The effect of combination of massage gun therapy with exercise on increasing range of motion and movement function in patients with non-specific low back pain

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ABSTRACT

Low back pain (LBP) is a musculoskeletal disorder caused by unergonomic positions. This study aimed to determine the effect of massage gun treatment and passive stretching in increasing range of motion (ROM) and joint function of non-specific LBP. The method used in this research was a quasi-experimental method with a one group pretest-posttest design, then a sampling technique was carried out using purposive sampling. The study included 20 voluntary participants (aged 20–65) with low back pain who provided informed consent. The results of the study showed that the range of motion, measured using a goniometer, increased in forward flexion, left flexion, right flexion, extension, left rotation, and right rotation in individuals with LBP. Measurements taken before treatment and after treatments 1 to 3 showed a significant increase (p=0.000, <0.05). Massage gun treatment combined with passive stretching also improved joint movement function, as measured using the Oswestry Disability Index (ODI), with pre- and post-treatment results from treatments 1 to 3 showing a significant improvement (p=0.000, <0.05). It can be concluded that massage gun therapy combined with passive stretching effectively increases the range of motion and motor function in individuals with non-specific LBP.

KEYWORDS

Low Back Pain; Massage Gun; Passive Stretching; Range of Motion; Movement Function

1. INTRODUCTION

Low back pain (LBP) is a common musculoskeletal disorder in the community. A slouched sitting position can trigger strong and prolonged muscle work, resulting in obstructed blood flow to the muscles (Dorsey & Starkweather, 2020). This can lead to the accumulation of excessive amounts of metabolic waste, which then increases the pressure inside and outside the muscle cells. This increase in osmotic pressure will then result in edema, which then compresses the sensory nerves, hence will be felt as musculoskeletal disorders in movement function. Studies have shown that sitting positions that are not ergonomic have a risk of experiencing low back pain as much as 50.0% (Utomo & Kushartanti, 2019). Unergonomic sitting positions such as sitting in a slouched position can trigger strong and prolonged muscle work, resulting in obstructed blood flow to the muscles. This can lead to the accumulation of excessive amounts of metabolic waste, which then increases the pressure inside and outside the muscle cells. This increase in osmotic pressure will then result in edema, which then compresses the sensory nerves. This will then be felt as musculoskeletal disorders (Anggait, 2022).

Back pain is a symptom of disease that is most often found in daily practice (Agustina & Khie Khiong, 2023). The onset of symptoms of LBP will have an impact in limiting joint motion and motion function so that someone who experiences this will experience a decrease in the performance of daily activities and is at risk in economic problems. Impaired range of motion and motion function experienced can lead to frustration in living daily life so that it can interfere with quality of life (Mahasih, 2019). This pain can make it difficult for sufferers to move or stand upright (Mustagfirin et al., 2020). Based on the lasting phase of back pain, it can be divided into three traits, including 1) the acute phase lasts less than 6 weeks, 2) the sub-acute phase lasts 6-12 weeks, and 3) the chronic phase is more than 12 weeks (WHO, 2023). Based on the condition of severity, low back pain can be divided into non-specific low back pain and specific low back pain. The prevalence of low back pain cases based on gender is 40% in men and 35% in women (Han et al., 2023).

About 80% of people have experienced LBP, so this complaint can affect a person's productivity and quality of life. In 2020, around 619 million people worldwide experienced symptoms of low back pain. It is estimated that by 2050, the number of cases will increase to 843 million, with the main influencing factors being high Body Mass Index (BMI) and excessive work demands (Ferreira et al., 2023), prevalence of these cases reaches 80%, which is felt at least once in a person's lifetime (Frizziero et al., 2021).

Non-pharmacological treatment in the form of percussion therapy can be applied manually (hand) and mechanically. Treatment in this study uses a massage gun which is a mechanical tool shaped like a small hammer with electric or battery power, and uses an applicator at the end of the tool shaped like a large ball, pointed tip, fork. The development of mechanical therapy methods produces effects comparable or even greater to manual therapy. The therapy tool impacts the tissue by adjusting the level of frequency, amplitude, and friction force (Comeaux, 2011). Massage gun tools work by providing vibration effects on myofascial tissue to increase joint range, relieve pain, and eliminate thighness in muscles (Cheatham et al., 2021).

A massage gun is a tool that can be applied easily and can be used to give a massage to the body. Massage gun consists of a handle that is connected to a massage head that vibrates quickly. Massage gun can facilitate with vibration that can be adjusted. Massage gun can function as a tool to relax tissues and muscles, improve blood circulation, help relieve pain and muscle tension, reduce stress levels, increase muscle flexibility, and increase lymphatic flow which helps remove toxins from the body and supports the immune system.

