



EFFECT OF BRUEGGER'S EXERCISE AND LUMBAR STABILIZATION EXERCISE ON PIRIFORMIS SYNDROME

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ABSTRACT

Background: Piriformis syndrome is a neuromuscular condition that causes buttock pain from the sciatic nerve being compressed by the piriformis muscle. With postural adjustments, Bruegger's exercise improves lumbar flexibility and lowers muscle tension, potentially easing piriformis compression. While piriformis muscle stress is decreased, better pelvic alignment is promoted by lumbar stabilization exercises, which work to strengthen core muscles. Both exercises offer non-invasive and efficient treatments for piriformis syndrome since they have the potential to reduce symptoms and improve general function in people with the illness.

Materials and Methods: The purpose of the study was to find out how Bruegger's exercise and Lumbar stabilization exercise Programme affected piriformis syndrome sufferers. For a 4-week intervention, participants were randomly allocated to one of two workout groups. Pre- and post-intervention outcome indicators, such as pain levels and functional capacity, were evaluated. To ascertain the importance of the exercises' effect on the treatment of piriformis syndrome, statistical analysis was done.

Results: The findings of the study indicate that there is a significant difference in the results obtained by both Groups before and after the intervention. Pain, functions in daily living, muscle strength were all significantly improved in Group 1 subjects compared to Group 2.

Conclusion: According to the results of our study, there was a discernible gap between the ratings both groups had given before to and after the completion of the intervention. When compared to Group 2 (Conventional Physiotherapy), the effects of Group 1 (Bruegger exercise programme) are much greater. In order to ensure that the Bruegger and lumbar stabilization exercise for piriformis syndrome is more successful.

Keywords :- Bruegger's exercise, Lumbar stabilization, Piriformis syndrome

INTRODUCTION

The peculiar term "piriformis syndrome" has been used to refer to the entrapment of the sciatic nerve in the deep gluteal region for a long time. The entitle "piriformis syndrome" was first used in 1947, even though the condition was originally identified in the year 1928 [Byung-Chul Son et al. 2022]. The clinical picture is often consistent, with patients frequently describing discomfort in the gluteal or buttock area that may radiate, burn, or ache down the back of the leg [Brandon L.Hicks et al. 2022].

The piriformis muscle, an external hip rotator, is located right next to the sciatic nerve. As a result, anytime the piriformis muscle is aggravated or inflamed, the sciatic nerve is also affected, which causes pain similar to that of sciatica. The piriformis muscle has a pyramidal structure and is flat and oblique. It begins anterior to the S2-S4 vertebrae, the sacrotuberous ligament, and the superior edge of the larger sciatic foramen. After passing through the larger sciatic notch, the muscle attaches to the greater trochanter of the hip bone. The piriformis muscle predominantly functions as an external rotator when the hip is extended, however when the hip is in flexion, it functions as a hip adductor. The L5, S1, and S2 nerve branches that innervate the piriformis muscle. The nearby sciatic nerve, which is quite close to the center of the muscle, is also stimulated when the piriformis muscle is overworked, aggravated, or inflamed. Up to 6% of all cases of sciatica and/or low back pain may be brought on by piriformis syndrome. The incidence of piriformis syndrome would be about 2.4 million per year, with an estimated 40 million additional occurrences of low back pain and sciatica per year. The majority of people with piriformis syndrome are middle-aged; the ratio of male to female patients who are affected is 1:6 [Brandon L.Hicks et al. 2022]. This syndrome's etiology is split into primary and secondary causes. [Yusak Mangara Tua Siahaan et al. 2019]

Swiss neurologist Bruegger emphasized that functional impairment always affected the entire body. The goal of Bruegger's exercises is to loosen up tight muscles and strengthen weak muscles that develop from spending a lot of time sitting still [Rajalaxmi V et al. 2020]

Bruegger proposed a study to examine how to improve posture while also analyzing it Bruegger's workout is a practice made to loosen the muscles that have been tense and to strengthen the muscles that have become weak from prolonged improper sitting position.

The patient does Bruegger's exercise while sitting on the edge of a chair with their feet externally rotated, their shoulders back, their head up, their forearm supinated, and their wrists and fingers extended. The patient is instructed to vigorously externally rotate their arms and spread their fingers while slowly exhaling through their mouth. Every 20-30 minutes of extended sitting, the patient should practice this exercise once or twice, holding the position for 30-60 seconds [Tyron Waters 2013]

A common form of exercise used to alleviate and lessen low back pain is lumbar stabilization exercise (LSE). Exercises for lumbar stabilization are designed to enhance the neuromuscular control, muscular strength, and endurance of the muscles required to uphold dynamic spinal and trunk stability. The various stages and minimal cost are considered advantages, making it a safe exercise [Lee Zhi Ling et al. 2022]

Numerous studies have shown that lumbar stabilization exercises help people with chronic low back pain stabilize themselves by strengthening the deep lumbar muscles [MIN-YEONG HEO et al. 2015] Patients with low back pain have been found to have structural as well as functional abnormalities, such as reduced and delayed activation of the transverse abdominis and atrophy of the lumbar multifidus. By retraining the appropriate activation and synchronization of the trunk muscles, lumbar stabilization exercises aim to remedy these deficits. Physical therapists frequently utilize stabilization exercises to treat low back pain [ALON RABIN et al. 2014]. Since each person has unique lumbar muscular strengths, lumbar stabilization programmes should be tailored to each person, incorporating a variety of postures and intensities to maximize therapeutic benefit. [Jee Hyun Suh et al. 2019]

