The Effectiveness between Superficial Heat and Deep Heat Therapy in the Management of Non-Specific Chronic Low Back Pain

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ABSTRACT:
Purpose: To compare the effectiveness of superficial and deep heat therapy in the management of non-specific chronic low back pain on pain reduction, functional disability and lumbar flexibility.
Methods: This is a parallel randomized clinical trial that enrolled a total of 46 patients with non-specific chronic low back pain (18-60 years). They were blinded to treatment allocation and randomly divided into 2 groups, group A on ultrasound and exercise therapy, while group B on hot packs and exercise therapy. Treatment effects were measured in terms of pain, functional disability and lumbar flexion range of motion before and after intervention.
Results: The results showed that both groups had improved in pain and functional disability and lumbar range of motion. However, no statistically significant difference found between 2 groups ($p>.05$).
Conclusion: The study demonstrated that both interventions, hot packs plus exercise therapy and ultrasound plus exercise therapy were equally effective in the management of non-specific chronic low back pain in terms of pain reduction, functional disability and lumbar flexibility improvement.

Keywords: non-specific chronic low back pain; hot packs; ultrasound; exercise; superficial heat therapy; deep heat therapy.

Introduction

The non-specific low back pain refers to low back ache that is not attributed to recognisable, known specific pathology and is the most typical kind of low back discomfort among patients with back pain (Burton, 2004). More than 90% of patients who seek primary care including physiotherapy treatment have non-specific low back pain (Koes et al., 2006).

Heat therapy is commonly used to treat low back ache. It helps to increase in blood flow due to vasodilation of the blood vessels, increase in metabolic activity and tissue extensibility (Petrofsky, 2017). Additionally, heat will

accelerate tissue healing, improve oxygen uptake, and raise the catabolic rate. Heat therapy can be categorised into superficial heat therapy and deep heat therapy. Examples of superficial heat therapy are hot packs, heat wraps whereas deep heat therapy include ultrasound, laser therapy and shortwave diathermy. Hot packs aid to loosen up tense muscles, lessen discomfort brought on by muscle tension or spasms, and dilate blood vessels (Petrofsky, 2017). Ultrasound is the most widely used electro-physical procedure in clinical setting (Blanger, 2010), and it works by transmitting energy to deep tissue, increasing tissue temperature and causing non-thermal physiologic changes which lead to pain reduction (Allen, 2006; Srbely & Dickey, 2007).

Engaging in regular exercise is crucial for persons with non-specific low back pain as continuing in physical exercise will hasten the healing process (Bekkering et al., 2003). Exercises help to build core strength and has shown to be beneficial. As a result, those who experience back discomfort frequently receive advice to "exercise more" and "stay active."

Increasing the spine's range of motion can help patients with back pain through stretching the hamstrings, hip flexor muscles, erector muscles of the spine, ligaments, and tendons. (Warneke et al., 2024). This is because stretching may make the back's muscles, tendons, and ligaments more flexible, which is important for expanding the range of motion of the joints (MacAuley, 2007). Besides, exercise rehabilitation regimens frequently include flexibility exercises as studies have shown they are successful in pain reduction linked to chronic low back ache (Gladwell et al., 2006; Masharawi & Nadaf, 2013).

Numerous research has been conducted on the use of hot packs, ultrasound, and exercises in the management of non-specific low back pain. However, these studies are predominantly focused on proving the effectiveness of one modality or comparing different type of modalities. To our knowledge, no combination of modalities using superficial or deep heat therapy with exercises were conducted in management of non-specific persistent low back pain. Thus, this study was to compare the effectiveness of superficial and deep heat therapy in the management of non-specific chronic low back pain in pain reduction, functional disability and improvement of lumbar flexibility. Further, this study hypothesized that there were statistically significant in pain reduction, improvement of functional rating index (FRI) and lumbar flexion range of motion (ROM) after intervention in group A-ultrasound and exercise therapy and group B-hot packs and exercise therapy. In addition, this study also hypothesized that there were statistically significant differences in pain reduction, improvement of FRI and lumbar flexion ROM after intervention between group A and group B.

