Dynamic Neuromuscular versus Lumbopelvic Stabilization Exercises for the Management of Chronic Lumbopelvic Pain in Menopausal Women: A Pilot Randomized Controlled Trial

Sadaf Khan , Jasmine Kaur Chawla

Abstract

Background- Chronic lumbopelvic pain is more prevalent in the female population worldwide. It is mostly attributed to the physiological changes induced in the woman's body during pregnancy and childbirth, which produce biomechanical alterations. Later in the menopausal stage, women tend to have impaired neuromuscular control and pelvic instability, leading to Lumbopelvic pain. Both Dynamic Neuromuscular Stabilization (DNS) and Lumbopelvic Stabilization exercises have demonstrated their therapeutic effects in alleviating pain, but their comparative effectiveness for managing chronic lumbopelvic pain is unknown.

Aims: The study aims to compare the therapeutic effects of lumbopelvic stabilization exercises and the Dynamic Neuromuscular Stabilization exercise protocol in alleviating chronic lumbopelvic pain in postmenopausal women.

Materials and Methods- A pilot randomized controlled trial was conducted on 30 postmenopausal women diagnosed with chronic lumbopelvic pain. Participants were randomly assigned to three groups (n = 10 each): dynamic neuromuscular stabilization (DNS), lumbopelvic stabilization (LPS), and control. The intervention groups received their respective protocols for 20 minutes, 3 times per week, for 4 weeks, while the control group received advice on healthy lifestyle modification. Pre- and post-intervention values of BMI, pain (NPRS), and muscle strength (pressure biofeedback) were analyzed to find a better approach for chronic lumbopelvic pain.

Results: The results showed that both groups are effective for alleviating the chronic lumbopelvic pain, but the DNS had a better prognosis in terms of decrease in Pain (DNS- mean change≈ -5.10, $p < 0.001$ vs LPS - mean change≈ -4.50, $p < 0.001$) and increased muscle strength (Pressure biofeedback DNS-mean change≈ +8.60, $p<0.001$ vs LPS - mean change≈ +5.90, $p < 0.001$).

Conclusion: DNS has more promising therapeutic effects and may offer additional benefits by restoring optimal neuromuscular control, lumbopelvic alignment, and postural alignment compared to the LPS group. The findings of this study suggest that DNS can be incorporated into rehabilitation programs for this high-risk population for long-term management.

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Keywords

chronic lumbopelvic pain, lumbopelvic stabilization exercise, Dynamic Neuromuscular Stabilization, obesity, postmenopausal women.

Introduction

Lumbopelvic pain is defined as pain in the lumbar spine and pelvic region, which includes the lumbar spine, sacroiliac joints, pelvis, or surrounding soft tissues [1,2]. Postpartum lumbopelvic pain (LBPP) is the most common occurrence in women [3], primarily due to ligament laxity and postural changes [4]. During pregnancy, hormonal shifts cause ligament laxity and structural misalignment in the lumbar spine, increasing lordosis as a result of weight gain [5,6]. These factors eventually lead to instability in the lumbopelvic region [7,8]. All these changes predispose women to decreased core muscle function, ultimately resulting in lumbopelvic pain[9].

The prevalence of musculoskeletal pain in women worldwide is 35%, out of which 29% is chronic lumbopelvic pain [2,3,10,11,] .77.8% of postmenopausal women suffer from LPP, and in the Indian population itself, it has been found to affect 70.4% of post- menopausal women [2,12,].

The exact pathological cause of lumbopelvic pain remains unknown [2,]as it's considered multifactorial because it is affected by biomechanical, hormonal, and neuromuscular factors [13]. It is often attributed to the pregnancy and childbirth-induced physiological changes in the body of the woman over the years [8,14,]. Ultimately leading to impaired core stability, altered neuromuscular control, and lumbopelvic asymmetry [1,15,16] . Despite high prevalence, there is a lack of evidence-based, effective therapeutic interventions that may provide long-term symptomatic relief. Current studies conducted on LPP reveal a gap in the literature in terms of management strategies for the menopausal women.

Dynamic Neuromuscular Stabilization exercises is based on developmental kinesiology as well as reflexive core activation[17], while Lumbopelvic Stabilization emphasizes strengthening of the core muscle group[18], both have proved to be beneficial for many musculoskeletal ailments. Studies are suggestive of the beneficial effects of targeted stabilization approaches, such as lumbopelvic Stabilization and Dynamic Neuromuscular stabilization, which have shown improvements in pain alleviation, posture control, and functional control, but their comparative efficacy as a therapeutic remedy for chronic lumbopelvic pain in menopausal women remains undiscovered.