In their investigation, Barton and Halin (1991) came to the conclusion that hip abductors strengthening exercises are necessary for the therapy of piriformis syndrome. In order to control the femur in the frontal plane during functional tasks, a therapy programme focusing on hip strengthening may be useful in the management of patients with piriformis syndrome. It's interesting to note that a lot of publications have identified weak hip abductors as a symptom of piriformis syndrome. [Krishnendu Laha et al. 2018]

For the piriformis muscle to be less stressed, the hip abductor muscles must be strengthened. Additionally, the hamstring pre-stretch mechanism during backward walking enhances hamstring and low back flexibility. It can extend the lumbar spine's range of motion and lessen low back discomfort. The effectiveness of strengthening hip abductor and extensor muscles together with walking

backwards on low back pain and range of motion is only partially supported by the literature [Ambarin Pirjade et al.2021]

HYPOTHESIS

ALTERNATIVE HYPOTHESES

There is a significant effect of Bruegger's exercise and lumbar stabilization exercise on piriformis syndrome.

NULL HYPOTHESES

There is no significant Effect of Bruegger's exercise and lumbar stabilization exercise on piriformis syndrome.

METHODOLOGY

TYPE OF STUDY: Experimental Study

SAMPLING: Random sampling will be done on the basis of inclusion and exclusion criteria

AREA OF PROJECT: People living in the Greater Noida, Delhi India

SAMPLING METHOD:

- No of Sample: 30 subjects will include on the basis of inclusion and exclusion criteria.
- Sample place: Galgotias University
- Duration Of Study- 8 Weeks

INCLUSION CRITERIA:

- Age 19-37 years
- Patient having piriformis syndrome
- Both male and female
- Patient having low back pain with or without radiating pain

EXCLUSION CRITERIA:

- Cord compression
- Spinal tumor
- Recent fracture
- Recent surgery
- Severe osteoporosis
- Myelopathy
- Ankylosing spondylitis

INSTRUMENTATION:

- BRIEF PAIN INVENTORY SCALE
- OSWESTRY LOW BACK DISABILITY QUESTIONNAIRE
- QUEBEC BACK PAIN DISABILITY SCALE
- OXFORD SCALE OF MANUAL MUSCLE TESTING