The use of massage gun in this study is combined with passive stretching as an exercise program which is one of the techniques to stretch the muscles by moving or adjusting the body position in a certain position with the aim of providing optimal lengthening of muscle and tendon tissue. Stretching is included in manual interventions to lengthen soft tissue structures due to shortening and decreased motion and has an analgesic effect (Lee et al., 2021) and provides a relaxing effect on muscles (Tian et al., 2012).

Passive stretching is an attempt to improve muscle flexibility. This process involves stretching the muscles with external assistance, such as using tools or assistance from others. The research conducted focuses on the use of non-pharmacological methods as an alternative treatment in the form of massage gun therapy and passive stretching. Massage gun is one of the recovery therapy tools that is currently popular. The performance of the massage gun is by providing vibrations to the musculoskeletal parts at varying amplitudes aimed at increasing joint mobility and function (Leabeater et al., 2024), while passive stretching is a muscle stretching movement with the help of a therapist or tool and is done repeatedly in increasing mobility, flexibility, and relaxation (Marufan et al., 2021). Therefore, this study aims to use massage gun with passive stretching as an injury treatment for patients with non-specific LBP related to range of motion and motion function.

2. METHODS

2.1. Design and Participants

This was a pre-experiment study employing a pre-test and post-test design. It utilized a sample group without a control group. An initial measurement was done before the treatment to obtain pre-test data. Another measurement was done after the treatment to gain post-test data.

The subjects of this study were men and women, who voluntarily participated in the study from beginning to end. All samples had agreed to participate and signed the consent with a sample size of 20 people who experienced low back pain.

The inclusion criteria in this study were 1) sufferers of non-specific LBP in the subacute and chronic phases, 2) willing to be respondents, 3) aged 20-65 years, while the exclusion criteria were 1) anatomical abnormalities of the spine, 2) fractures, 3) having open wounds, 4) having specific disorders.

2.2. Measurement

In practice, the sample will be measured in the pretest phase including range of motion using a goniometer, which is a tool used to measure degrees of lower back joint angles and guidelines for standardizing degrees of ROM (D. J. Cook et al., 2015). The standard degree of ROM flexion in the low back is 45-500, the standard degree of ROM extension in the low back is 20-350, lateral flexion 300, rotation 450. Validity and reliability tests on the goniometer instrument produced a validity of 0.97 and a reliability of 0.51 (Rosmita, 2009). Measuring joint movement function using the Oswerty Disability Index instrument is a measuring tool used to determine body function ability scores (C. E. Cook et al., 2021). This measuring tool is in the form of a questionnaire containing ten questions that describe the body's ability to carry out daily work functions. The results obtained are in the form of an accumulated score of answers which is calculated using a special formula. The smaller the score obtained, the better the function of the limbal joint.

2.3. Procedure

Treatment, the measured samples will receive treatment in the form of massage using a massage gun starting from the back towards the upper thigh area. The use of a massage gun is effective in the field because the use of this tool does not require the sample to remove clothing. After the massage treatment is complete, it is continued with passive stretching, namely the sample is stretched with the help of a therapist 3 times in 3 days. The data taken is movement function, and