Methods

This was a single blinded parallel randomized controlled trial involving 50 participants. Participants were blinded to treatment allocation into groups. The study was performed in outpatient unit of physiotherapy rehabilitation department of Hospital Sultan Abdul Halim, Kedah, Malaysia. The study was conducted from October 2023 to March 2024 for a duration of six (6) months.

Fifty (50) participants were randomly selected from the out-patients registered at rehabilitation department. The selected participants were randomly allocated into 2 groups; Before allocation process, the opaque sealed envelopes were prepared for randomization by the statistician employing a computer-generated randomization schedule. To ensure that there were an equal number of subjects in each group, half of the envelopes were distributed to each group. Group A was ultrasound and exercise therapy. Group B was hot pack and exercise therapy. All participants were patients on follow-up at physiotherapy out-patient department with non-specific long-term pain at lower back, age ranged from 18 to 60 years. With the identification of eligible participants at baseline and the exclusion criteria was verified. The eligible participants who met the inclusion criteria signed an informed consent form. All

participants who were randomly assigned would attend clinic visits one week after baseline assessment and intervention. The process of enrolment, randomization and interventions followed CONSORT guidelines (Moher et al., 2010) and flowchart (Fig. 1).

Sample size was determined with G power version 3.1.9.7 software. Taking into account the effect size of 0.80 with alpha set at 0.05 and a power of 0.8 with attrition rate of 10%, the final sample size determined was 50 that 25 were randomly allocated to each group.

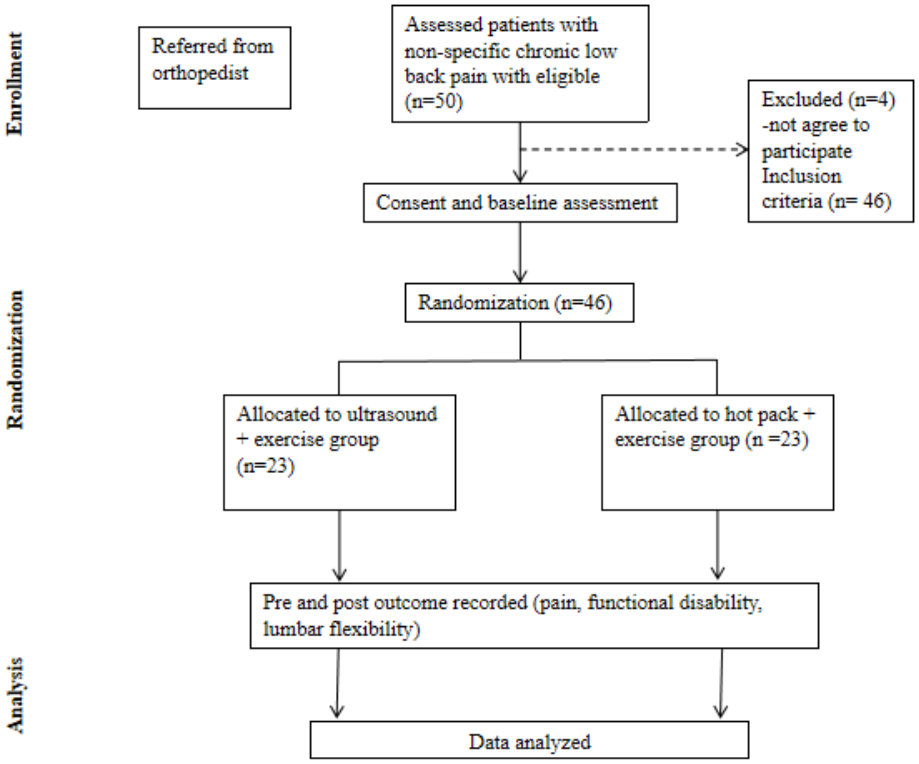


Fig 1: CONSORT flow chart

Inclusion criteria in this study were patients having non-specific persistent pain at lower back, aged between 18 and 60, regardless of race and gender. For participants aged above 60 and children, with nerve root symptoms, systemic illness and disorders, such as tumour, fracture, spondylolisthesis, spinal stenosis, ankylosing spondylitis, or history of low back surgery, on pharmacological treatment for psychological issues and pregnant women were excluded.

