

Effect of Pilates Exercise and Core Stabilization as an Exercise on Non-Specific Sub Acute Low Back Pain- Target the Disabled Living in the Coast - A Randomized Trial

Received: 22 October 2022, **Revised:** 18 November 2022, **Accepted:** 24 December 2022

Abitha.T¹, Murugaraj.T¹, Shanmungananth.E¹

¹Research Scholar, Academic Department of physiotherapy, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth, (deemed to be university) Puducherry, India.

¹Assistant professor, Academic Department of Physiotherapy, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth, (deemed to be university) Puducherry, India.

¹Professor, HOD, Academic Department of Physiotherapy, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth, (deemed to be university) Puducherry, India.

Corresponding Author: T. Murugaraj

Assistant Professor, Department of Physiotherapy, Mahatma Gandhi Medical College And Research Institute, Sri Balaji Vidyapeeth, Puducherry, India.

Mail Id: Boouok@Gmail.Com

Keywords:

education, special Non-specific low back pain, pilates, core stabilization, disabled visual analogue scale.

Abstract

Background: Many people experience low back discomfort during their lives. —between 60% and 80% of people—making it the most common reason for healthcare visits. Exercise is crucial for the treatment of back pain. The goal of this exercise with Pilates is to improve physical strength, posture, and awareness through a set of exercises that must be performed with specialist tools and require specialised training. In the coastal city of Pondicherry, the study's goal is to find out how Pilates exercise with or without core stability exercise will decrease non-specific subacute low back pain.

Methods: In the Mahatma Gandhi Medical College and Research Institute, Pondicherry, a quasi-experimental study was carried out. Through convenient sampling, 30 people between the ages of 19 and 35 years were chosen. There were two groups made up of the subjects. Pilates exercises were given to Group A, and core stabilisation work out were given to Group B. The Oswestry questionnaire approved for low back disability and visual analogue scoring on a scale were used as the end measures.

Results: The data demonstrated that pilates exercise was much more beneficial than core stabilisation exercise in lowering pain and functional handicap. The difference which we saw between the two groups was significant (p 0.05).

Conclusion: This study demonstrates that, when managing non-specific (NS) subacute low back pain, exercise as core stability performed less than pilates exercise regarding pain reduction and functional disablement.

1. Introduction

Living near the coast can cause back pain from prolonged sitting or standing, bad posture, and repeated motions like moving heavy objects or surfing. Up to 84% of people, it has been reported, will suffer from low back discomfort at some point in their lives. Between 11 and 12% of people will have low back pain-related impairment, and about 23% of people will experience chronic low back pain [1].

Low back pain is referred to as non-specific when it isn't brought on by a distinct, recognized pathology [1].

Acute, subacute, and chronic low back pain are the three subtypes that are most commonly recognised. Depending on the duration that the back discomfort has persisted, this division is established. Acute, subacute, and chronic low back pain are the three different forms. This division is made according to how long the back ache has existed. If a pain in the back episode lasts less than six weeks, between 6 and 12, 12 weeks, or greater weeks, it is categorized as acute, subacute, or chronic.[2].

Journal of Coastal Life Medicine

Three movements of the lumbar spine are possible: rotation, side bending, and flexion/extension. [3]. The abdominal, gluteal, and leg muscles, as well as the back (lumbar area) muscles [4]. Low back pain (LBP), which affects 60–80% of individuals at some point in their life, is the sixth most prevalent cause of doctor visits. [5][6]. In the 2010 Global Burden of Disease study, the age-standardized point percentage of LBP (from 0 to 100 years of age) report was 9.4% worldwide. [7].

