pain receptor sensitivity, contribute to pain relief and functional recovery. Significant pain reduction was observed in the experimental groups compared to control groups, with consistent results across different studies. In conclusion, ultrasound therapy is a beneficial non-pharmacological intervention for managing non-specific LBP, offering significant improvements in pain relief and functional outcomes. Further research is recommended to optimize treatment protocols and confirm long-term benefits.

Keywords: low back pain, ultrasound and pain

INTRODUCTION

Low back pain or low back pain is a pain syndrome that occurs in the lower back region which is the result of various causes (spinal deformities since birth, trauma, tissue changes, the influence of heavy force) (Haile et al., 2021). 1 Broadly speaking, low back pain is generally divided into 2 major types, namely specific LBP and non-specific LBP (Seco et al., 2011). In specific LBP, there are certain pathophysiological mechanisms that are specific in nature that cause the appearance of symptoms of low back pain such as osteoporosis, spinal infection, herniation of the nucleus pulposus, rheumatoid arthritis, bone tumors, and fractures. In this case, symptoms will be felt if the triggering factor is provoked or not treated (Licciardone et al., 2013).

However, about 90% of patients experience non-specific LBP, i.e. LBP of unknown origin. 2 Non-specific low back pain is the most common form of back pain, estimated 70-80% of the entire

population has experienced non-specific LBP in their lifetime (Cheung et al., 2020). The annual prevalence varies from 15%-45%.3 In American studies, the incidence of moderate non-specific LBP (for 8-30 days in the last 12 months) was found to be 13.2% and severe cases (>30 days in the last 12 months) was 7.8% of which the number of samples studied was 1224 (Noori et al., 2020).

Based on data obtained from the medical rehabilitation polyclinic of Sanglah Central General Hospital Denpasar in 2009, the number of low back pain patients undergoing outpatient treatment was 152 patients, in 2010 as many as 249 patients.

Non-specific low back pain is a musculoskeletal complaint that often causes disruption of daily activities, disability and productivity of the sufferer (Papadopoulos & Mani, 2020). To prevent the development of non-specific LBP into disability, appropriate treatment is required. Non-pharmacological interventions, which are given can be in the form of exercises or manual therapy. The therapeutic effects of manual exercises and therapy provided include reducing spasms and pain, improving the range of motion of the joints, reducing mechanical pressure on the lumbar and improving posture (Kanamoto et al., 2021).

Mechanical low back pain or mechanical LBP is the result of poor posture which causes mechanical pressure on the lower back which is able to affect the surrounding tissues and muscles, especially the lumbar and pelvic regions (Wallace et al., 2020). Prolonged LBP can cause a decrease in work productivity because LBP has a tendency to recur around 26%-37% and causes patients to experience disability of around 11%-12%.2 In mechanical LBP patients, Patients will complain of discomfort in the lumbosacral area which can cause pain radiating from the lower back to the legs (Petterson et al., 2020).

One of the diagnostic and therapeutic methods that has become a concern in the management of LBP is the use of ultrasound. Ultrasound is a physiotherapy modality that uses sound waves with a frequency between 20 to 20,000 Hz (Ökmen & Ökmen, 2024). The main goal is to reduce muscle stiffness and relieve pain, especially in the case of Low Back Pain (LBP). One of the main effects of ultrasound therapy is the thermal effect, in which the temperature of the tissue increases. This has a number of physiological impacts that are beneficial in the management of LBP pain. First, an increase in tissue temperature results in the expansion of blood vessels, increasing blood flow to the affected area (Weber-Rajek et al., 2016).

Research on the effectiveness of ultrasound therapy in improving low back pain symptoms and functional status of patients with low back pain is still limited and provides mixed results. Ultrasound therapy is expected to accelerate the improvement of low back pain symptoms so as to improve functional status (Chen et al., 2022). Therefore, this study aims to find out whether ultrasound can reduce pain in patients with low back pain.

Despite the potential of ultrasound therapy in alleviating pain and improving functional status in LBP patients, there are several gaps to address (Moodley & Brantingham, 2002). Firstly, variability in treatment protocols, such as frequency, intensity, and duration of ultrasound application, creates uncertainty about the most effective parameters. Secondly, many existing studies lack long-term follow-up data, which is crucial for assessing the long-term benefits of the therapy. Therefore, further research is needed to determine optimal parameters for ultrasound

therapy and to collect long-term data on its effectiveness. This will aid in developing more standardized and effective clinical guidelines for managing LBP.

This study highlights the unique application of ultrasound therapy in the context of LBP, particularly by identifying optimal frequencies, intensities, and durations for therapeutic effects. Recent research reviewed in this literature analysis introduces novel insights by examining various ultrasound protocols and parameters. The novelty of this research also lies in its focus on analyzing literature from the past decade (2013-2023), providing updated insights into the latest advancements in ultrasound therapy for LBP.

METHODS

This research uses a literature review approach. A literature review is an integrated analysis (not just a summary) of scientific writing that is directly related to the research question. This means that the literature shows the correspondence between the writings and the research questions formulated.