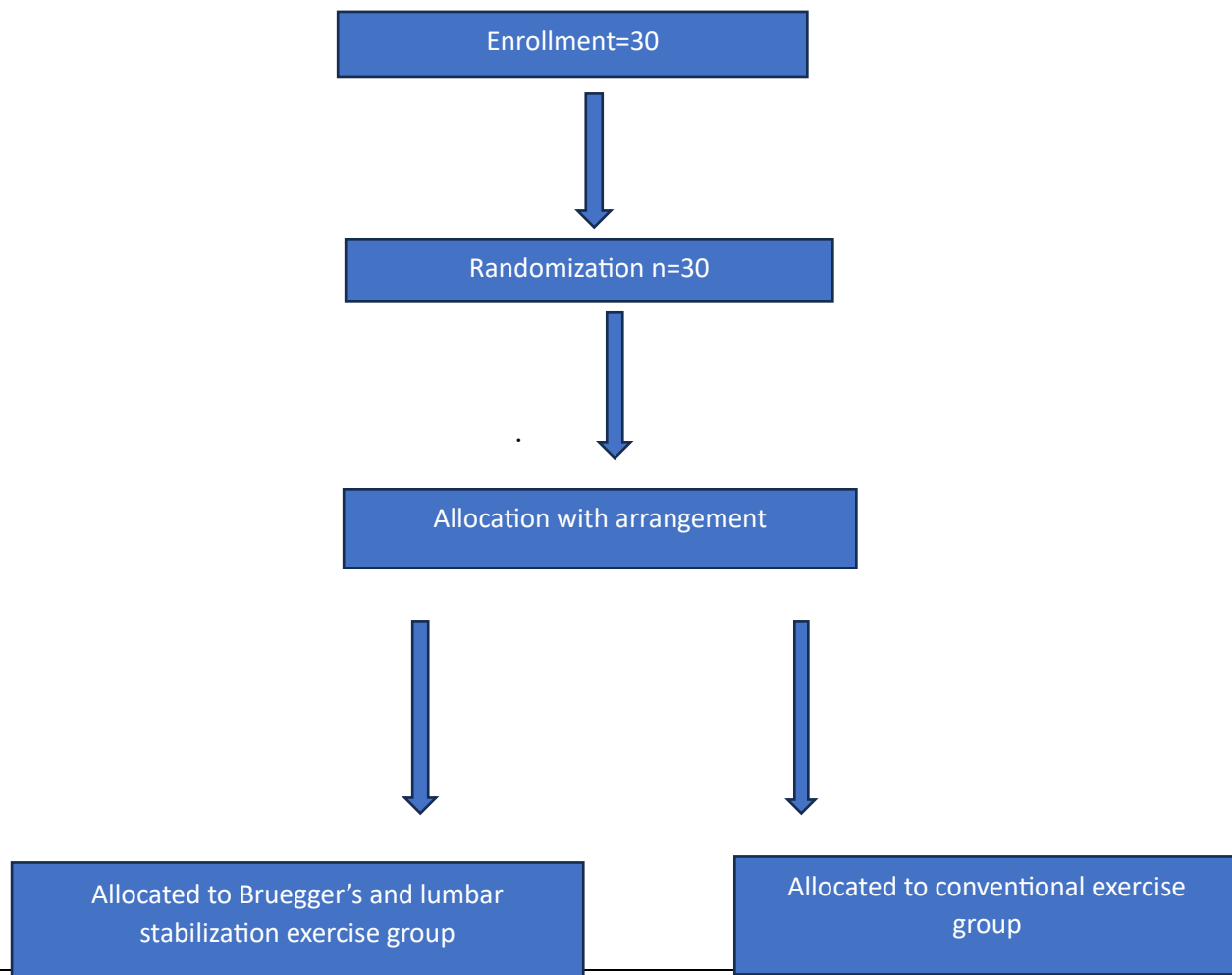
PROCEDURE

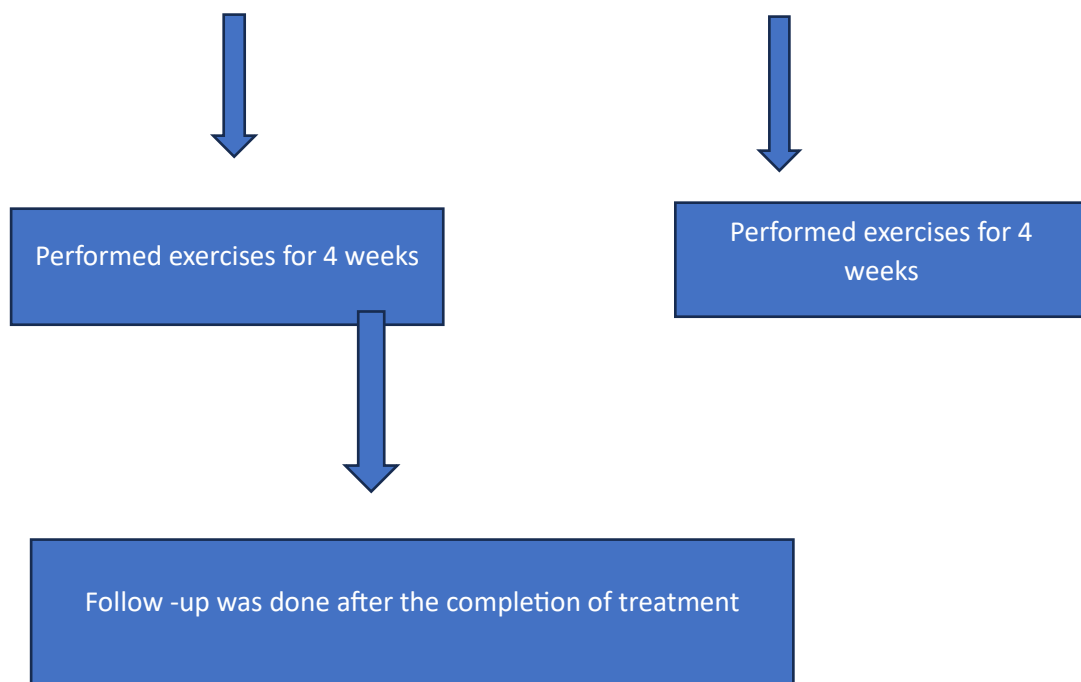
The study chose thirty people who met the inclusion and exclusion requirements. Prior to the investigation, an explanation from the investigator and a consent form were given to the subjects. They had enough time to think on whether or not to participate in the study. They were then asked to sign the consent form with their name after they had consented to participate. After that, they were allocated at random into the groups for Bruegger's exercise and lumbar stabilization exercise.

Patients asked to conduct the treatment five days a week after receiving the appropriate treatment for four weeks. They were reevaluated after four weeks.

On the first and last visits, participants pain, low back impairment, and strength were evaluated. The level of pain was evaluated for both rest and exercise using the Brief Pain Inventory Scale. Next, Oxford scale of manual muscle testing is used to determine how much force or power is generated when muscle contracts. Beside it, physical disability brought on by non-specific low back pain was measured using the Oswestry Disability Index, a self-administered questionnaire that assesses the limitations of many everyday life activities. Lastly, the level of functional disability in people with back pain is measured using the Quebec Back Pain Disability Index.

Participants in the Lumbar stabilization exercise group underwent lumbar stabilization exercise five days a week for eight weeks. Before each exercise, the physical therapist verbally explains the start and finish position in details. Participants in the Bruegger's exercise group were required to complete this exercise five days a week for a total of four weeks. Patients were instructed to sit on a chair's edge with their hips abducted, their feet rotated outward, their heads held high, their forearms supinated, and their wrists and digits extended. Then they were instructed to softly exhale through their lips while aggressively lateralizing their arms and spreading their digits.







DATA ANALYSIS

For the purpose of data analysis, the version 27.0 of the Social Science Packaging Software SPSS was used. When doing the readings, both an independent T-test and a paired T-test were used. In order to make the graphical representation, MS EXCEL 2021 was used.