Acute low back pain must be treated with paracetamol, NSAIDs, spinal manipulation therapy, reassurance, recommendations to maintain activity, concise education, muscle relaxants (as a secondary treatment due to side effects), and the less efficacious opioids (in some circumstances), in accordance with the majority of clinical practice guidelines [9][10]. Many studies recommend relieving pain with superficial heat and topical pharmaceutical therapy [11]. The vast bulk of suggestions advise to take NSAIDs, mild opioids (short-term usage), any sort of exercise treatment, spinal manipulation, and shorter informative sessions for individuals with chronic low back pain [12]. Other recommendations include the use of potent opioids, extra analgesics, multimodal rehabilitation, and cognitive behavioural therapy. In various recommendations for persons with depression, antidepressants are mentioned as a supplementary therapy choice. [13]. Encourage folks who have low back pain to exercise. A recently published meta-analysis and systematic review of patients with non-specific LBP revealed that home-based exercise training including significantly reduced pain intensity and functional limitations, with the best results coming from instructing under the supervision and adhering to advised workout routines. [14].

Using specialised equipment, Pilates is an exercise regimen that aims to enhance posture, physical flexibility and strength, as well as mental awareness [15]. Pilates is a strategy and exercise movement that has several benefits. Its methodical application results in increased lung capacity and circulation. Every Pilates exercise must be done softly and contain all six fundamental principles, which must be remembered [16].

Globally, Pilates is becoming more and more well-liked. It is utilised in some rehabilitation programmes in addition to exercise programmes

[17]. Many studies and clinical trials have proven the advantages of Pilates exercises. Pilates also makes use of set breathing methods. It has been discovered that active breathing improves how well the respiratory muscles perform [18]. Studies show that a variety of Pilates movements can successfully cure lower back pain. Daily Pilates practitioners reported less discomfort, fewer impairments, and improved views of their physical and emotional well-being [19].

Patients who had traditional physiotherapy treatment were found to benefit from doing Pilates; the improvement was particularly pronounced in the female demographic group. [20]. In inactive obese women, modern Pilates which include mat and ball exercises lessened obesity, body composition indices, and flexibility. [21].

Every time we move, certain muscles hold us steady while other muscles carry out the actual movement. The process by which your trunk muscles preserve the integrity of your spine and complete body is referred to as "core stabilisation." We can move while remaining balanced thanks to this. Stability, breathing, and synchronised movement are prioritised. [22]. As Pilates exercises call for breathing, focus, centering, control, and precision in their execution. It is crucial to compare the efficiency of these principles on pain relief and the person's functional abilities to core stabilisation exercises that exclusively concentrate on components of stability, conditioning, and strengthening. So, the goal of this study is to determine how well Pilates exercises and core stability exercises can reduce discomfort and improve a person's functional capacity.

2. Methodology

This study is a quasi-experimental work which aimed to investigate the virtue or the benefit of Pilates exercise and core stabilization on non-specific (NS) subacute low back pain. The study recruited 30 participants who were diagnosed to have the problem (NSLBP), aged from 19 to 35 years, and who had pain for 6 to 12 weeks. The participants were both male and female and were in the coastal Bay of Bengal.

The study excluded participants who had a history of spinal fracture, antenatal cases and other disease which are proved to cause the pain. The participants were then assigned into two groups in a random manner: Group

Journal of Coastal Life Medicine

A, which performed Pilates exercise, and Group B, which performed core stabilization. The baseline assessment of pain and functional disability was evaluated using VAS and ODI.

Before starting the exercise program, the participants in both groups received conventional therapy (IFT) for 15 minutes during the first week of the exercise program. The Pilates exercise was performed by Group A for a period of 6 weeks, while the core stabilization exercise was performed by Group B for the same period. Each session lasted for 30 to 45 minutes, and each group performed 3 sets of 10 repetitions for 5 sessions/week. Informed consent was got from each of the research participants. A total of 30 participants who satisfied the selected criteria were divided randomly into two groups .i.e. group A (pilates exercise) and group B (core stabilization exercise) through convenient sampling by using odd and even method. Each group consist of 15 participants, group A (n=15) and group B (n=15). Baseline assessment of pain and functional disability was assessed by using VAS and ODI. Before starting these exercise the conventional therapy (IFT) was given for 15 minutes during the first week of exercise programme. Group A participants were perform pilates exercise for a period of 6 weeks while group B participants were performed core stabilization exercise for a period of 6 weeks. Each session performed for 30 to 45 minutes with 3 sets of 10 repetition for 5 sessions/week.