range of motion in patients with lower back pain. The treatment protocol was conducted with a frequency of three times in three days, at a moderate intensity, for a duration of 30 minutes per session, and included a combination of massage gun therapy and passive stretching (Figure 1).
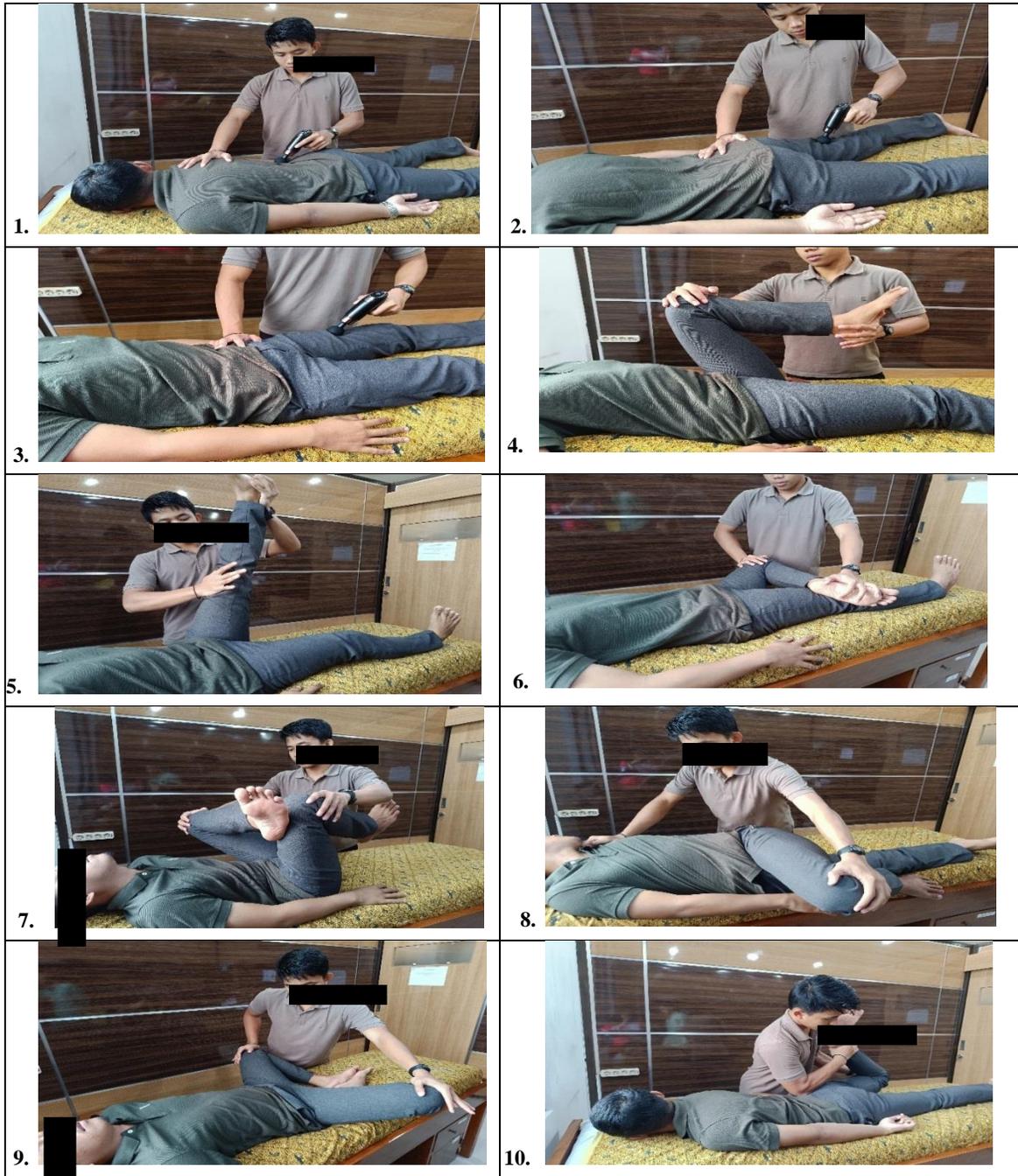
Figure 1. Massage gun treatment

2.4. Statistical Analyses

Analysis of the collected data using the SPSS application to test the effect of the treatment carried out with the normality test step to determine whether the data is normally distributed or not and continued with a difference test using the paired t test or the Wilcoxon test.. In contrast, if the data are not normally distributed, non-parametric statistics will be used instead. In the normality test of motor function, and range of motion, it can be said to be normally distributed if the p value > 0.05. If the p value < 0.05, then the data is said to be not normally distributed. The paired t-test was used as the difference test with 0.05 significance. The test will produce a t value and probability value (p) that can be used to prove whether there is a significant difference between the pre-test and the post-test at the 5% level. The significance can be seen from the value of p. It can be said that there is a significant difference if p<0.05. Whereas p>0.05 means there is no significant difference.

3. RESULTS

Table 1 presents the data obtained based on the causes of impaired range of motion and function of the lower back joints have three categories including sports, lifting weights, long periods of silence.

Table 1. Data by cause of injury

Causes of Injury	
Sports	6
Weight Lifting	3
Long periods of silence	11
Total	**20**

This condition is related to the results of previous research that there are several factors that make lower back muscle tension a problem such as incorrect positioning, excessive pressure on the back muscles, which encourages stiffness in the back muscles which makes joint motion limited.

Table 2 below presents the results of the Shapiro–Wilk normality test for range of motion (ROM) and Oswestry Disability Index (ODI) measurements across three posttest assessments.

