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A comparative study on the role of pilates exercise program and conventional exercise program in managing non-specific low back pain and improving the flexibility among postmenopausal women

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Abstract

Low back pain (LBP) is a common condition affecting postmenopausal women, particularly those aged between 45-60. The period after menopause brings about significant hormonal changes, most notably a reduction in estrogen levels, which can negatively affect bone density, muscle mass, and joint health. These changes increase the risk of musculoskeletal issues such as LBP, which can become chronic and debilitating if not managed properly. For postmenopausal women, LBP is not just a health issue but also a social and economic concern. The pain often interferes with daily activities, limiting physical mobility, work productivity, and overall quality of life. This in turn may lead to increased healthcare costs due to more frequent doctor visits, pain management interventions, and potentially long-term medication use. Pilates, a form of low-impact exercise that emphasizes core strength, flexibility, and postural alignment, has been found to be especially beneficial for women in the postmenopausal phase. Pilates exercises focus on controlled movements, deep core stabilization, and breathing techniques, all of which contribute to strengthening the muscles that support the spine. The evidence supporting the benefits of Pilates for postmenopausal women suffering from LBP is compelling. Its focus on core strength, flexibility, and postural alignment directly addresses the musculoskeletal issues brought on by menopause, making it an effective and holistic approach to managing pain. Beyond pain relief, the incorporation of Pilates into the routine of postmenopausal women can improve their physical health, reduce medication use, and enhance their overall well-being. This makes it an important and highly recommended exercise intervention for women in this stage of life.

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Introduction

Low back pain (LBP) presents a significant challenge in today's society, impacting both social and economic spheres. Postmenopausal women, who have undergone menopause, may experience certain changes in their bodies that could contribute to or influence lower back pain. It's important to note that the hormonal changes and aging processes associated with menopause can contribute to musculoskeletal issues.

Musculoskeletal pain, particularly prevalent among adults, is a common issue, especially affecting women according to Bingefors *et al.* in 2004 and Wijnhoven *et al.* in 2006. LBP is highly prevalent and tends to increase with age, peaking in one's sixth decade (Hoy *et al.*, 2010; Manchikanti *et al.*, 2014). It significantly impacts individuals' physical and psychological well-being, leading to work absences and substantial socioeconomic costs. Despite various treatments available for LBP, their effectiveness is not fully established as per Manchikanti *et al.* in 2014 and Bachmann *et al.* in 2013. Physical activity is recommended as a beneficial intervention for managing sub-acute or non-specific LBP (van Tulder *et al.*, 2002; Lizier *et al.*, 2012) by daily doing of pilates exercises (Notarnicola *et al.*, 2014; Saner *et al.*, 2015). LBP significantly diminishes as said by Notarnicola and Saner. The individuals' quality of life and productivity, with women, particularly after menopause, being more susceptible by doing the Pilates Exercises (Werner *et al.*, 2009; Rolli Salathé *et al.*, 2012). It is a significant global public health concern, causing considerable pain and functional impairment. LBP imposes a significant economic burden and negatively affects individuals' physical, mental, and emotional health (Shaw *et al.*, 2011; Dixit, 2017; Wang *et al.*, 2017). In India, the prevalence of LBP is alarming, affecting a large portion of the population at some point in their lives (Kozinoga *et al.*, 2015). In 2020, the World Health Organization (WHO) reported that LBP impacted 619 million individuals globally, with projections indicating a rise to 843 million cases by 2050 due to population growth and aging as said in Global burden of studies in 2021. The prevalence of LBP rises with age, peaking around 50–55 years, and is more common among women Global burden of studies in 2019. Risk factors for non-specific LBP include low levels of physical activity, smoking, obesity, and high physical stress at work (Rydeard *et al.*, 2006).

Postmenopausal women face a heightened susceptibility to osteoporosis, a condition marked by diminished bone density. Weakening of the bones can contribute to fractures and may lead to back pain (Latey *et al.*, 2002). Maintaining regular physical activity and strength training can help mitigate these effects (Bird *et al.*, 2012). Some women may experience weight gain during and after menopause. Excessive weight potentially leading to discomfort and declining estrogen levels during menopause can influence the body's reaction to pain and inflammation (Caldwell *et al.*, 2008) and in over time, leading to conditions like degenerative disc disease (Curnow *et al.*, 2009) causing pain in the lower back. As individuals age, the likelihood of developing osteoarthritis rises and has the potential to impact the spinal joints, resulting in lower back discomfort (Sowers *et al.*, 2007). Therapeutic options for non-specific LBP encompass medications, physical interventions to bolster muscle strength and mobility, psychological and social aid to facilitate pain management and activity resumption, and lifestyle modifications, such as increased physical activity, a nutritious diet, and improved sleep habits (Martin *et al.*, 2009; Lee *et al.*, 2016).