Treatment Procedure

In this study, the treatment procedure involved 2 different exercise interventions pilates exercise and core stabilization exercise.

Participants in each group received their respective exercise interventions for 6 weeks with 3 sets of 10 repetitions for 5 sessions per week, and each session lasting for 30 to 45 minutes.

Pilates group (Group A) consists of 15 subjects were received Pilates exercise. The pilates exercise are chest lift, supine spine twist , single leg lifts , basic back extension , shoulder bridge prep.

Core stabilization exercise (Group B) consists of 15 subjects were received core stabilization exercise. The core stabilization work out or the exercise are unilateral leg extension, lifting hip up in bridged position , dead bug exercise , bilateral leg extension , superman exercise.

Procedure of Ift

Vectrostim was the machine that was used to treat the test subjects. The interferential vector method is the technique. 80 to 100 Hertz. Intensity: The intensity was changed in accordance with the patients' sensitivity. Trapezoid waveform. fifteen minutes. Four electrodes total. Cross fire electrode placement: over the lower back. FIGURES:



Figure 1: Chest lift



Figure 2: Shoulder bridge prep



Figure 3: Unilateral leg extension



Figure 4: Lifting hip up in bridged position

Outcome Measurements

The outcome measures included functional disability and pain intensity as determined by the questionnaire of Oswestry for low back disability. Prior to the start of treatment, the VAS and ODI outcome measures were assessed the level of pain and functional impairment

associated with non-specific subacute low back pain. Following a six-week course of treatment, a post-test was conducted to gauge the level of functional impairment and pain severity associated using the VAS and ODI outcome measures.

Journal of Coastal Life Medicine

VAS:

It is a single-dimensional measure of pain that patients' pain progression is tracked via. Reposting pain is a reliable and legitimate measure. It has a 100mm horizontal line with labels at the left and right ends that read "no pain" and "severe pain," respectively. No pain (0–4 mm), mild pain (5–44 mm), moderate pain as 45–74 mm severe pain have been indicated as the pain VAS (75-100mm)

ODI:

It is a questionnaire designed to assess low back dysfunction or pain. There are 10 sections in this self-reported questionnaire, and there are 6 potential responses for each. Statement 1 receives a grade of 0, whereas statement 6 receives a rating of 5. Pain severity, personal care, lifting, moving about while sitting or standing, sleeping, social life, travel, and employment/homemaking are the sections that make up this list. All the portions were to be completed, according to instructions. A percentage was used to represent the final grade. 0% - 20% of patients means a mild disability, 21 - 40% - a moderate disability, 41 - 60% a severe disability, 61 - 80% of patients - crippled, and 81 - 100% patients - bedridden. If the score drops, the impairment is lessened.

STATISTICS:

Continuous detected variables were described using descriptive statistical analysis (mean, standard deviation), and the Shapiro-Wilk test was used to evaluate if the data were regularly distributed. During the VAS and ODI group analysis, a paired "t" test was used. For all outcome variables, an unpaired t-test was used to compare the outcomes of group A's pilates exercise and group B's core stabilisation exercise. 0.05 was chosen as the statistical significance level, and SPSS software version 16 was used to conduct the analyses.

3. Result

Interpretation of the result:

The average and range (SD)of the VAS scores for Group A and Group B taken prior to treatment (pre). Group A's mean VAS was 7.60, whereas group B's was 7.67. Group A's VAS standard deviation was 0.737, whereas group B's was 0.724.

The outcome demonstrates that there is no discernible difference between the pre-VAS levels for Groups A and B. (Table 1).

The average and range (SD)of the ODIs for Groups A and B taken prior to treatment (pre). In group A, the average ODI was 44.00, whereas in group B, it was 41.07. In group A, the ODI's standard deviation was 10.282 and in group B, it was 10.416. The result shows there is no significant difference between pre values of ODI for Group A and B (Table 2).