Intervention

The intervention consists of treatment sessions under supervision of physiotherapists. Participants in group A received ultrasound and exercise therapy while group B received hot packs and exercise therapy. Duration for ultrasound therapy and hot pack are both 20 minutes. For the group that used ultrasound as treatment, the lumbar region divided into 2 and ultrasound was applied 10 minutes for each region and total of 20 minutes for the whole lumbar region. Exercises given in this study not depend on the duration but repetitions. Pain and flexibility of lumbar were recorded before and after the treatment of that session. Readings for functional disability were recorded at baseline and 1 week later after receiving treatment. Group A received continuous ultrasound (1MHz and 1.5W/cm2) with exercises. Ultrasound gel applied on patient's body and on transducer. The transducer head was moved slowly in a circular motion across the uncomfortable paravertebral low back region.

Exercise given included stretching exercise and strengthening exercise. Four (4) stretching exercises were given to patients. (i) Knee to chest stretch, patient in crook lying position. Extend

left knee straight out along the floor. Clasping hand behind or at the top of shinbone and bring right knee to the chest. Lengthen the spine all the way to the tailbone and avoid to elevate hips. Hold this position for 1 minute, 2 sets. Repeat with other leg. (ii) Pelvic tilt, patient in crook lying position. Activate abdominal muscle as flatten the back against the floor. Hold 10 seconds and breathe normally. Release after 10 seconds, 5 repetitions, 2 sets. (iii) Trunk rotation, patient in crook lying position. Extend both arms to the side and turn head to the left while knees fall to the right. Hold for 20 seconds, and return to original position. 5 repetitions, 2 sets. Repeat for other side. (iv) Hamstring stretch, can be done by using towel. Patient should progressively elevate the right leg while supine with left leg down on the floor. Towel was wrapped around the ball of right foot and two ends of the towel were hold. Right leg was straightened gently and left knee bended slightly to 90^{o} angle. Once comfortable stretch was felt, maintain the posture for 10 seconds and return to starting position, 10 repetitions, 2 sets. Repeat on the other leg.

Two (2) strengthening exercises were given. (i) Bridging exercise, patients in crook lying position, feet flat on floor, hip width apart. Both hands placed beside the body, press the feet into floor when lift the buttock slowly off the floor until body was in a straight line. Shoulder kept on floor. Hold for 10 seconds, lower down buttock to original position. 10 repetitions, 2 sets. (ii) Lying lateral leg raises, patient in side lying, lower leg slightly bends on the floor. Draw belly button towards spine to engage the core. Then, raise the top leg without moving the body, hold for 5 seconds, 10 repetitions, 2 sets. Repeat on the other leg.

Group B received hot packs with exercises therapy. Exercises given in this group was the same as group A mentioned above. Hot packs cover with 7 layers of towel and apply on lower back of patients. These interventions were implemented for a period of one week follow with a post intervention visit to physiotherapist for assessment and recording of all outcome measures. There were 4 patients excluded from the study due to refusal to receive treatment.

Outcome measures

The primary outcome measure was pain. The patient indicated the present degree of pain by placing a point on a 10 cm VAS, which was used to measure the pain before and after intervention. The scale goes from 0 (no pain) to 10 (pain that is intolerable). Functional disability: The Functional Rating Index (FRI) was used to calculate the functional disability. Functional Rating Index (Naghdi et al., 2016) combines the ideas from the Oswestry Low Back Disability Questionnaire (Niskanen et al., 2002) with the Neck Disability Questionnaire (Vernon & Mior, 1991). This self-reporting tool has 10 items with a total of 5 potential responses, each of which describes the type of dysfunction and discomfort. On a point scale, 0 corresponds to no pain and complete functionality, while 4 corresponds to the worst agony conceivable and inability to perform function. By adding together, the evenly weighted scores and dividing by the total number of available points, the index score is obtained (If 10 questions completed, total possible score=40) and multiply by one hundred percent (100%). Total score is calculating in percentage range between 0% to 100%. Higher scores denote more impairment. Scores between 0 and 20% denote low impairment, 21% and 40% moderate impairment, 41% and 60% severe impairment, and scores beyond 60% extremely severe impairment.