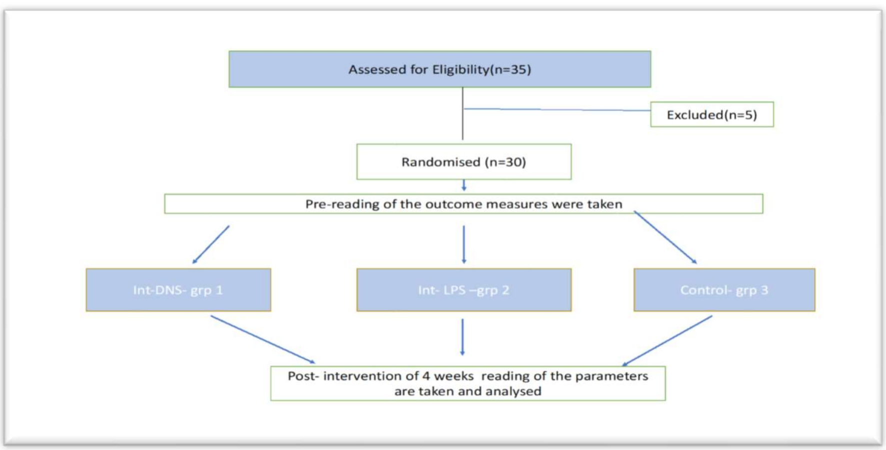
This study aims to interpret the effectiveness of the menopause population-specific exercise protocol of the interventions for the alleviation of chronic lumbopelvic pain. The objective is to find the effectiveness of the menopause population-specific exercise protocols, compare them, and validate the protocol for the alleviation of chronic lumbopelvic pain, its effect on obesity, and abdominal muscle strength. Hence, the experimental hypothesis is that there is a significant difference in the pre-post intervention values of LPP, obesity, and abdominal muscle strength.

Materials and Methods-

This pilot study is a Pilot randomized controlled trial adhering to the CONSORT guidelines. It is conducted to evaluate the effectiveness of the Dynamic neuromuscular stabilization exercise versus the Lumbopelvic stabilization exercise protocol for menopausal women. The research is approved by the Institutional Ethical Committee of Manav Rachna International University and is conducted on the campus. A convenient sampling method is opted for sample population selection. The inclusion criteria comprise menopausal women with cessation of menses for a year, who are suffering from chronic lumbopelvic pain for more than three months. Women of the age group 40-55 years having a BMI more than 23 (classified as overweight/obese) [19]. Informed consent was obtained from the 24 women who fulfilled the inclusion criteria and were willing to finish the protocol. The women with a history of recent trauma or any surgery, mainly fractures, abdominal surgery, or hysterectomy, any spinal injury or deformity, radiculopathy or inflammatory pathology of the spine, or neurological or systemic conditions (e.g., rheumatoid arthritis, fibromyalgia) are excluded. Screening of participants was conducted as per the inclusion criteria, and the women who were willing to finish the protocol duration were only recruited.

Protocol- A four-week exercise protocol was demonstrated to participants in the respective intervention groups, with the same dosing schedule of 3 times per week for 20 minutes. Demographic data and informed consent were obtained from the sample population. Pre-intervention readings were taken of the outcome measures, which include Pain (Numeric Pain Rating Scale that is calibrated from 1-10, Abdominal Muscle strength assessed through the isometric contraction of the Transverse abdominis muscle through the Pressure Biofeedback unit, and also obesity, by measuring the weight changes in kg that may develop and be evaluated in terms of BMI (in kg/m^2). The BMI was recorded as a secondary anthropometric variable. Both the intervention exercises were designed according to menopausal population-specific requirements to target the Lumbopelvic musculature, which may help restore biomechanical alignment for the treatment and prevention of chronic lumbopelvic pain. Both exercise protocols are designed in a progressive manner, with initial contraction and later progressive strengthening of the musculature.