The mean and standard deviation of VAS of Group A and Group B measured after the treatment (post). The mean of VAS in group A was 2.93 and in group B was 5.80. The standard deviation of VAS in group A was ±0.99 and in group B was ±1.146. After analysing the post data of both groups, the obtained t-value is 7.339 and p value is 0.0001.

The result shows there is significant difference between post values of VAS for Group A and B (Table 3).

The Group A and Group B ODI mean and standard deviation measured following therapy (post). Group A's mean ODI was 20.20, whereas group B's was 31.33. Standard deviations for the ODI in groups A and B were respectively 8.385 and 10.761. Following analysis of the post-test results for both groups, a t-value of -3.161 and a p-value of 0.004 were found.

The outcome demonstrates a substantial difference between the post-ODI scores for Groups A and B. (Table 4).

Table 1: Inter group pre-test comparison of VAS (Between group A and group B)

| Sl.NO | VAS | N | MEAN | S.D | t-value | p-value |
|-------|---------|----|------|-------|---------|---------|
| 1. | GROUP A | 15 | 7.60 | 0.737 | -0.250 | .804 |
| 2. | GROUP B | 15 | 7.67 | 0.724 | | |

Journal of Coastal Life Medicine

Table 2: Inter group pre-test comparison of ODI (Between group A and group B)

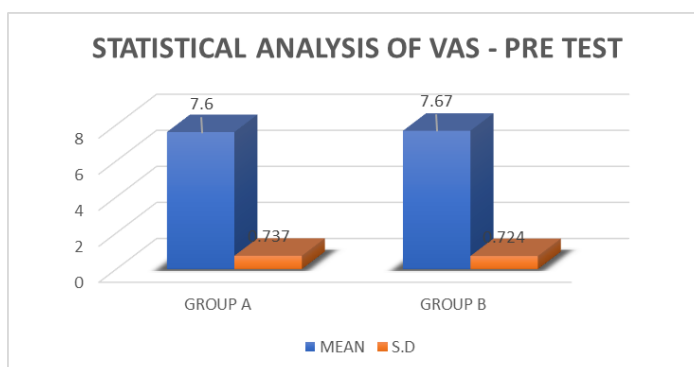
| SLNO | ODI | N | MEAN | S.D | t-value | p-value |
|------|---------|----|-------|--------|---------|---------|
| 1. | GROUP A | 15 | 44.00 | 10.282 | 0.776 | .444 |
| 2. | GROUP B | 15 | 41.07 | 10.416 | | |

Table 3: Inter group post-test comparison of VAS (Between group A and group B)

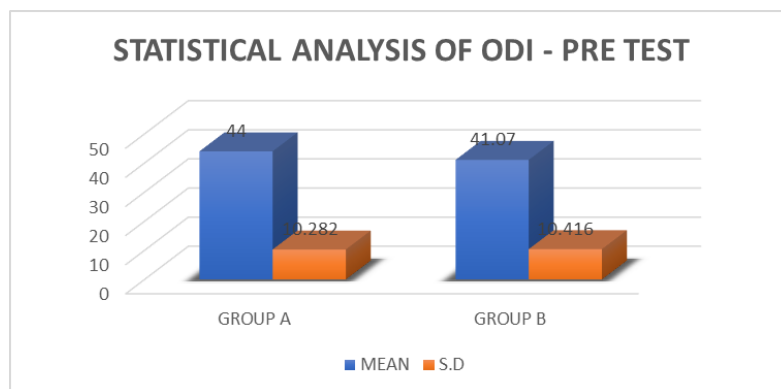
| SLNO | VAS | N | MEAN | S.D | t-value | p-value |
|------|---------|----|------|-------|---------|---------|
| 1. | GROUP A | 15 | 2.93 | 0.99 | 7.339 | .0001 |
| 2. | GROUP B | 15 | 5.80 | 1.146 | | |

Table 4: Inter group post-test comparison of ODI (Between group A and group B)