Table 2. Normality test results of ROM and ODI measurements using shapiro–wilk test

	Shapiro-Wilk		
ROM Flexion 1	Data	p value	Information
	Posttest 1	0,000	#Not Normal
	Shapiro-Wilk		
ROM Flexion 2	Data	p value	Information
	Posttest 2	0,000	#Not Normal
	Shapiro-Wilk		
ROM Flexion 3	Data	p value	Information
	Posttest 3	0,000	#Not Normal
	Shapiro-Wilk		
ROM Extension 1	Data	p value	Information
	Posttest 1	0,023	#Not Normal
	Shapiro-Wilk		
ROM Extension 2	Data	p value	Information
	Posttest 2	0,008	#Not Normal
	Shapiro-Wilk		
ROM Extension 3	Data	p value	Information
	Posttest 3	0,571	*Normal
	Shapiro-Wilk		
ROM Left Flexion 1	Data	p value	Information
	Posttest 1	0,007	#Not Normal
	Shapiro-Wilk		
ROM Left Flexion 2	Data	p value	Information
	Posttest 2	0,093	*Normal
	Shapiro-Wilk		
ROM Left Flexion 3	Data	p value	Information
	Posttest 3	0,045	#Not Normal
	Shapiro-Wilk		
ROM Right Flexion 1	Data	p value	Information
	Posttest 1	0,012	#Not Normal
	Shapiro-Wilk		
ROM Right Flexion 2	Data	p value	Information
	Posttest 2	0,820	*Normal
	Shapiro-Wilk		
ROM Right Flexion 3	Data	p value	Information
	Posttest 3	0,786	*Normal
	Shapiro-Wilk		
ROM Left Rotation 1	Data	p value	Informasi
	Posttest 1	0,221	*Normal
	Shapiro-Wilk		
ROM Left Rotation 2	Data	p value	Information
	Posttest 2	0,148	*Normal
	Shapiro-Wilk		
ROM Left Rotation 3	Data	p value	Information
	Posttest 3	0,074	*Normal

ROM Righ Rotation 1	Shapiro-Wilk		
	Data	p value	Information
	Posttest 1	0,174	*Normal
ROM Right Rotation 2	Shapiro-Wilk		
	Data	p value	Information
	Posttest 2	0,062	*Normal
ROM Rotasi Kanan 3	Shapiro-Wilk		
	Data	p value	Information
	Posttest 3	0,041	#Not Normal
ODI 1	Shapiro-Wilk		
	Data	p value	Information
	Posttest 1	0,000	#Not Normal
ODI 2	Shapiro-Wilk		
	Data	p value	Information
	Posttest 2	0,000	#Not Normal
ODI 3	Shapiro-Wilk		
	Data	p value	Information
	Posttest 3	0,000	#Not Normal

The results of Table 2 show that in observations 1 to 3 of the ROM Flexion normality test, the posttest significance value is 0.000, indicating that all data are not normally distributed. In ROM Extension, observations 1 and 2 have significance values <0.05 (not normal), while observation 3 has a value >0.05 (normal). For Left Flexion, observations 1 and 3 have significance values <0.05 (not normal), whereas observation 2 has >0.05 (normal). In Right Flexion, observations 2 and 3 show significance values <0.05 (not normal), while observation 1 shows >0.05 (normal). For Left Rotation, observations 1 to 3 have significance values >0.05, indicating normal distribution. In Right Rotation, observations 1 and 2 have >0.05 (normal), while observation 3 has <0.05 (not normal). Lastly, in observations 1 to 3 of the ODI normality test, all significance values are <0.05, indicating that the data are not normally distributed.

After conducting the normality test, the next step was to perform the t-test. The basis for determining the decision on the comparison of p with the value of $\alpha = 0.05$. If $p < 0.05$ then H0 is rejected and H1 is accepted. Conversely, if $p > 0.05$ then H_0 is accepted and H_1 is rejected. The results of the difference test are briefly explained in the table below.

Table 2. Results of difference tests for ROM and ODI

Treatment 1	p value	Result	Description
ROM Flexion	0,000	Significant	#Uji Wilcoxon
ROM Extension	0,001	Significant	#Uji Wilcoxon
ROM Left Flexion	0,001	Significant	#Uji Wilcoxon
ROM Right Flexion	0,000	Significant	#Uji Wilcoxon
ROM Left Rotation	0,000	Significant	*Uji *Paired T test*
ROM Right Rotation	0,000	Significant	*Uji *Paired T test*
ODI	0,000	Significant	#Uji Wilcoxon
Treatment 2	**p value**	**Result**	Description
ROM Flexion	0,000	Significant	#Uji Wilcoxon
ROM Extension	0,000	Significant	#Uji Wilcoxon
ROM Left Flexion	0,000	Significant	*Uji *Paired T test*
ROM Right Flexion	0,000	Significant	*Uji *Paired T test*
ROM Left Rotation	0,000	Significant	*Uji *Paired T test*
ROM Right Rotation	0,000	Significant	*Uji *Paired T test*
ODI	0,000	Significant	#Uji Wilcoxon
Treatment 3	**p value**	**Result**	Description
ROM Flexion	0,000	Significant	#Uji Wilcoxon
ROM Extension	0,000	Significant	*Uji *Paired T test*
ROM Left Flexion	0,000	Significant	#Uji Wilcoxon
ROM Right Flexion	0,000	Significant	*Uji *Paired T test*
ROM Left Rotation	0,000	Significant	*Uji *Paired T test*
ROM Right Rotation	0,000	Significant	#Uji Wilcoxon
ODI	0,000	Significant	#Uji Wilcoxon