The secondary outcome measure was lumbar flexion range of motion using modified version of the Schober test (Hershkovich et al., 2022), the lumbar flexibility was assessed both before and after the therapy. Individual is in standing position. Investigator will mark both posterior superior iliac spine (PSIS), and in the middle of both marks, will draw a line after instructing the patient to reach forward as if attempting to touch their toes, the examiner proceed to measure again the length between the top and bottom lines. The reliability across classes (r=0.92) and between classes (r=0.96) was fairly good.

Ethical consideration

The study protocol was approved by AIMST University Human Ethics Committee (AUHEC) with ref no: AUHEC/FAHP/2023/22/02/R6 and registered under National Medical Research Registry (NMRR) with research ID: RSCH ID-23-01044-OCL.

Statistical tools

Both a notebook and computerised Microsoft Excel sheets were used to record all information. All statistical analyses were conducted by using IBM SPSS ver.25.0 software (IBM Co., Armonk, NY, USA) with a P-value of below 0.05 considered as significant for all tests. The values of the data were carefully verified for any errors and missing values prior to putting them into SPSS for statistical analysis and reporting. Using the mean, standard deviation (SD), standard error of the mean (SEM), and confidence interval (CI), a descriptive approach was used to summarise the data. Paired t-test was used to test for within group comparison for pre and post intervention. The efficacy of the two groups was compared using an independent samples t-test.

Results

A total of 50 patients with non-specific persistent pain at lower back participated in this trial, 25 of them were assigned to the group A-ultrasound and exercise therapy, while another 25 patients were assigned to the group B-hot packs and exercise therapy. However, four (4) of them dropped out as they disagreed to participate, left 46 patients remaining in this trial. A total 19 males and 27 females participated in this study. In this study, female predominant with 58.7%. Majority of participants (30.4%) with age between 51 to 60. Majority of ethnicity (37.7%) was Malay. The participants mean age was 43.46 ±SD 11.38 years (Table 1).

Table 1: Baseline data of study samples

	Mean (SD)	Frequency (n=46)	Percentage (%)
Gender			
Male		19	41.3
Female		27	58.7
Age	43.46 (11.38)		
<20		1	2.2
21 – 30		6	13.0
31 – 40		12	26.1
41 – 50		13	28.3
51 - 60		14	30.4
Ethnicity			
Malay		33	71.7
Chinese		5	10.9
Indian		8	17.4
Study group			
Treatment		23	50.0
Control		23	50.0

Note: SD: Standard deviation

In group A, the mean FRI pre-intervention was 16.83 ±6.52, SEM was 1.36 whereas the mean FRI post-intervention was 13.96 ± 6.05 with SEM 1.26. The mean VAS of pre-intervention was 4.26 ± 1.60 with SEM 0.33 whereas post-intervention was 2.96 ±1.49, with SEM 0.31. The mean ROM flexion of lumbar pre-intervention was 3.09 ± 1.24 with SEM 0.26, whereas the mean post-intervention was 4.78 ± 1.24 with SEM 0.26.

In group B, then mean FRI pre-intervention was 16.83 ± 7.00, SEM was 1.46 whereas the mean FRI post-intervention was 13.74 ± 6.66 with SEM 1.39. The mean VAS of pre-intervention was 3.91 ± 1.90 with SEM 0.40 whereas post-intervention was 2.35 ±1.58, with SEM 0.33. The mean ROM flexion of lumbar pre-intervention was 2.65 ± 1.40 with SEM 0.29, whereas the mean post-intervention was 4.26 ± 1.10 with SEM 0.23 (Table 2).