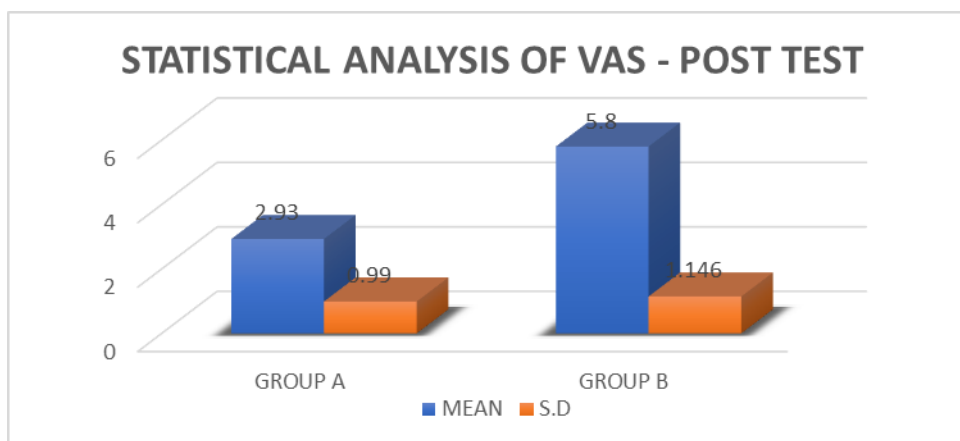
| SLNO | ODI | N | MEAN | S.D | t-value | p-value |
|------|---------|----|-------|--------|---------|---------|
| 1. | GROUP A | 15 | 20.20 | 8.385 | -3.161 | .004 |
| 2. | GROUP B | 15 | 31.33 | 10.761 | | |



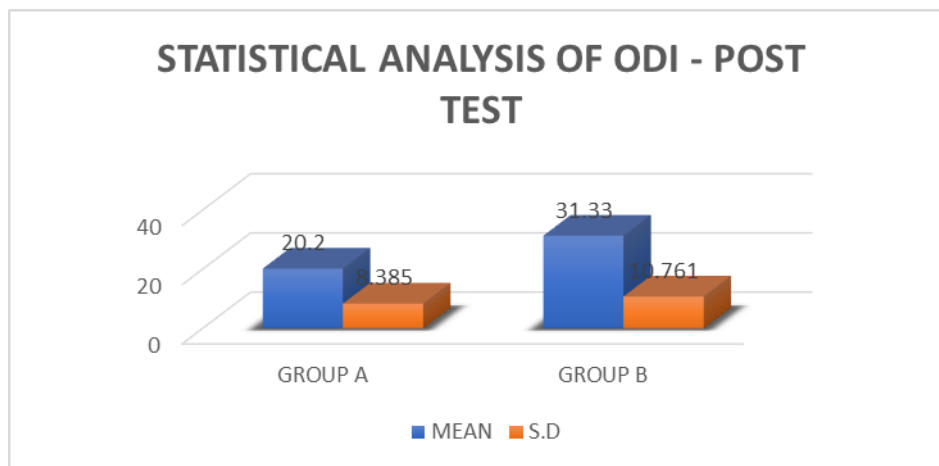
Graph 1: Pre comparison of VAS (Group A & B)



Graph 2: Pre comparison of ODI (Group A & B)



Graph 3: Post comparison of VAS (Group A & B)



Graph 4: Post comparison of ODI (Group A & B)

4. Discussion

The main intent for which the current study was initiated was to compare pilates and core stability in order to reduce pain and functional dysfunction in non-specific pain in the low back patients. Low back pain has been linked to the weakening and dysfunction of the deeper abdominal muscles. Subacute LBP of nonspecific nature, often known as common LBP, is characterised as LBP that cannot be definitively linked to a particular, well-established pathology. For many individuals, pathology or neurological dysfunction cannot be the cause of their discomfort. The study's objectives were to improve functional impairment and strengthen the lower back in both male and female participants with non-specific subacute low back pain.