Based on the calculation of data analysis, the results obtained according to treatment 1 to treatment 3 get a significance value of 0.000 and 0.001 which is smaller than 0.05. Therefore, the data can be concluded that there is an effect of massage gun treatment and passive stretching in increasing range of motion and joint motion function in patients with low back pain, the following authors present the increase based on the average measurement graph.

The diagram below shows an increase in ROM Flexion taken from the overall average value of pretest and posttest data.
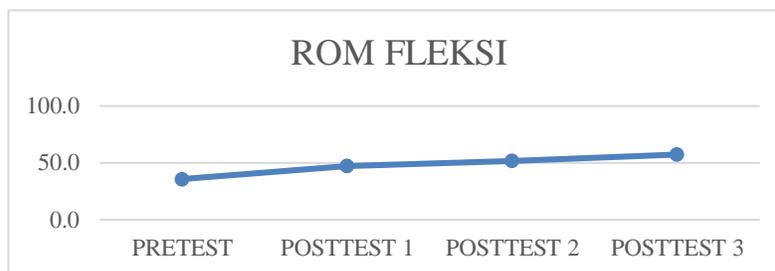

Diagram 1. ROM Flexion

Diagram 1 shows that before treatment of 35.8 and after treatment 1 to 47.3 treatment 2 increased to 52.0 and in treatment 3 increased to 57.4 and a significance value of 0.000 <0.05 in treatment 1 to treatment 3. The diagram below shows an increase in Extension ROM taken from the overall average value of pretest and posttest data (Diagram 2).
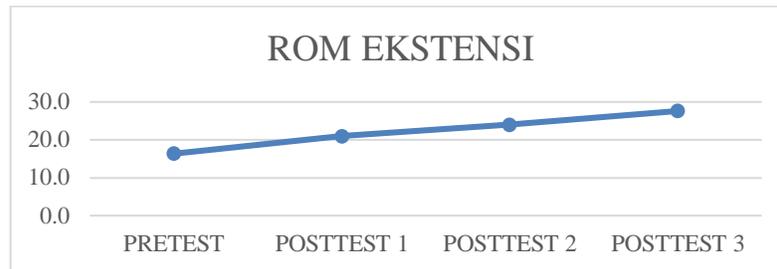

Diagram 2. ROM Extension

Diagram 2 shows that the value increased from 16.4 before treatment to 21.0 after treatment 1, 24.0 after treatment 2, and 27.0 after treatment 3. The differences were statistically significant, with p = 0.001 (<0.05) for treatment 1 and p = 0.000 (<0.05) for treatments 2 and 3. Below, diagram 3 presents the results of ROM left flexion.
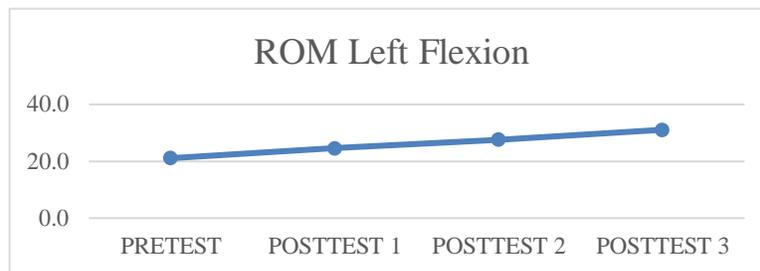
Diagram 3. ROM Left Flexion

The diagram above shows an increase in Left Flexion ROM taken from the overall average value of pretest and posttest data. The results increased from 21.1 before treatment to 24.6 after treatment 1, 27.6 after treatment 2, and 31.0 after treatment 3.1 and a significance value of 0.001 <0.05 in treatment 1 and 0.000 <0.05 in treatment 2 and 3. Diagram 4 presents the results of ROM right flexion.
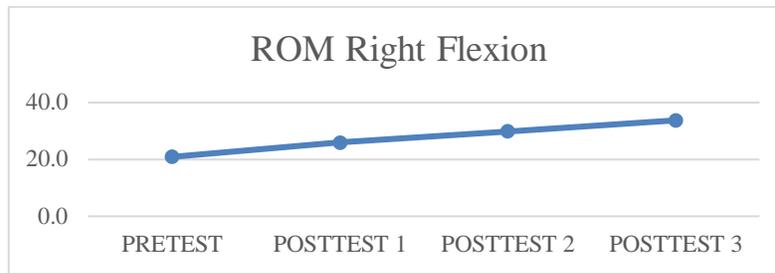
Diagram 4. ROM Right Flexion