Table 2: Descriptive statistics of FRI, VAS and lumbar ROM flexion ROM for group A (n-23) and group B (n=23)

	Mean	SD	SEM	95% CI	
				Lower	Upper
Group A					
FRI	16.83	6.52	1.36	14.01	19.65
Pre-intervention	13.96	6.05	1.26	11.34	16.57
Post-intervention	4.26	1.60	0.33	3.57	4.95
VAS	2.96	1.49	0.31	2.31	3.60
Pre-intervention	3.09	1.24	0.26	2.55	3.62
Post-intervention	4.78	1.24	0.26	4.25	5.32
Lumbar ROM flexion					
Pre-intervention					
Post-intervention					
Group B					
FRI	16.83	7.00	1.46	13.80	19.85
Pre-intervention	13.74	6.66	1.39	10.86	16.62
Post-intervention	3.91	1.90	0.40	3.09	4.74
VAS	2.35	1.58	0.33	1.66	3.03
Pre-intervention	2.65	1.40	0.29	2.05	3.26
Post-intervention	4.26	1.10	0.23	3.79	4.73
Lumbar ROM flexion					
Pre-intervention					
Post-intervention					

Note: SD: Standard deviation; SEM: Standard error of mean; CI: Confidence interval; FRI: Functional rating index; VAS: Visual analogue scale; ROM: Range of motion

In group A, the t value for within group comparison for FRI, VAS and lumbar flexion ROM was 7.575, 11.194 and -10.632 respectively, whereas for group B, the t value for within group comparison for FRI, VAS and lumbar flexion ROM was 6.815, 7.942 and -9.857 respectively. The p value of <0.05 was reported for FRI, VAS and lumbar flexion for group A and group B respectively (Table 3).

Table 3: Results of effect in FRI, VAS and lumbar ROM flexion ROM for group A (n-23) and group B (n=23)

	Mean	SD	95% CI of the difference		t	p[a]
			Lower	Upper		
Group A						
FRI-pre-intervention	16.83	6.52	2.08	3.66	7.575	0.000
FRI-post intervention	13.96	6.05				
VAS-pre-intervention	4.26	1.60	1.06	1.55	11.194	0.000
VAS-post-intervention	2.96	1.49				
Lumbar ROM flexion-pre intervention	3.09	1.24	-2.03	-1.36	-10.632	0.000
Lumbar ROM flexion-post intervention	4.78	1.24				
Group B						
FRI-pre-intervention	16.83	7.00	2.15	4.03	6.815	0.000
FRI-post intervention	13.74	6.66				
VAS-pre-intervention	3.91	1.90	1.16	1.97	7.942	0.000
VAS-post-intervention	2.35	1.58				
Lumbar ROM flexion-pre intervention	2.65	1.40	-1.95	-1.27	-9.857	0.000
Lumbar ROM flexion-post intervention	4.26	1.10				

Note: SD: Standard deviation; SEM: Standard error of mean; CI: Confidence interval; Functional rating index; VAS: Visual analogue scale; ROM: Range of motion; [a]: paired-t test

In comparison of outcome measures between group A and group B, the t value for between group comparison for FRI, VAS and lumbar flexion ROM was -0.368, -1.139 and 0.381 respectively. The p value for pre and post intervention of FRI, VAS and lumbar ROM flexion was 0.715, 0.262 and 0.705 respectively (Table 4).

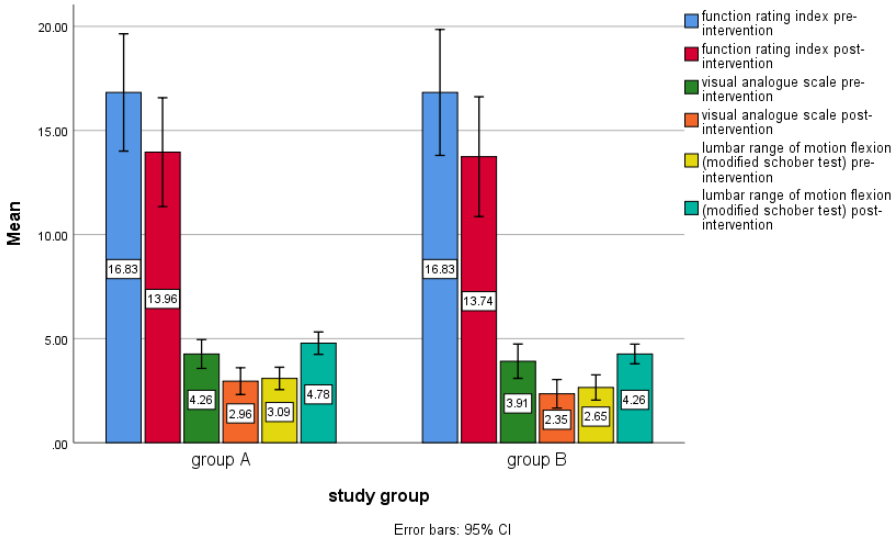
Table 4: Comparison of outcome measures between group A (n-23) and group B (n-23)