Pilates exercise, when synchronized with breath, aims to optimize body potential by rectifying muscle imbalances, achieving ideal alignment, and fostering efficient movement patterns (Marini *et al.*, 2016). It emphasizes core engagement while promoting a balance of strength, mobility, and flexibility, thereby enhancing functional activity and core strength (Natour *et al.*, 2014; K¨uc *et al.*, 2012). Pilates intervention has demonstrated significant improvements in muscle strength, trunk flexibility, and postmenopausal symptoms as per (Gladwell *et al.*, 2006; Rodrigues *et al.*, 2010). It is described as a mind-body exercise that enhances core stability, strength, and flexibility, benefiting personal autonomy and static balance, particularly in elderly females.

Materials and methods

Subjects and procedure

Before recruitment approval was obtained from an institutional research ethics committee .The work has been approved by the appropriate ethical committees (K. A. P. V. Government Medical College Institutional Ethics Committee, KAPV/IEC/221104001 and subjects gave informed consent to the work. The declaration of consent was on par with Helsinki's regulation.

The study is characterized as an experimental study including a randomized control trial - parallel group design – single-blind study, with a total of 80 participants The participants were selected according to their convenient accessibility, and the independent variables included age, body mass index (BMI), height, and weight, while the dependent variables comprised flexibility assessed as a range of motion (ROM) using a goniometer and the Oswestry disability scale, pain using numerical pain rating scale (NPRS), endurance using the Krause Weber test, and QOL through the Menopause-Specific Quality of Life (MENQOL) Questionnaire. Inclusion criteria encompassed females of the age group between 45 to 56 years diagnosed with Menopause, and postmenopausal women experiencing non-specific LBP without a specific identifiable cause. Postmenopausal women with non-specific LBP experienced for duration of three months. Postmenopausal women with a severity of pain of more than 5 as assessed in the NPRS. Post-menopausal women who have not responded adequately to previous physiotherapy modalities.

Postmenopausal with functional limitation and decreased ability to perform the work due to low back pain as assessed by Oswestry Disability Index (ODI) score of less than 40. Decreased QOL due to LBP as assessed by MENQOL Questionnaire score more than 40. Exclusion criteria involved subjects aged more than 57, premenopausal women, women with psychological pain, menopause women diagnosed with lumbar fractures, menopausal women who have undergone any lumbar surgery, stroke, spinal cord pathology, inflammatory joint disease, lumbar spine infection, marked osteoporosis, lumbar spine cancer, congestive heart failure, uncontrolled hypertension, pacemaker, internalized metal stent, lack of cooperation, an inability to read and write, or unwillingness to participate.

Conduction of study

The study was conducted in the outpatient Physiotherapy department of Shri Indra Ganesan Institute of Medical Science College of Physiotherapy, Trichy, Tamil Nadu, India. In the current study, the effectiveness of the Pilates exercise program for non-specific low back pain among post-menopausal women is investigated. Eighty postmenopausal women with non-specific low back pain were selected and were randomly divided into two groups viz. group 'A' for them, Pilates exercise training along with the warming up exercise was given (experimental group) and group 'B' for them normal conventional exercise along with the warming up exercise was given (control-conventional group). Baseline measurements were recorded, including age, BMI, height, and weight. Subjects were assessed for flexibility as ROM using a goniometer and the Oswestry disability scale, pain using NPRS, endurance using the Krause Weber test, and QOL through the MENQOL Questionnaire.

Intervention

The following treatment method was adapted to the patients:

Group A: Experimental group

i. Pilates exercise program (The hundred, side kick, roll on, spine stretch and saw)

ii. Warming up exercises (arm swing, side stretch and leg circles)

Group B: Control-conventional group

i. Conventional exercise program (bridging, partial curls, drawing in manuver, lateral leg rises and Superman)

ii. Warming up exercises

iii. Note: The treatment was administered for 12 weeks, 3 days a week

Statistical analysis

Statistical analysis was conducted using SPSS software version 21 (IBM Corporation, Armonk, New York). Data was presented as Mean ± standard deviation. A predetermined significance level (alpha), such as $p < 0.05$, was utilized to assess the statistical significance of the findings. A statistically significant difference indicated a meaningful impact of Pilates on the dependent variables. After the completion of the study, the collected data from both Group A (experimental) and Group B (control-conventional) were subjected to data analysis using appropriate statistical methods. The statistical analysis is categorized into two sections: (i) within-group analysis and (ii) between-group analysis. Within-group analysis was conducted using Wilcoxon's signed rank test, while between-group analysis utilized Mann Whitney's 'U' test and the independent unpaired "t" test.