The diagram above shows an increase in Right Flexion ROM taken from the overall average value of pretest and posttest data. The results increased from 20.9 before treatment to 26.0 after treatment 1, 29.9 after treatment 2, and 33.8 after treatment 3, with significance values of 0.000 (<0.05) for all three treatments. Diagram 5 presents the results of ROM left rotation.
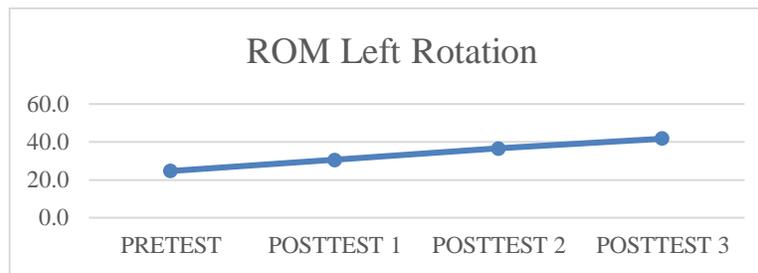

Diagram 5. ROM Left Rotation

The diagram above shows an increase in Left Rotation ROM taken from the overall average value of pretest and posttest data. The results increased from 24.7 before treatment to 30.5 after treatment 1, 36.7 after treatment 2, and 41.7 after treatment 3, with significance values of 0.000 (<0.05) for all three treatments. Diagram 6 shows the results of ROM right rotation.
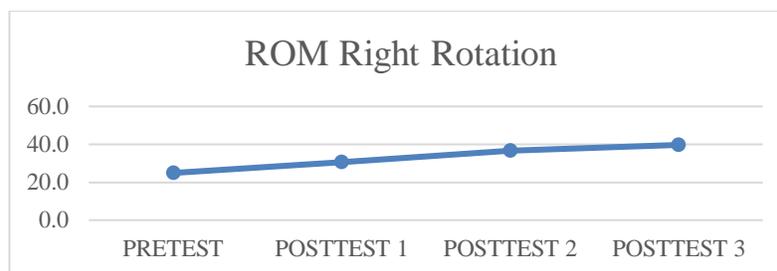

Diagram 6. ROM Right Rotation

The diagram above shows an increase in Right Rotation ROM taken from the overall average value of pretest and posttest data. The results increased from 24.9 before treatment to 30.8 after treatment 1, 36.7 after treatment 2, and 39.7 after treatment 3, with significance values of 0.000 (<0.05) for all three treatments. Diagram 7 shows the results of ODI right rotation.
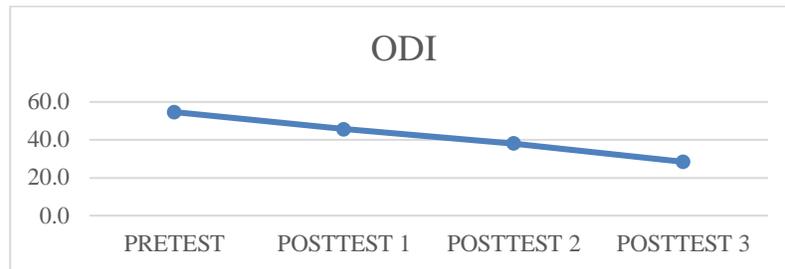

Diagram 7. ODI

The diagram above shows a decrease in measurements using the ODI measuring instrument taken from the overall average value of pretest and posttest data. The results decreased from 54.6 before treatment to 45.7 after treatment 1, 38.1 after treatment 2, and 28.4 after treatment 3, with significance values of 0.000 (<0.05) for all three treatments. Lower ODI values indicate better joint motion function.