Patients between the ages of 19 and 35 who had symptoms of non-specific subacute low back pain for a period of 6 to 12 weeks were included in the current

study. A comparison of the efficacy of two therapies, namely pilates and core stabilisation, in treating patients was made. Both groups received the same treatment, known as IFT. Both groups improved during the course of the treatment programme, which lasted six weeks, as determined by the VAS and ODI for functional impairment and pain, respectively.

A few trials focused on subacute non-specific low back pain; in the majority of studies, all therapies were based on acute and chronic non-specific low back pain. Hence, in order to determine the effectiveness of Pilates and core stabilisation on our patients, we conducted a study.

In our study, core stabilisation work out as exercises were administered for a total of six weeks, with pain and functional impairment as outcome measures. This study, which was similar to one by Sung [23], examined two interventions: spinal flexibility exercise

Journal of Coastal Life Medicine

(SFE) and core stability exercise (CSE), and it was shown that the level of disability decreased following the CSE intervention.

According to Gauri Shankar et al.^[24]'s research on core stability training, both Swiss ball and non-Swiss ball core stabilisation exercises are equally effective at enhancing trunk endurance.

The Pilates approach has been shown in another study by Pappas et al.^[25] to be effective in reducing pain and enhancing function for persons with CLBP when compared to no intervention.

In our study, functional impairment and pain severity were assessed using the VAS and the ODI questionnaire. The efficacy of two active interventions—Pilates and conventional—was compared in patients with non-specific low back pain (NSLBP) over the course of three months in a study that is comparable to that conducted by Manikandan et al. [26]. By the completion of the interventional programme, both groups had experienced changes in their pain scores as measured by the Modified Oswestry Questionnaire, Patient Specific Functional Scale (PSFS), and Visual Analogue Scale (VAS) (ODI). The effectiveness of Pilates technique in adults with chronic non-specific low back pain was established.

The Pilates method and doing nothing to exercise were compared similarly by da Fonseca et al. [27] and Alves de Araujo et al. [28]. Data were collected both before and after the intervention for the Pilates group in da Fonseca's study, which included 15 Pilates sessions. Following the intervention, the Pilates group showed a sizable decrease in pain, whereas the no-Pilates group did not. 31 female students with scoliosis were divided into two groups in the study by Alves de Araujo: CG = 11, which received no therapeutic intervention, and EG = 20, which received Pilates-based therapy. The Pilates group's discomfort was significantly reduced following the session. (P 0.0001).

The Pilates is a interacted mind-body exertion that emphasises centre stability, strength, muscle control, flexibility, breathing, and posture, according to the literature. With the Pilates method, the pelvis and lower back are dynamically balanced using the trunk muscles.

Flexibility may have increased as a result of Pilates exercises, which may or may not be the case. Stretching

several short muscles leads to improved flexibility, which promotes fluid motion at multiple-level joints. Strengthening is a further benefit of pilates practise^[29].

In this study, pilates is helpful for treating patients in NSLBP, including the pre test mean value of VAS between group A (pilates) 7.60 and group B (core stabilization) 7.67, did not show a significant difference. At the end of the treatment session, the post test mean value showed a significant difference between group A (pilates) 2.93 and group B (core stabilization) 5.80. In group A (pilates) VAS shows better result than group B (core stabilization).

In this study, pilates is helpful for treating patients with non specific sub acute low back pain, including the pre test mean value of ODI between group A (pilates) 44 and group B (core stabilization) 41.07, did not show a significant difference. At the end of the treatment session, the post test mean value showed a significant difference between group A (pilates) 20.20 and group B (core stabilization) 31.33. In group A (pilates) ODI shows better result than group B (core stabilization).

As Pilates exercise involves breathing, concentration, centering, control, precision and following movements. It makes essential to assess the effectiveness of these principles on pain reduction and functional ability of the individual against core stabilization exercise which focuses only on stability, conditioning and strengthening aspects alone.

The study's findings were statistically supported by the described data, such as mean and standard deviation, which showed that both groups had improved in terms of pain relief and functional ability by the end of the treatment. When the study's findings from the two groups were compared, Pilates exercise (Group A) demonstrated much greater benefits than core stabilization exercise (Group B).