Outcome	Mean difference	SE difference	95% CI of the difference		t	P[a]
			Lower	Upper		
FRI						
Pre intervention Post-intervention	-0.22	0.59	-1.41	0.97	-0.368	0.715
VAS						
Pre-intervention Post-intervention	-0.26	0.23	-0.73	0.20	-1.139	0.262

Lumbar ROM flexion						
Pre-intervention	0.09	0.23	-0.37	0.55	0.381	0.705
Post-intervention						

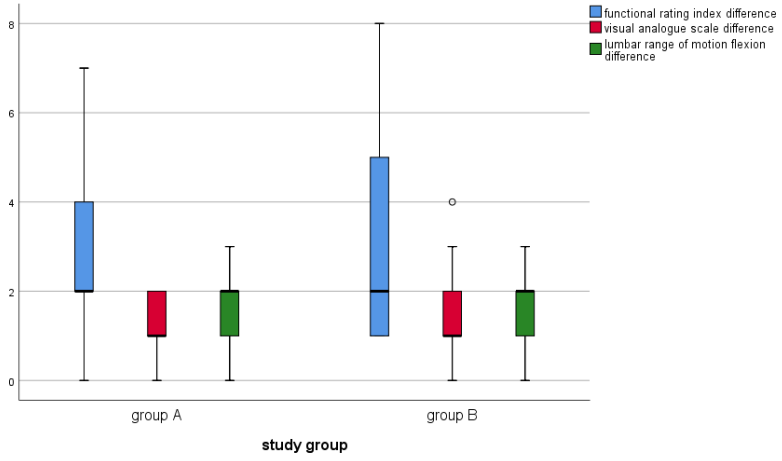
Note: SD: Standard deviation; SEM: Standard error of mean; CI: Confidence interval; Functional rating index; VAS: Visual analogue scale; ROM: Range of motion; [a]: Independent samples t test

Figure 2 shows the distribution of pre and post-intervention scores for FRI, VAS and Lumbar flexion ROM for both group A and group B. Figure 3 shows the distribution of scores increase or decrease from pre to post intervention in FRI, VAS and lumbar flexion ROM between group A and group B.



Note: FRI: Functional rating index; VAS: Visual analogue scale; ROM: Range of motion

Figure 2: Distribution of pre and post-intervention scores for FRI, VAS, Lumbar flexion ROM for group A and group B



Note: FRI: Functional rating index; VAS: Visual analogue scale; ROM: Range of motion

Figure 3: Distribution of scores gain or decrease from pre to post intervention in FRI, VAS and lumbar flexion ROM between group A and group B

Discussion

This was the first study that compared the efficacy of superficial heat therapy and deep heat therapy in treating non-specific persistent low back ache. The results of the current study show that applying a combined ultrasound and exercise

therapy and a combined hot packs and exercise therapy can reduce pain significantly. The inclusion of heat therapy, to an active exercise plan support functional restoration has proven to best successful. The use of heat therapy is advised in the most recent clinical guidelines for the management of low back ache as it is understood that it helps to alleviate pain in acute low back pain in short term (Qaseem et al., 2017). But, the long-term impact of these interventions is still uncertain. The lack of information is significant since heat therapy may only provide temporary pain relief without changing the long-term course of low back ache. However, it is important to note that heat therapy could enhance other treatments that might be long lasting and effective, such as exercises.