RESULTS

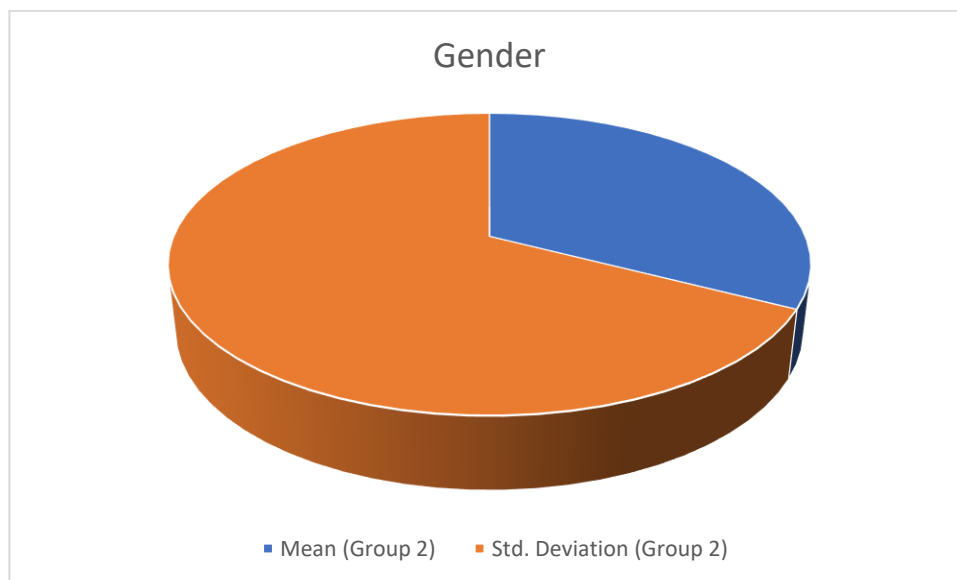
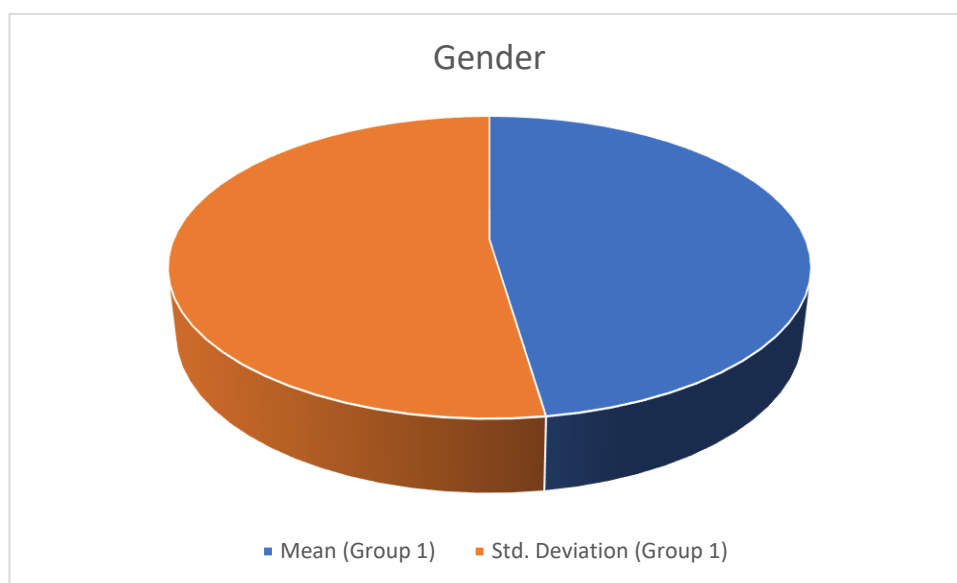
Independent samples t-tests to compare the means of various measures between two groups: BRUEGGER'S AND LUMBAR STABILIZATION EXERCISE (Group 1) and PIRIFORMIS STRENGTHENING (Group 2). The results are as follows:

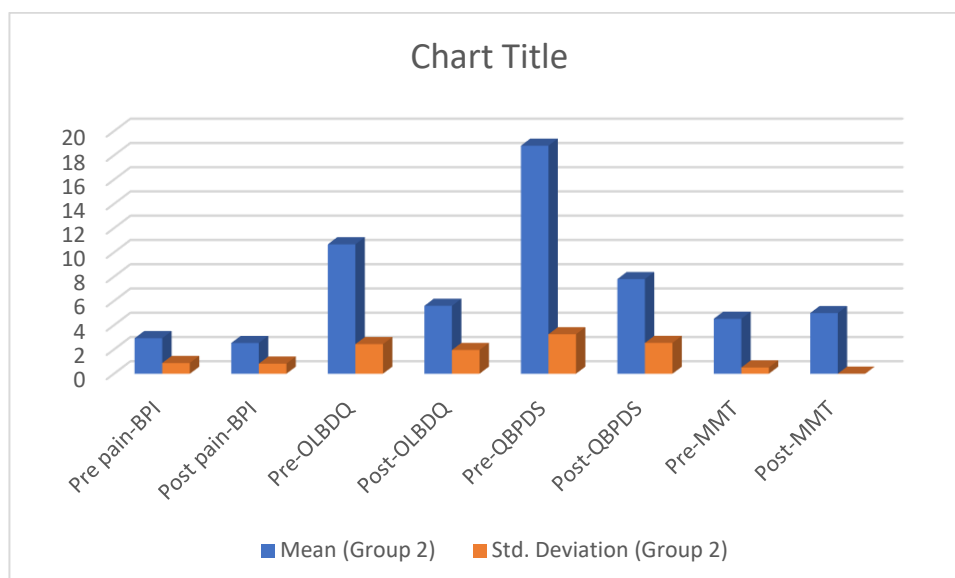
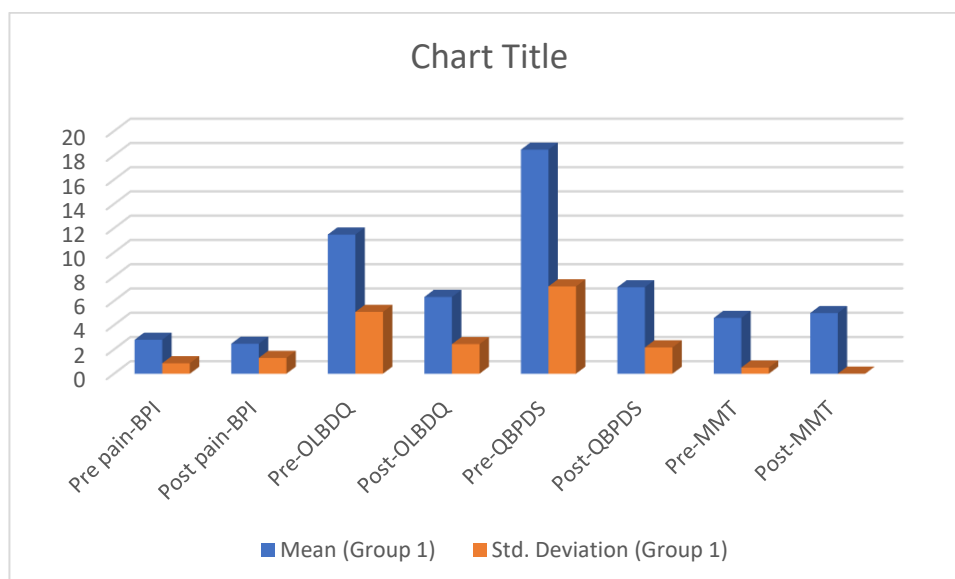
1. Gender: The t-test showed no significant difference in gender distribution between the two groups ($p > 0.05$).
2. Pre-pain BPI (Brief Pain Inventory) scores: There was no significant difference in pain levels between BRUEGGER'S AND LUMBAR STABILIZATION EXERCISE and PIRIFORMIS STRENGTHENING before the study ($p > 0.05$).
3. Post-pain BPI scores: After the study, there was no significant difference in pain levels between BRUEGGER'S AND LUMBAR STABILIZATION and PIRIFORMIS STRENGTHENING ($p > 0.05$).
4. Pre-OLBDQ (Oswestry Low Back Pain Disability Questionnaire) scores: The two groups showed no significant difference in disability levels before the study ($p > 0.05$).
5. Post-OLBDQ scores: After the study, there was no significant difference in disability levels between gamers and non-gamers ($p > 0.05$).
6. Pre-QBPDS (Quebec Back Pain Disability Scale) scores: There was no significant difference in back pain disability levels between the two groups before the study ($p > 0.05$).
7. Post-QBPDS scores: After the study, there was no significant difference in back pain disability levels between BRUEGGER'S AND LUMBAR STABILIZATION and PIRIFORMIS STRENGTHENING ($p > 0.05$).
8. Pre-MMT (Oxford Scale of Manual Muscle Testing) scores: The two groups showed no significant difference in manual muscle strength before the study ($p > 0.05$).
9. Post-MMT scores: After the study, both groups showed the same muscle strength (the standard deviations are 0 for both groups), and thus, a t-test could not be computed (a). This means that there was no significant difference in muscle strength between BRUEGGER'S AND LUMBAR STABILIZATION and PIRIFORMIS STRENGTHENING after the study.

Measure	Mean (Group 1)	Std. Deviation (Group 1)	Mean (Group 2)	Std. Deviation (Group 2)	P-value
Gender	0.47	0.516	0.2	0.414	0.13
Pre-pain-BPI	2.8	0.862	2.93	0.884	0.679
Post pain-BPI	2.47	1.302	2.53	0.834	0.869
Pre-OLBDQ	11.47	5.097	10.67	2.44	0.588

Post-OLBDQ	6.33	2.44	5.6	1.957	0.372
Pre-QBPDS	18.47	7.2	18.8	3.256	0.871
Post-QBPDS	7.13	2.167	7.8	2.541	0.446
Pre-MMT	4.6	0.507	4.53	0.516	0.724
Post-MMT	5	0.000a	5	0.000a	-

TABLE- summarizing the mean, standard deviation, and p-value for each comparison between BRUEGGER'S AND LUMBAR STABILIZATION (Group 1) and PIRIFORMIS STRENGTHENING (Group 2)