5. Recommendations

To experiment with larger sample size and control group.

Long term effects of the exercise need to be observed with longer study duration.

To perform a study with equal gender distribution to obtain unbiased results.

Study can be done by including different treatment protocol.

6. Conclusion

The study's data were statistically analysed, and the results showed that coastal individuals with non-specific subacute low back pain saw a greater improvement in pain and functional impairment following pilates exercise than they did following core stabilisation exercise. It can be stated that, when compared to core stabilisation exercise, pilates exercise, a type of special education, proved to be better choice of exercise for non-specific subacute low back pain.

Reference

- [1] Balagué, Federico, et al. "Non-specific low back pain." *The Lancet* 379.9814 (2012): 482-491. Level of evidence 1A
- [2] Burton AK, Tillotson KM, Main CJ, Hollis S. Psychosocial predictors of outcome in acute and subchronic low back trouble. *Spine (Phila Pa 1976)*. 1995 Mar 15;20(6):722-8. Level of evidence 3C
- [3] Prabhu, L. V., et al. "Vertebral body integrity: a review of various anatomical factors involved in the lumbar region." *Osteoporosis international* 18.7 (2007): 891-903. Level of evidence 2A
- [4] Fortin, Maryse, and Luciana Gazzi Macedo. "Multifidus and paraspinal muscle group cross-sectional areas of patients with low back pain and control patients: a systematic review with a focus on blinding." *Physical therapy* (2013). Level of evidence 2A
- [5] Burton AK, Tillotson KM, Main CJ, Hollis S. Psychosocial predictors of outcome in acute and subchronic low back trouble. *Spine (Phila Pa 1976)*. 1995 Mar 15;20(6):722-8. Level of evidence 3C
- [6] Truchon M. Determinants of chronic disability related to low back pain: towards an integrative biopsychosocial model. *Disabil Rehabil*. 2001 Nov 20;23(17):758-67. Level of evidence 2B
- [7] Damian Hoy, Lyn March, Peter Brooks, Fiona Blyth, Anthony Woolf, Christopher Bain, Gail Williams, Emma Smith, Theo Vos, Jan Barendregt, Chris Murray¹¹, Roy Burstein¹¹, Rachelle Buchbinder. The global burden of

Funding

No source of funding.

Author Contribution Statement

Text preparing, Data collection and Result by Abitha.T. Communication, design and concept by Murugaraj.T. Overall supervision and design suggestion by Shanmuganath.E

Conflict of Interest

none.

10. IHEC approval – Yes

- low back pain: estimates from the Global Burden of Disease 2010 study. *Ann Rheum Dis* 2014;73:968-974. Level of evidence 2A
- [8] David Health Solutions Ltd. "Non-specific Low Back Pain – Diagnosis and Treatment – Pain Relief." David, davidhealth.com/patient-information-for-pain-relief/back-or-neck-pain-diagnosis-and-treatment/acute-low-back-pain. Accessed 15 Mar. 2023.
- [9] Dagenais S, Tricco AC, Haldeman S. Synthesis of recommendations for the assessment and management of low back pain from recent clinical practice guidelines. *Spine J* 2010; 10: 514–29.
- [10] Chou R. Pharmacological management of low back pain. *Drugs* 2010; 70: 387–402.
- [11] McCarberg BH. Acute back pain: benefits and risks of current treatments. *Curr Med Res Opin* 2010; 26: 179–90.
- [12] Dagenais S, Tricco AC, Haldeman S. Synthesis of recommendations for the assessment and management of low back pain from recent clinical practice guidelines. *Spine J* 2010; 10: 514–29.
- [13] Savigny P, Kuntze S, Watson P, et al. Low back pain: early management of persistent non-specific low back pain. London: National Collaborating Centre for Primary Care and Royal College of Physicians, 2009. <http://www.nice.org.uk/nicemedia/live/11887/44334/44334.pdf> (accessed Oct 18, 2010).
- [14] Quentin C, Bagheri R, Ugbole UC, Coudeyre E, Péliissier C, Descatha A, Menini T, Bouillon-Minois JB, Dutheil F. Effect of Home Exercise Training in Patients with Nonspecific Low-Back Pain: A Systematic Review and