4. DISCUSSION

This study aimed to determine how effective the effect of LBP injury management using massage gun treatment combined with passive stretching on Health and Sport Center patients in increasing ROM and motion function. The results of this study indicate that treatment using massage guns and passive stretching is known to have a significant effect in improving motion function and ROM in patients with non-specific LBP. The combination of Mulligan mobilization and percussive massage using a massage gun can provide significant improvements in individuals with non-specific low back pain, particularly by increasing lumbar range of motion (ROM). A study conducted by Ayudi (2022) states that the use of massage guns has an effect in reducing pain. Cheatham et al. (2021) showed that passive stretching can reduce pain, provide lower back stabilizers through active development of the abdominal muscles, gluteus maximus, and hamstrings and can reduce the pain scale in patients with low back pain. Moreover, Mustagfirin et al. (2020) showed that the use of stretching has an effect on reducing the scale of back pain. Thus the treatment of massage gun and exercise with passive stretching is able to have an influence in increasing ROM and joint motion function in patients with non-specific low back pain.

Massage guns can be used in several ways such as combined with dynamic stretching and cardio warm-up exercises, using a massage gun for 30 seconds to 1 minute on targeted points. This prepares the muscles by increasing blood flow and improving muscle mobility. Massage guns are able to reduce the pain scale by improving blood circulation and reducing acid lactate, thereby reducing pain and increasing muscle flexibility (Wardana et al., 2024). This increase in osmotic pressure will then result in edema, which will further compress the sensory nerves. Then it will be felt as musculoskeletal disorders or muscle pain, by stretching (stretching) the muscles, which can be done by contracting the antagonist muscles or by passively stretching the muscles concerned in various ways. Stretching aims to lengthen muscle tendons, viscoelastic changes in muscles and tendons that can reduce pain levels (Bolarinde et al., 2017). Stretching can also reduce muscle stiffness caused by decreased muscle flexibility and muscle ability (Zulkarnain & Nugraha, 2023) Research has shown that passive stretching and gun massage can increase joint range of motion and joint function. This method is optimally used when the agonist muscle (the main muscle in movement) is weak, so it can help increase muscle and joint flexibility. In practice, passive stretching is done by stretching the muscle as far as possible and holding it for a while. This gives the muscle a chance to stretch to its maximum and reduce tension. However, keep in mind that passive stretching can pose a risk of pain if excessive force is applied or done quickly.

Previous research recommends massage gun tools as clinical and sports therapy in supporting warming up, recovery. The results of the study (Ferreira et al., 2023) showed the effects of using massage guns as follows; 1) muscle activation (strength, speed, endurance, oxygen absorption), 2) reaction, balance, agility, 3) joint range, myofascial release, 4) prevention of DOMS. Giving massage gun as muscle relaxation followed by exercise therapy in the form of passive stretching is beneficial for the body to improve the quality of muscle flexibility and muscle strength. A study by Mentari et al. (2024) shows that passive stretching can reduce tension in flexor muscles in the cubital region in stroke patients. In addition, this method is also useful in increasing overall body flexibility. Thus, passive stretching is a good alternative in reducing muscle pain and improving quality of life.

5. CONCLUSIONS

The combination of massage gun therapy and passive stretching exercises 3 times therapy in 3 days, effectively applied to 20 samples experiencing lower back pain complaints can improve the quality of life of patients with non-specific lower back pain as seen from the increase in joint range of motion and joint motion function.

6. REFERENCES

1. Agustina, S., & Khie Khiong, T. (2023). Low Back Pain Ditinjau Dari Teori Medis Barat Dan Tcm. *Journal of Comprehensive Science, 2*(4), 971–980. https://doi.org/10.59188/jcs.v2i4.303

2. Anggait, L. (2022). Terapi masase dalam intervensi fisioterapi. *BFS Medika, 15*(2), 1-59.

3. Ayudi, A. R. (2022). The Effect of Swedish massage And Sport Massage on the Recovery of Fatigue on Labor Workers or Collectors. *International Journal of Multidisciplinary Research and Analysis, 5*(2), 359–365. https://doi.org/10.47191/ijmra/v5-i2-18

4. Bolarinde, S. O., Adegoke, B., Ayanniyi, O., & Olagbegi, O. (2017). Effects of Stretching Exercises on Pain and Functional Disability in Quarry Workers with Work-related Low Back Pain. *Journal of Health and Safety, Research and Practice, 9*(2), 1–11.