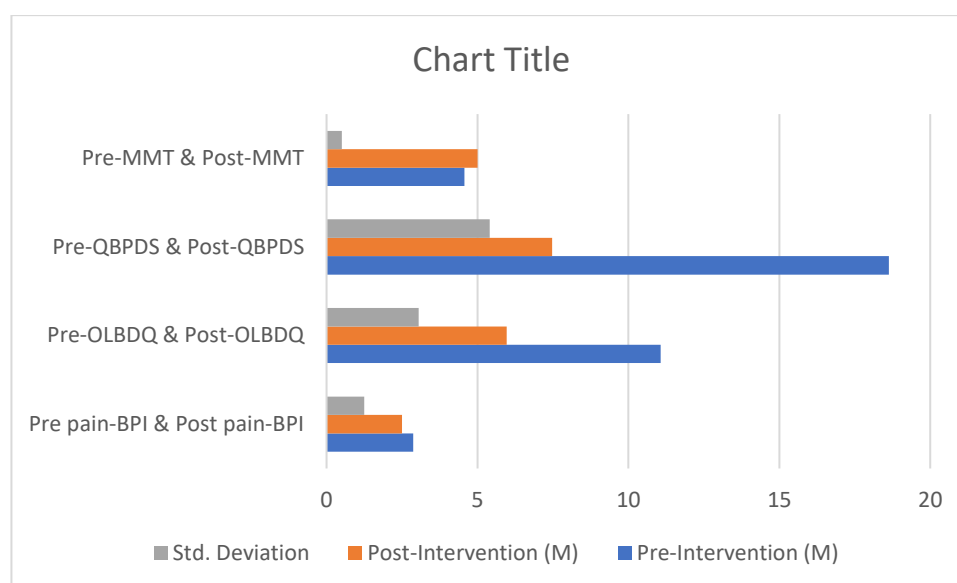


The study aimed to investigate changes in various measures before and after an intervention. The measures included pain, disability, back pain, and muscle strength. The results of the paired samples t-tests are as follows:

1. Pre-pain-BPI and Post pain-BPI: There was a small but non-significant reduction in pain levels from pre-intervention ($M = 2.87$, $SD = 0.860$) to post-intervention ($M = 2.50$, $SD = 1.075$) ($t(29) = 1.613$, $p = 0.118$).
2. Pre-OLBDQ and Post-OLBDQ: There was a significant reduction in disability levels from pre-intervention ($M = 11.07$, $SD = 3.947$) to post-intervention ($M = 5.97$, $SD = 2.205$) ($t(29) = 9.143$, $p < 0.001$).
3. Pre-QBPDS and Post-QBPDS: There was a significant improvement in back pain disability levels from pre-intervention ($M = 18.63$, $SD = 5.493$) to post-intervention ($M = 7.47$, $SD = 2.345$) ($t(29) = 11.323$, $p < 0.001$).
4. Pre-MMT and Post-MMT: There was a significant improvement in manual muscle strength from pre-intervention ($M = 4.57$, $SD = 0.504$) to post-intervention ($M = 5.00$, $SD = 0.000$) ($t(29) = -4.709$, $p < 0.001$).

Pair	Measures	Pre-Intervention (M)	Post-Intervention (M)	Mean Difference	Std. Deviation	t-value	df	p-value
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Pair 1	Pre pain-BPI & Post pain-BPI	2.87	2.5	0.367	1.245	1.613	29	0.118
Pair 2	Pre-OLBDQ & Post-OLBDQ	11.07	5.97	5.1	3.055	9.143	29	< 0.001
Pair 3	Pre-QBPDS & Post-QBPDS	18.63	7.47	11.167	5.402	11.323	29	< 0.001
Pair 4	Pre-MMT & Post-MMT	4.57	5	-0.433	0.504	-4.709	29	< 0.001



DISCUSSION

In this study, we looked at how people with piriformis syndrome responded to Bruegger's exercise and lumbar stabilization exercise as compared to conventional physiotherapy exercise. Inflammation or entrapment of the sciatic nerve by the piriformis muscle results in piriformis syndrome, a neuropathic disorder [12]. In addressing piriformis syndrome, Bruegger's exercises and lumbar stabilization exercises can be helpful. Through a sequence of controlled motions, Bruegger's exercise a posture correction technique, aims to improve posture and spinal alignment. By encouraging an upright posture and good pelvis placement, it fosters muscular balance and releases strain on the sciatic nerve. This exercise indirectly targets the piriformis by lessening needless strain on the muscle, which may eventually help with symptoms. Bruegger's relief exercise aids electronic device users in improving posture, cervical range of motion and functional status while also reducing discomfort (26). One such self-care activity that helps to correct forward head posture by strengthening the scapular retractors while stretching the protractors is the Bruegger's postural relief position.

The participants become accustomed to maintaining the Bruegger's posture with repeated practice and longer holds, and the forward head posture reverses (15). Lumbar stabilization exercise largely focuses on enhancing neuromuscular control, strength and endurance of the muscles, which are thought to be essential for maintaining dynamic spinal and trunk stability. Patients with chronic low back pain must maintain their posture and create lumbar stability by contracting lumbar region muscles, such as transverse abdominis and multifidus. Therefore, lumbar stabilization exercises help individuals with chronic low back pain restore their posture balance [7]. All patients with non-specific low back pain may benefit from stabilization training to lessen their discomfort and level of disability (Norris C,2000) [19].

Lumbar stabilization exercises have been recommended to lessen persistent low back pain. It focuses on strengthening the core, which improves muscle endurance and may reduce the risk of low back discomfort, this increases isometric endurance (23). In individuals with non-specific chronic low back pain, lumbar stabilization exercises were more successful at alleviating functional impairment and strengthening lumbar extensors at minor lumbar flexion angles (35).

There is evidence to support the idea that performing core stability exercises on their own or as an adjuvant to other conventional treatments can significantly reduce low back pain patient's pain and functional issues. By minimising the load on the lumbar vertebrae, lumbar stabilization exercises have the effect of decreasing the stimulation supplied to painful and sensitive tissues and improving function of the spinal stabiliser muscles, it can help to stabilise the spine and lessen discomfort (34). A spinal stabilization programme was found to be more successful than manual applied therapy in the long- term treatment of persistent low back diseases, according to Goldby et al. (25).