Journal of Coastal Life Medicine

- Meta-Analysis. International Journal of Environmental Research and Public Health. 2021 Jan;18(16):8430.
- [15] Oxford Dictionaries, Definition of Pilates in English. Available from: <http://oxforddictionaries.com/definition/english/Pilates> (accessed 20 Oct 2013).
- [16] Pilates Method Alliance, An Exercise in Balance: The Pilates Phenomenon. Available from: <http://www.pilatesmethodalliance.org/i4a/pages/index.cfm?pageid=3277> (accessed 20 Oct 2013).
- [17] Di Lorenzo CE. Pilates: what is it? Should it be used in rehabilitation? Sports Health 2011;3(4):352-61. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23016028> (accessed 20 Oct 2013).
- [18] Giacomini MB, da Silva AM, Weber LM, Monteiro MB. The Pilates Method increases respiratory muscle strength and performance as well as abdominal muscle thickness. Journal of bodywork and movement therapies. 2016 Apr 1;20(2):258-64.
- [19] Notarnicola A, Fischetti F, Maccagnano G, Comes R, Tafuri S, Moretti B. Daily pilates exercise or inactivity for patients with low back pain: a clinical prospective observational study. Eur J Phys Rehabil Med 2013. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/24104699> (accessed 20 Oct 2013).
- [20] Quinn K, Barry S, Barry L. Do patients with chronic low back pain benefit from attending Pilates classes after completing conventional physiotherapy treatment?. Physiotherapy Practice and Research. 2011 Jan 1;32(1):5-12.
- [21] Cakmakçi O. The effect of 8 week pilates exercise on body composition in obese women. Coll Antropol 2011;35(4):1045-50. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/22397236> (accessed 20 Oct 2013).
- [22] COMMUNITY EVENTS. "The Importance of Core Stabilization Exercises - Bon Secours InMotion." Bon Secours InMotion, 5 Aug. 2011, www.bonsecoursinmotion.com/the-importance-of-core-stabilization-exercises.
- [23] P. S. Sung, "Disability and back muscle fatigability changes following two therapeutic exercise interventions in participants with recurrent low back pain," Medical Science Monitor: International Medical Journal of Experimental and Clinical Research," vol. 19, pp. 40-48, 2013.
- [24] Gauri Shankar, Vinod Chaurasia. Comparative Study of Core Stability Exercise with Swiss Ball in Improving Trunk Endurance. Int J Health Sci Res. 2012;2(5):56-63.
- [25] Pappas E, Panou H, Souglis A. The effect of a pilates exercise programme using fitball on people suffering from chronic low-back pain in terms of pain reduction and function improvement. J Phys Edu Sport 2013; 13:606-611.
- [26] Manikandan et al: Effectiveness of Pilates exercises on non-specific low back pain to determine pain and disability Biomedicine- Vol. 41 No. 4: 2021 <https://doi.org/10.51248/v41i4.1361>
- [27] da Fonseca JL, Magini M, de Freitas TH. Laboratory gait analysis in patients with low back pain before and after a pilates intervention. J Sport Rehabil 2009; 18:269-282.
- [28] Alves de Araujo ME, Bezerra da Silva E, Bragade Mello D, et al. The effectiveness of the Pilates method: reducing the degree of non-structural scoliosis, and improving flexibility and pain in female college students. J Bodyw Mov Ther 2012; 16:191-198.
- [29] Belavy DL, Owen PJ, Miller CT, Mundell NL, Tagliaferri SD, Brisby H, et al. Response to discussion: 'Which specific modes of exercise training are most effective for treating low back pain? Network meta-analysis'. Br J Sports Med. 2021;55:287-288.
- [30] Batıbay S, Külcü DG, Kaleoğlu Ö, Mesci N. Effect of pilates mat exercise and home exercise programs on pain, functional level, and core muscle thickness in women with chronic low back pain. J Orthop Sci. 2020.