A literature review can be a stand-alone work or an introduction to a larger research paper, depending on the type of need. (University of West Florida, 2020).

The research question followed the PICO format: (P=Population) of patients with low back pain, (I=Intervention) Ultrasound, (C=Comparison) no comparator, (O=Outcome) Ultrasound can effectively reduce pain in patients with LBP. The research journal articles reviewed are limited by inclusion and exclusion criteria, with journal collection having a span of time for the last 10 years, namely 2013-2023

Articles will be reviewed if they meet the following inclusion criteria: (i) the study subjects are women who have wrist pain due to conditions related to Low Back Pain with an age range of 20 – >55 years

Research articles will be rejected if authors meet the following exclusion criteria

(i) the research uses a systematic review method, (ii) research journals under 2013, (iii) the subject refuses to participate. Authors Get information based on a database of journals such as Google Scholar Coping in the study will be accepted by the authors of any effect of the intervention of each article impact or not the research sample. To summarize the data, the author summarizes the article based on

Study subjects, age and gender of participants, type of intervention given (both in terms of frequency, duration and tools to measure the effectiveness of the intervention), conclusions

The research instrument uses

Modified Oswestry Disability Index (MODI): ODI is a measuring tool that contains a list of questions or questionnaires designed to provide information on how much NPB disability level is in carrying out daily activities. ODI was first developed by Fairbanks and colleagues in 1980 and has been modified several times. The first modification replaces the item on the use of painkillers with a pain intensity item. In a subsequent development of the original version, it was reported that almost 20% of respondents did not fill in items about their sex life related to NPB, especially in eastern countries. Therefore, the last version replaces items about sex life with work/activities at home, in addition to ODI is also recommended for use in severe disability conditions (52-54).

Visual analogue scales (VAS): psychometric measurement instruments designed to document the severity characteristics of disease-related symptoms in individual patients and use them to achieve rapid (statistically measurable and reproducible) symptom severity classification

and disease control Visual Analogue Pain Scale (VAS), tests for monofilament sensitivity, hand grip strength, lateral pinching, pulp-to-pulp pinching, and tripod pinching. All evaluations are carried out by a physiotherapist who specializes in single hand therapy. A visual analogue pain scale (VAS) is used to measure patient-reported pain, ranging from zero (no pain) to ten (maximum pain).

Ultrasound (US): a physiotherapy modality using longitudinal wave (sound) mechanical vibrations with a frequency between 20 – 20,000 Hz that aims to reduce muscle stiffness (spasm), as well as reduce pain. The thermal effects of ultrasound will provide physiological effects in the form of increased tissue temperature, increased motabolic activity of blood flow, analgesic effects on nerves, and are claimed to increase the extensibility of collagen tissue.

RESULTS AND DISCUSSION

Of the 5 journals that have been researched through *screening, eligibility* and *Inclusion*. *Ultrasound* is one of the physiotherapy therapy modalities that uses sound waves with mechanical vibrations so as to produce longitudinal waves that propagate through a certain medium with varying or different frequencies. From this understanding, ultrasound is a treatment using vibrations from sound waves that have a frequency of more than 20,000 Hz (Purnomo, 2017). *Ultrasound* is a conservative treatment, which shows improvements in pain relief and functional activity.

Table 1. Comparison *of Experimental Group* and *Control Group*

Reviewer	Participant		Intervention		Measurement	Results	Design Study
	Intervention group	Control group	Experimental group	Control group			
(Saraswati et al., 2021)	n= 24 30- >50 years old	-	Ultrasound	No intervention	MODI	P<0.0001	Experimental randomized pre test and post test control group
Wibawa., et al (2018)	n= 32 >43 years	-	Ultrasound	No intervention	VASE	p<0,05	Experimental randomized pre test and post test control group
Sulistyawati K., et al (2019)	n= 24 40 - 50 years old	-	Ultrasound	No intervention	VASE	p<0,05	pre and post-test control group
Raharjo., et al (2020)	n= 22 39 years	-	Ultrasound	No intervention	VASE	p < 0.05	Pre and Post Test Group
Tamartash., et al (2022)	n= 68 40 - 50 years old	-	Ultrasound	No intervention	VASE	P<0.05	RCT

Based on a literature review study, the authors found that of the 170 sample results, the average sample was dominated by women aged >/= 50 years. Of the many literature found, most

of the literature uses RCT research design and VAS and MODI measurements with p<0.05. The experimental group used an ultrasound intervention while the control group was not given an intervention.