This study demonstrated that Bruegger's and lumbar stabilization exercise is more effective in treating patients with piriformis syndrome. Pain strength, functional disability assessed by Brief pain inventory scale, Oswestry low back disability questionnaire, oxford scale of MMT showed significant reduction before and after the intervention. According to the results traditional physiotherapy exercises didn't show a reduction in pain and disability in patients. Hip abductor weakness has been identified by numerous writers as a characteristic of piriformis syndrome. Therefore, the therapy of patients with piriformis syndrome may involve addressing hip strength and movement reeducation to control the femur in the frontal and transverse planes during functional tasks.[31] The tension on the piriformis might be reduced, resulting in less compression on the sciatic nerve, if the incorrect movement patterns could be rectified by strengthening the hip/pelvic musculature together with movement reeducation. Instead of concentrating on the muscle directly, we were able to help this patient in the long run by treating the suggested functional cause of the piriformis irritation (31).

In conclusion, for those with piriformis syndrome Bruegger's exercise and lumbar stabilization exercises may be helpful. The Bruegger's exercise improves posture and alignment, while the lumbar stabilization exercise strengthens core strength and stability. A tailored fitness programme that uses both methods may be an efficient way to treat the symptoms of piriformis syndrome and enhance the general health of those who are affected.

CONCLUSION According to the results of our study, there was a discernible gap between the ratings both groups had given before to and after the completion of the intervention. When compared to Group 2 (Conventional Physiotherapy), the effects of Group 1 (Bruegger's and lumbar stabilization exercise) are much greater. In order to ensure that the Bruegger and lumbar stabilization exercise for piriformis syndrome is more successful.

REFERENCES

- [1] Son BC, Lee C. Piriformis syndrome (sciatic nerve entrapment) associated with type C sciatic nerve variation: A report of two cases and literature review. *Korean Journal of Neurotrauma*. 2022 Oct;18(2):434.
- [2] Hicks BL, Lam JC, Varacallo M. Piriformis syndrome.
- [3] Siahaan YM, Ketaren RJ, Hartoyo V, Tiffani P. The predisposing factors of piriformis syndrome: Study in a referral hospital. *MNJ (Malang Neurology Journal)*. 2019 Apr 29;5(2):76-9.
- [4] Mehta TB, Sharma A. Treatment strategies for lower cross syndrome.
- [5] Waters T. The effect of Bruegger's exercise on chronic low back pain in association with lower crossed syndrome. University of Johannesburg (South Africa); 2014.
- [6] Ling LZ, Singh K, Govind S, Wah YC. Effect of Lumbar Stabilization Exercise and Myofascial Release Therapy in Non-specific Low Back Pain: A Randomized Controlled Trial. *Journal of Positive School Psychology*. 2022 Mar 11;6(3):4035-46.

- [7] Heo MY, Kim K, Hur BY, Nam CW. The effect of lumbar stabilization exercises and thoracic mobilization and exercises on chronic low back pain patients. *Journal of physical therapy science*. 2015;27(12):3843-6.
- [8] Suh JH, Kim H, Jung GP, Ko JY, Ryu JS. The effect of lumbar stabilization and walking exercises on chronic low back pain: A randomized controlled trial. *Medicine*. 2019 Jun;98(26).
- [9] Laha K, Sarkar B, Kumar P, Patel L, Sarkar N. Efficacy of hip abductor and extensor strengthening on pain, strength and lower extremity function in piriformis syndrome: a randomized clinical trial. *Int J Health Sci Res*. 2018;8(9):80-.
- [10] Probst D, Stout A, Hunt D. Piriformis syndrome: a narrative review of the anatomy, diagnosis, and treatment. *PM&R*. 2019 Aug; 11:S54-63.
- [11] Ro TH, Edmonds L. Diagnosis and management of piriformis syndrome: a rare anatomic variant analyzed by magnetic resonance imaging. *Journal of clinical imaging science*. 2018;8.
- [12] Siahaan YM, Tiffani P, Tanasia A. Ultrasound-guided measurement of piriformis muscle thickness to diagnose piriformis syndrome. *Frontiers in Neurology*. 2021 Sep 7;12:721966.
- [13] Jardak M, Chaari F, Bouchaala F, Fendri T, Harrabi MA, Rebai H, Sahli S. Does piriformis muscle syndrome impair postural balance? A case control study. *Somatosensory & Motor Research*. 2021 Oct 2;38(4):315-21.
- [14] Suh KC, Lee BK, Lee YS, Seo DK. The Effects of Sitting Questionmark Exercise and Brugger's Relief Exercise on Pain, ROM, Proprioception, NDI in Patients with Chronic Cervical Pain. *Journal of The Korean Society of Integrative Medicine*. 2019;7(4):151-9.
- [15] Gurudut P, Welling A, Chodankar A. Effect of self-care exercises in forward head posture on craniovertebral angle and craniocervical flexion endurance: A pilot study. *Indian Journal of Physical Therapy and Research*. 2020 Jan 1;2(1):25.
- [16] Chodankar A, Gurudut P, Welling A. Bruegger's exercises vs deep cervical flexor training in asymptomatic participants with forward head posture: a randomised controlled trial. *International Journal of Therapy and Rehabilitation*. 2022 Jun 2;29(6):1-1.
- [17] Dalawar A, Afzal H, Dalawar I, Murtaza A, Ghafoor A, Fiaz S. Effects of Muscle Energy Technique vs Bruegger's Relief Exercise on Forward Head Posture among electronic gadget users. *Pakistan Journal of Medical & Health Sciences*. 2022 May 26;16(05):51-.
- [18] Shanmuga Jayanthan S, Rajkumar SS, Kumar VS, Shalini M. Pyomyositis of the Piriformis Muscle—A Case of Piriformis Syndrome. *Indian Journal of Radiology and Imaging*. 2021 Oct;31(04):1023-6.
- [19] Chitra R. Effect of lumbar stabilization exercise and lumbar extension exercise in the treatment of chronic low back pain. *European Scientific Journal*. 2014 Jul 1;10(21).
- [20] Javadipour Z, Sedaghati P, Ahmadabadi S. The effects of combining core stability with stretching exercises on pain intensity and motor function in people with chronic nonspecific low back pain with and without hyperlordosis. *Annals of Applied Sport Science*. 2021 Jul 10;9(2):0-.
- [21] Childs JD, Fritz JM, Flynn TW, Irrgang JJ, Johnson KK, Majkowski GR, Delitto A. A clinical prediction rule to identify patients with low back pain most likely to benefit from spinal manipulation: a validation study. *Annals of internal medicine*. 2004 Dec 21;141(12):920-8.
- [22] Nowotny AH, Calderon MG, de Souza PA, Aguiar AF, Léonard G, Alves BM, Amorim CF, da Silva RA. Lumbar stabilisation exercises versus back endurance-resistance exercise training in athletes with chronic low back pain: protocol of a randomised controlled trial. *BMJ open sport & exercise medicine*. 2018 Nov 1;4(1):e000452.
- [23] Putri YP, Naufal AF, Wijayaningsih A. PHYSIOTHERAPY MANAGEMENT FOR LUMBAL STRETCHING EXERCISE AND LUMBAL CORE STABILIZATION EXERCISE IN CHRONIC LOW BACK PAIN: A CASE STUDY. In *Academic Physiotherapy Conference Proceeding* 2021.
- [24] Luque-Suárez A, Díaz-Mohedo E, Medina-Porqueres I, Ponce-García T. Stabilization exercise for the management of low back pain. *Low back pain*. 2012 May 9;261-92.
- [25] Senbursa G, Pekyavas NO, Baltaci G. Comparison of physiotherapy approaches in low back pain: a randomized controlled trial. *Korean journal of family medicine*. 2021 Mar;42(2):96.