Results

Analysis of pain score NPRS within group comparison

The evaluation of pain was measured by the NPRS. The pain score was compared at baseline (start of the study) and post-treatment (completion of the study period) within groups using Wilcoxon's signed rank test as the variables were non-normally distributed (Table 1).

Table 1. Numerical pain rating scale – within group analysis

Groups pre & post measurement		NPRS – pre and post-treatment comparison						
		Shapiro-Wilk test of normality		M	S.D.	M.D.	Wilcox on signed rank test	
		Value	P				Z	P
A	Pre	0.80	0.001*	7.2	0.75	2.5	5.51	0.0001*
	Post	0.83	0.001*	4.7	0.85			
B	Pre	0.82	0.002*	6.97	0.96	1.12	4.85	0.0001*
	Post	0.83	0.004*	5.85	0.72			

Group A-Experimental group, Group B – Control group, M – Mean, S.D. – Standard Deviation, M.D. – Mean Difference, z – Test statistics ; p – Probability value; * - Significant

Table 2. Krause Weber test – within group analysis

Groups pre & post measurement		Krause Weber test – pre and post-treatment comparison						
		Shapiro-Wilk test of normality		M	S.D.	M.D.	Wilcoxon signed rank test	
		Value	P				Z	P
A	Pre	0.89	0.001*	6.10	0.96	2.37	5.38	0.0001*
	Post	0.90	0.001*	8.47	0.94			
B	Pre	0.84	0.002*	6.30	3.09	1.02	5.08	0.0001*
	Post	0.86	0.001*	7.32	2.37			

Group A-Experimental group, Group B – Control group, M – Mean, S.D. – Standard Deviation, M.D. – Mean Difference, z – Test statistics ; p – Probability value; * - Significant

The mean pre-score for group 'A' patients was 7.2 ± 0.75 whereas it was significantly improved to 4.7 ± 0.85 post-treatment, the mean difference was 2.5, $z = 5.51$, $p = 0.0001 < 0.05$. The mean pre-score for group 'B' patients was 6.97 ± 0.96 and it was improved significantly to 5.85± 0.72 following the end of treatment sessions, $z = 4.85$, $p = 0.0001 < 0.05$, the mean difference was 10.37, $z = 4.85$, $p = 0.0001< 0.05$.

Analysis of Krause Weber test

It's a six-item medical fitness assessment evaluating the strength and flexibility of essential postural (core) muscles. The test includes five strength tasks and one overall flexibility procedure. A modified scoring approach allows partial movements, with scores ranging from 0 to 10, where higher scores reflect better function and vice versa. It was recorded before the commencement of the study and again after the completion of the study period. The pre-post comparison of Krause Weber score was evaluated by Wilcoxon's signed rank test after ascertaining the normality of the distribution. The analysis is presented in Table 2. The mean pre-score for group 'A' patients was 6.10 ± 0.96 whereas it was significantly improved to 8.47 ± 0.94 post-treatment, the mean difference was 2.37, z = 5.38, p = 0.0001 < 0.05. The mean pre-score for group 'B' patients was 6.30 ± 3.09 and it was improved significantly to 7.32 ± 2.37 following the end of treatment sessions, z = 5.08, p = 0.0001 < 0.05, the mean difference was 1.02, z = 5.08, p = 0.0001< 0.05.

Analysis between groups comparison of measurements

The post values of the experimental and control groups that is A and B of the Lumbar ROM, the ODI, MENQOL scores, and Krause Weber values were calculated separately for two groups. The data was scored in the Shapiro Walk test of Normality, and unpaired t-test and the results are interpreted below. The mean differences in the shoulder ROM between groups were studied using the Mann-Whitney 'U' test.

Analysis of NPRS, ODI score, MENQOL score, and Krause Weber score between the group

Analyzing the level of pain through the NPRS, the level of flexibility and disability through the Oswestry Disability score, the level of improved quality of life through the MENQOL questionnaire, and the level of improved endurance through the Krause Weber test.

NPRS, ODI, MENQOL, Krause Weber - between group analysis

The level of pain is analyzed through the Numerical pain rate scale, the level of flexibility and disability through the Oswestry Disability score, the level of improved quality of life through the Menopause Quality of Life questionnaire, and the level of improved endurance through the Krause Weber test (Table 3).