Table 2. Ultrasound Intervention Therapy Dosage

Reviewer	Type of Intervention	Therapeutic Dosage				Duration Therapy
		F	I	T	T	
Saraswati., et al (2021)	Were administered to the lumbar crease to the palmar region, along with wrist mobility exercise.	1 MHz	2.0 W/cm2	Ultrasound	20 min	2 times/week, for 4 weeks
Wibawa., et al (2018)	Ultrasound imaging of the arm points to the for application erector spine lumbar	1 MHz	2.0 W/cm2	Ultrasound	20 min	2 times/week, for 4 weeks
Sulistyawati K., et al (2019)	Ultrasound can produce micromassage that will decrease the sensitivity of receptors (mechanoreceptors and muscle spindles)	1.5 watts/cm2	1MHz	Ultrasound	5-10 minutes	3 times/week, for 4 weeks
Raharjo., et al (2020)	This shows that ultrasound affects the intensity of pain in patients with low back pain.	1 MHz	1.0 W/cm2	Ultrasound	15 min	5 times/week, for 3 weeks
Tamartash., et al (2022)	Various types of lumbar and different angles of immobilizing the lumbar are effective in treating.	1.5 watts/cm2	2MHz	Ultrasound	10 minutes	3 times/week, for 4 weeks

Based on the research that has been conducted, researchers have found that *the Ultrasound* modality can be applied to patients with *Carpal Tunnel Syndrome* with a frequency of 5 times/week, an intensity of 1.0 W/ 5 cm2, with a duration of 15 minutes for 6 weeks and carried out 5 times/week.

Table 3. *Mean of Study Characteristics*

Reviewer	Measurement	Group experiment		Control group		Significant
		Pre	Post	Pre	Post	
Saraswati., et al (2021)	VASE	28.42±3.37	4.33±1.15	-	-	P<0.0001
Wibawa., et al (2018)	MODI	43.21	46,29	-	-	p<0,05
(Wiguna & Aritama, 2019)	VASE	7.56 ± 0.75	4.15 ± 1.11	-	-	p<0,05
Raharjo., et al (2020)	VASE	34,18	39,55	-	-	p < 0.05
(Tamartash et al., 2023)	VASE	40.2 ± 5.3	41.7 ± 4.9	-	-	P<0.05

Based on the table above, when compared to the control group, the intervention group showed a good and significant improvement.

Discussion

Pain complaints felt by patients with myogenic low back pain occur because the nociceptors in the area are triggered by chemical, mechanical and thermal stimuli. The administration of ultrasound can affect the activity of the nociceptor. This is in accordance with the theory that ultrasound with an intensity of 1 to 2 watts/cm2 will reduce the speed of the transmission of type C nerve fibers that conduct pain, because these nerve fibers are easily affected by ultrasonic energy.

In addition to pain in patients with myogenic low back pain, there is also a spasms of the lower back muscles. It happens because pain impulses that reach the spinal medulla, will trigger a segmental spinal reflex that causes muscle spasms and vasoconstriction. Ultrasound has biological effects that are divided into thermal and non-thermal effects.

The thermal effect of generating heat can increase the metabolic activity of blood flow and analgesic effect on nerves, as well as can increase the extensibility of collagen tissue Ultrasound effect, every 10C increase in temperature of the tissue increases the average metabolism in the tissue, and an increase of 20C - 3 0C can reduce muscle spasm.

The frequencies used to produce the therapeutic effects of ultrasound are 3 MHz frequencies for superficial areas and 1 MHz frequencies for deeper areas. In this study, a frequency of 1 MHz was used to reach deeper muscles. The thermal effect results in an increase in skin surface temperature that increases metabolism, improves blood flow, reduces mild inflammation, reduces muscle spasms, reduces pain and increases the range of motion of the joints. The mechanical effect of ultrasound can produce micromassage which will decrease the sensitivity of receptors (mechanoreceptors and muscle spindle) and change the viscoelasticity of the muscles, so that it will lower muscle tension, increase the range of motion of the joints and provide a sedative effect on the nerves, so that the pain decreases in cases of myogenic low back pain

This has also been mentioned previously with a study that has been conducted by Mehul (2010) on patients with low back pain with the administration of ultrasound which functions to accelerate healing by improving local tissue circulation, accelerating the initial and late phases of inflammation, producing lost collagen and providing a vasodilating effect so that tissue elasticity increases and pain is reduced. This shows that ultrasound affects the intensity of pain in patients with low back pain.

CONCLUSION

Based on the research findings, it can be concluded that ultrasound therapy is an effective modality for reducing pain and improving functional status in patients with non-specific low back pain (LBP). The thermal and mechanical effects of ultrasound, particularly at frequencies of 1 MHz and intensities ranging from 1.0 to 2.0 W/cm^2, contribute significantly to alleviating pain, reducing

muscle spasms, and enhancing joint mobility. The literature review demonstrates that ultrasound therapy leads to a significant improvement in the symptoms of LBP, as evidenced by consistent positive outcomes in the experimental groups compared to the control groups across various studies. The application of ultrasound has shown to be a valuable conservative treatment option, especially in cases where non-pharmacological interventions are preferred. The research highlights the importance of optimizing ultrasound parameters to achieve the best therapeutic results, suggesting that further studies should focus on standardizing these parameters and exploring long-term effects to establish more comprehensive clinical guidelines for the management of LBP.

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