- [26] Afzal H, Dalawar I, Dalawar A, Murtaza A, Tanveer S, Ahsan A. Effect of Bruegger s relief exercise on forward head posture among electronic gadget users. *Rawal Medical Journal*. 2022 Nov 12;47(4):1042-.
- [27] Narouei S, hossein Barati A, Akuzawa H, Talebian S, Ghiasi F, Akbari A, hossein Alizadeh M. Effects of core stabilization exercises on thickness and activity of trunk and hip muscles in subjects with nonspecific chronic low back pain. *Journal of Bodywork and Movement Therapies*. 2020 Oct 1;24(4):138-46.
- [28] Sharma A, Ahmad I. Tale of Two Non-Discogenic Pains, Sacroiliac Joint and Piriformis Syndromes A Less Travelled Clinical Entities. *Majmaah Journal of Health Sciences*. 2020 Mar 3;7(1):86-.
- [29] Alarab A, Unver F. Stretching Exercise Versus Tissue Mobilization Technique in Piriformis Syndrome. *European Journal of Medical and Health Sciences*. 2020;2(6).
- [30] Pavlů D, Bilková I. Effectiveness of Brügger-therapy in conservative treatment of children with idiopathic scoliosis. *Scoliosis*. 2009 Jan;4(1):1-.
- [31] Tonley JC, Yun SM, Kochevar RJ, Dye JA, Farrokhi S, Powers CM. Treatment of an individual with piriformis syndrome focusing on hip muscle strengthening and movement reeducation: a case report. *journal of orthopaedic & sports physical therapy*. 2010 Feb;40(2):103-11.
- [32] Pirjade A. Effectiveness of Hip Muscle Strengthening and Backward walking in Piriformis Syndrome. *International Journal of Musculoskeletal Pain Prevention*. 2021 Oct 10;6(4):573-9.
- [33] Larivière C, Rabhi K, Preuss R, Coutu MF, Roy N, Henry SM. Derivation of clinical prediction rules for identifying patients with non-acute low back pain who respond best to a lumbar stabilization exercise program at post-treatment and six-month follow-up. *Plos one*. 2022 Apr 27;17(4):e0265970.
- [34] Pandya RP, Shukla YU. Effect of Lumbar Stabilization Exercises on Stable versus Unstable Surface on Pain and Function in Mechanical Low Back Pain-an Evidence Based Study. *International Journal of Science and Healthcare Research*. 2021;6(2):273-9.
- [35] Moon HJ, Choi KH, Kim DH, Kim HJ, Cho YK, Lee KH, Kim JH, Choi YJ. Effect of lumbar stabilization and dynamic lumbar strengthening exercises in patients with chronic low back pain. *Annals of rehabilitation medicine*. 2013 Feb 28;37(1):110-7.
- [36] Boucher JA, Preuss R, Henry SM, Dumas JP, Larivière C. The effects of an 8-week stabilization exercise program on lumbar movement sense in patients with low back pain. *BMC musculoskeletal disorders*. 2016 Dec;17(1):1-8.