Of all 46 participants with non-specific persistent low back pain, 23 of them on ultrasound and exercise therapy while another 23 on hot packs and exercise therapy. Any age group might have lower back pain. However, older age group of 51 to 60 account for 30.4% of the study samples, this consistent with report by WHO (2023) that the prevalence is highest among age 50 to 59. 13.0 % of younger age group of 20 to 30 has non-specific low back pain in this study, this may be relevant to previous research that changes in pain sensitivity across menstrual cycle among female may account for pain reporting in younger persons (Riley et al.,1999), because female with non-specific low back pian was accounted for 58.7% in this study. This was consistent with past population study conducted by Bento et al. (2020) on persons aged 20 and older that found 60.9% of women reporting having low back pain. Wu et al. (2020) also found that women had a greater age-standardized prevalence of low back pain than men did. This is partly due to the accelerated spine and lumbar disc degeneration during female menopause (Wang & Griffith, 2010; Wang et al., 2011; Wang, 2015). The majority (30.4%) of participants in this study were in 51 to 60 years age group, follows by 41 to 50 aged group (28.3%). According to Leveille et al. (2005), women are more prone than males to experience excruciating musculoskeletal issues and other types of chronic pain concerns.

There were statistically significant differences before and after intervention in pain, functional disability and lumbar flexibility for two groups. Based on paired t-test results, the FRI, VAS and lumbar flexion ROM measures of group A and group B exhibited statistically significant differences before and after intervention. The results show that ultrasound used in the group A and the hot packs used in group B were equally beneficial in treating patients with non-specific persistent low back pain in terms of pain relief, functional disability reduction, and lumbar flexibility. However, in comparison based on t-values, the group A has an edge over group B. The findings for group A using hot packs were in line with evidence from several past studies that found short-term pain reduction from the application of superficial heat (Qaseem et al., 2017; Chou et al., 2017; Chou et al., 2007; French et al., 2006) but its long-term effect is unknown. There are no previous studies that we can use to compare in equal weightage to our study that focus on combination of superficial or deep and exercise therapy.

In comparison of outcome measures between group A and group B. The findings demonstrated that there was no statistically significant difference ($p > 0.05$) between group A and group B for the parameters of pain, functional impairment, and lumbar flexibility. Although the results were not significantly difference between group A and group B, but based on with within group analysis, group A showed to be more effective in comparison to group B.

In this study, exercises had been used instead of physical activity due to exercises were planned and structured which was easier to applied on the patients. In the other hand, physical activity is not structured and it is hard to standardized on all the patients.

Low back ache is among the most common disorders globally. Non-specific low back pain can be chronic that persists for more than 12 weeks. Thus, a comprehensive method to treating chronic low back ache should be used, taking into account pharmacological, psychological, progressive relaxation,

biofeedback, physical, and rehabilitation treatments, as well as eventual minimally invasive or invasive techniques can be considered (Urits et al., 2019).

As the majority of research compared different thermotherapy modality with no combination of exercise therapy, the role of heat therapy in combination with exercise regime was not adequately studied (Lin, 2003; Lee & Ng, 2008; Patel et al., 2013). Therefore, it is crucial to evaluate how different types of thermotherapies improve flexibility by applying varying amounts of heat to the body. Maintaining flexibility throughout life is an essential component of healthcare practises due to its functional implications, which include lowering the patients' capacity to do chores around the house, in their careers, or in sports. (Mayer et al.,2005). As Sahrmann et al. (2017) pointed out that chronic low back pain is caused by the repetition of improper daily movement practises over time. Hence, using correct postures for everyday work is very important to prevent low back pain.

One of limitations of this study was the limited samples present in the study setting which might influence the generalisability of the study. Secondly, the intervention was conducted for a short period of time might not provide accurate changes with structured exercises. However, the strength of study was the use of combined thermotherapy with exercise therapy since heat therapy is common treatment used for low back ache but not adequately explored to be used as combined modality.

Conclusion

Non-specific low back pain can affect all gender, ethnicity and aged group. The superficial heat and deep heat therapy are both effective in treating patient with non-specific persistent low back pain. Despite the fact that neither group's differences are particularly noteworthy. However, bot groups show statistically significant differences in the outcome measures in pain, functional disability and lumbar ROM before and after treatment. Thus, the use of ultrasound and hot packs treatment might successfully help patients with non-specific persistent pain at lower back to reduce the pain, increase the lumbar flexibility, and improve the functional impairment. It was suggested a larger sample size can be taken to achieve a better result to compare the effect between both groups. Besides that, experimental study in a large hospital setting that have large patients pool can be carried out, in addition to lengthen the duration of experiment. Necessary blinding can be used to eliminate study bias in future study.

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