Table 3. NPRS, ODI, MENQOL, Krause Weber - between group analysis

Groups	Scales	Shapiro Walk test of normality		MD	Mann – Whitney U test		Unpaired T test	
		Value	P		Z	P	T	P
A	NPRS	0.83	0.001*	1.07	3.46	0.0005*	6.0001	0.0001*
B	NPRS	0.84	0.004*					
A	ODI	0.92	0.001*	3.42	-3.58	0.0003*	2.439	0.0001*
B	ODI	0.91	0.004*					
A	MENQOL	0.91	0.001*	4.05	-2.74	0.0061*	3.24	0.0001*
B	MENQOL	0.87	0.004*					
A	Krause weber	0.90	0.001*	1.13	4.68	0.0001*	5.47	0.0001*
B	Krause weber	0.86	0.001*					

From the Table 3, the values of intensity of pain from NPRS for group 'A' was 0.83 and p = 0.001 was reduced compared to group B of 0.84 and following post-treatment, z = 3.46, p = 0.0005, and the mean difference was 1.07. There was a significant decrease in pain in group 'A' of two-tailed t = 6.0001, the two-tailed p-value of P = 0.0001 < 0.05, estimated as statistically significant. The values of disability and flexibility from the ODI scale for group 'A' was 0.92 and p = 0.004 was reduced compared to group B of 0.91 and following post-treatment, z = -3.58, p = 0.0003, and the mean difference was 3.42. A significant improvement was observed in group 'A' of two-tailed t = 2.439, and the two-tailed p-value of P = 0.0001 < 0.05, estimated as statistically significant. The values of QOL from the MENQOL Questionnaire for group 'A' was 0.91 and p = 0.0061 was reduced compared to group B of 0.87 and following post-treatment, z = -2.74, p = 0.0001, and the mean difference was 4.05. A significant improvement was observed in QOL in group 'A' of two-tailed t = 3.24, and the two-tailed p-value of P = 0.0001 < 0.05, estimated as statistically significant. The values of improvement in endurance and strength from the Krause Weber test for group 'A' was 0.90 and p = 0.001 was reduced compared to group B of 0.86 and following post-treatment, z = 4.68, p = 0.0001, and the mean difference was 1.13. A significant improvement was observed in group 'A' of two-tailed t = 5.47, and the two-tailed p-value of P = 0.0001 < 0.05, considered statistically significant (Fig. 1).

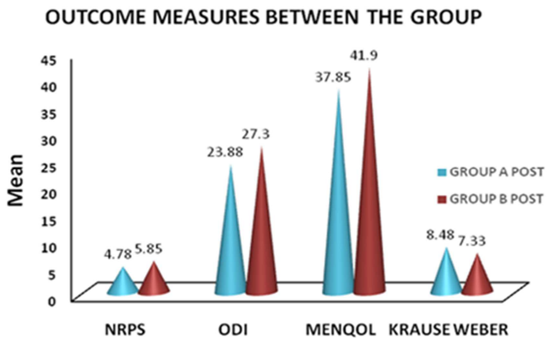

Fig. 1. Outcome measures NRPS, ODI, MENQOL, and Krause Weber between the groups A and B

Discussion

Pilates exercise effectiveness was compared with conventional physical therapy, involving regular back care exercises and warm-up exercises, administered three days a week for 12 weeks. Effectiveness was ascertained by pretreatment and post-treatment comparison of the ROM, NPRS, ODI scale for function and flexibility, QOL of postmenopausal women through the MENQOL questionnaire and Krause Weber test score for the endurance of the lumbar muscles. The comparison was made within as well as between groups. Likewise, the relationship between improvement in pain, function strength, and endurance in the lumbar region was also evaluated.

From the above discussions, we can find out that there is improvement in pain, flexibility, strength, functional status, and QOL of postmenopausal women with non-specific LBP. Both the exercises Pilates and the conventional exercise showed improvement and compared to group B, group A showed significant changes in all outcome variables. Pilates exercise (Haelim Lee *et al.*, 2016; Yu-Hsiu Kao *et al.*, 2014; Laura Horvath, 2023) are more beneficial for postmenopausal women and found significant differences in changes related to postmenopausal symptoms, including vasomotor, mental, and physical symptoms, compared to the control group. Pilates exercise is improving the flexibility, endurance and plays an important part in decreasing the LBP. Thus Pilates help in the flexibility especially for the elderly adult particularly the post-menopausal women.

Conclusion

The findings suggest that Pilates exercise training is more effective than conventional physical therapy in alleviating non-specific LBP and enhancing lumbar function, range of motion, strength, and endurance in post-menopausal women. Exploring the impact of Pilates training during the early stages of postmenopausal symptoms could enhance quality of life. Additionally, Pilates proves beneficial in preventing falls and managing balance in women during later stages of life, offering both static and dynamic balance improvements. Moreover, Pilates may positively influence physical well-being, quality of life, and psychological factors related to fear of falling. Pilates reduces pain by core strengthening, improving spinal alignment, balanced muscle development, dynamic stretching, and controlled movements, encouraging mindfulness and awareness of movement patterns, specific breathing techniques, mind-body connection approach. The gradual progression of exercises can help in proper form to decrease the risk of exacerbating existing pain.

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