5. Cheatham, S. W., Baker, R. T., Behm, D. G., Stull, K., & Kolber, M. J. (2021). Mechanical percussion devices: A survey of practice patterns among healthcare professionals. *International Journal of Sports Physical Therapy, 16*(3), 766–777. https://doi.org/10.26603/001c.23530

6. Comeaux, Z. (2011). Dynamic fascial release and the role of mechanical/vibrational assist devices in manual therapies. *Journal of Bodywork and Movement Therapies, 15*(1), 35–41. https://doi.org/10.1016/j.jbmt.2010.02.006

7. Cook, C. E., Garcia, A. N., Wright, A., Shaffrey, C., & Gottfried, O. (2021). Measurement Properties of the Oswestry Disability Index in Recipients of Lumbar Spine Surgery. *Spine, 46*(2), 118–125. https://doi.org/10.1097/BRS.0000000000003732

8. Cook, D. J., Yeager, M. S., & Cheng, B. C. (2015). Range of motion of the intact lumbar segment: A multivariate study of 42 lumbar spines. *International Journal of Spine Surgery, 9,* 1–8. https://doi.org/10.14444/2005

9. Ferreira, R. M., Silva, R., Vigário, P., Martins, P. N., Casanova, F., Fernandes, R. J., & Sampaio, A. R. (2023). The Effects of Massage Guns on Performance and Recovery: A Systematic Review. *Journal of Functional Morphology and Kinesiology, 8*(3), 1–20. https://doi.org/10.3390/jfmk8030138

10. Frizziero, A., Pellizzon, G., Vittadini, F., Bigliardi, D., & Costantino, C. (2021). Efficacy of core stability in non-specific chronic low back pain. *Journal of Functional Morphology and Kinesiology, 6*(2), 1-12. https://doi.org/10.3390/jfmk6020037

11. Han, C. S., Hancock, M. J., Sharma, S., Sharma, S., Harris, I. A., Cohen, S. P., Magnussen, J., Maher, C. G., & Traeger, A. C. (2023). Low back pain of disc, sacroiliac joint, or facet joint origin: a diagnostic accuracy systematic review. *EClinicalMedicine, 59,* 1-12. https://doi.org/10.1016/j.eclinm.2023.101960

12. Leabeater, A. J., Clarke, A. C., James, L., Huynh, M., & Driller, M. (2024). Under the Gun: Percussive Massage Therapy and Physical and Perceptual Recovery in Active Adults. *Journal of Athletic Training, 59*(3), 310–316. https://doi.org/10.4085/1062-6050-0041.23

13. Lee, I., Sim, S., & Jin, S. (2021). Hamstring stretching significantly changes the sitting biomechanics. *International Journal of Industrial Ergonomics, 84*(1), 1-16. https://doi.org/10.1016/j.ergon.2021.103163

14. Mahasih, T. (2019). Pengaruh Stimulus Kutaneus Slow Stroke Back Massage (Ssbm) Terhadap Intensitas Nyeri Pada Pengrajin Rotan Yang Menderita Low Back Pain (Lbp). *Jurnal Kesehatan, 10*(1), 1266-1272.

15. Marufan, D. A., Kurniawan, R., Pratama, M. F., & Hidayat, T. (2021). Exercise Therapy Berpengaruh Terhadap Peningkatan Kualitas Hidup Lansia: Studi literature. *Physiotherapy Evidences, 2*(3), 189–208. https://doi.org/10.23917/fisiomu.v2i3.15204

16. Mentari, D., Fradianto, I., & Tafwidhah, Y. (2024). Implementasi Manajemen Nyeri Menggunakan Stretching Exercise pada Asuhan Keperawatan Keluarga Lansia dan Pensiunan

dengan Masalah Nyeri Sendi. *Malahayati Health Student Journal, 4*(5), 1903–1914. https://doi.org/10.33024/mahesa.v4i5.14426

17. Mustagfirin, M. I., Nataliswati, T., & Hidayah, N. (2020). Studi Literatur Review: Latihan Stretching Terhadap Penurunan Tingkat Nyeri Punggung Bawah Pada Lansia. *Hospital Majapahit, 12*(2), 143–155.

18. Tian, M., Herbert, R. D., Hoang, P., Gandevia, S. C., & Bilston, L. E. (2012). Myofascial force transmission between the human soleus and gastrocnemius muscles during passive knee motion. *Journal of Applied Physiology, 113*(4), 517–523. https://doi.org/10.1152/japplphysiol.00111.2012

19. Wardana, A. A. P., Kardjono, K., & Mustaqim, R. (2024). Efektifitas Penggunaan Media Massage Gun Terhadap RPE Atlet Sepakbola. *Jurnal Kepelatihan Olahraga, 16*(1), 13–18. https://doi.org/10.17509/jko-upi.v16i1.62991

20. World Health Organization. (2023, June 19). *Low back pain*. https://www.who.int/news-room/fact-sheets/detail/low-back-pain

21. Zulkarnain, A. N., & Nugraha, Y. S. (2023). Pengaruh Passive Stretching Dan Istrument Assisted Soft Tissue Mobilization (Iastm) Terhadap Penurunan Nyeri Otot Perserta Lari Marathon. *Journal of Health and Medical Research, 3*(2), 151–159.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.