Fig. 1 CONSORT Flow Diagram



Interventions

Group one was demonstrated dynamic neuromuscular stabilization exercises protocol for eight weeks with the progression for the dosimetry of 20 min per day for 3 days per week. Week1&2 exercises lay emphasis on Foundational Stabilization and Breathing Retraining. It includes 3 exercises, namely the Supine 3-Month-Old Position, Diaphragmatic Breathing with Abdominal Wall Activation, and Side-Lying Position with Ribcage Expansion. Week 3&4 exercises were based on Core Activation and Dynamic Stabilization. It includes three exercises namely Quadruped Position with Diaphragmatic Breathing, Quadruped Rocking and Wall-Supported Squat with DNS Breathing. Week 5&6 e &r6 exercises e for Advanced Stability and Functional Movements, which include Modified Bear Position (Kneeling on All Fours), Rolling Pattern Activation, and Bird Dog with DNS Breathing. Week 7&8 exercises were for functional Integration and Stability in Dynamic Tasks. It includes Dead Bug in DNS 3-Month-Old Position, lunge with DNS core engagement and DNS Plank with Shoulder Taps**.**

Group two demonstrated the Lumbopelvic Stabilization exercises for the same dosimetry of 8 weeks, 3 days per week. Week 1&2 exercises were included to activate the muscles and achieve stability.

They include Abdominal hollowing (Drawing-in Maneuver), Alternate Leg Raise with core stabilization (Marching), Isometric Gluteal Squeezes, and the Clamshell. Week 3-6 exercises were incorporated for achieving stability and building endurance through exercise progression. The exercises included are Clamshell progression, Gluteal Bridge progression, Pelvic tilts- (antero-posterior), Wall-supported Mini squats, Modified Dead Bug (with single limb). The week 7&8 exercises are to bring the dynamic control with strengthening and Functional movements. They are inclusive of Dead Bug (with alternate limbs), Side-lying hip abduction (Clamshell progression), Bridging Progression - Single-leg Bridge (Gluteal bridge progression), Side plank with knees supported, and Bird Dog- (Quadruped Arm and leg reach).

Group three comprises the control group that continued with their daily routine. All the groups were sensitized for healthy lifestyle modifications for the menopausal age like instructions for a proper, balanced diet rich in proteins and nutrients. Additionally, certain precautions while lifting anything heavy, wearing the proper footwear, and using proper ergonomics for daily life activities, such as sitting with a straight back or avoiding standing in one place for too long. After the four weeks, post-intervention reading was taken from all the groups for the statistical evaluation.

Statistical Analysis

The data were collected and analyzed through IBM SPSS software (Statistical Package of Social Science). A p-value of less than 0.05 was considered significant, and a parametric test was applied for analysis. For the within-group Paired t-test was performed, while for the pre-post values analysis, One-way ANOVA is used.

Results

The sample population of obese post-menopausal women with chronic lumbopelvic pain was allocated to three groups: Control (lifestyle advice), DNS, and LPS. The Shapiro-Wilk test was used to assess the normality of the data, and the baseline characteristics were analyzed.

Table 1. Within-group paired t-tests for BMI, pain, pressure biofeedback
(n = 10 per group)

Variable	Group	t statistic	p value	Mean change (Post − Pre)
BMI	Control	—	—	0.00
BMI	DNS	13.37	<0.001	−0.87
BMI	LPS	7.65	<0.001	−0.52
Pain	Control	1.50	0.168	−0.20
Pain	DNS	21.86	<0.001	−5.10
Pain	LPS	16.74	<0.001	−4.50
Pressure biofeedback	Control	−1.00	0.343	0.10
Pressure biofeedback	DNS	−25.30	<0.001	8.60
Pressure biofeedback	LPS	−32.87	<0.001	5.90

Note:

- Abbreviations: BMI – Body Mass Index; DNS – Dynamic Neuromuscular Stabilization; LPS – Lumbopelvic Stabilization exercises.
- ‘Pressure biofeedback’ refers to pressure readings obtained using a pressure biofeedback unit as an indirect measure of Transversus abdominis isometric activation. Mean change refers to the difference between post-intervention and pre-intervention values.
- ‘—' indicates no variability in change scores, hence no t-test computed

Within-group changes in pain, muscle activation, and BMI (Table-1): In the control group, there was no meaningful improvement in any primary outcome across the intervention period. Pain scores showed only a small, non-significant reduction (mean change ≈ −0.20, p = 0.168), while BMI also remained unchanged (mean change = 0.00 for both outcomes), and pressure biofeedback values demonstrated a negligible, non-significant increase (mean change ≈ 0.10, p = 0.343). These findings indicate that lifestyle advice alone was insufficient to alter the chronic lumbopelvic pain, trunk muscle performance, as well as weight or BMI over the four weeks.

Although in contrast, both active interventions demonstrated statistically and clinically relevant improvements in all primary outcomes. In the DNS group, pain decreased substantially (mean change ≈ −5.10, p < 0.001), accompanied by a large increase in pressure biofeedback values (mean change ≈ +8.60, p < 0.001) alongside a modest but significant reduction In BMI (mean change≈ −0.87, p < 0.001).Similarly the LPS group exhibited pronounced reduction in pain

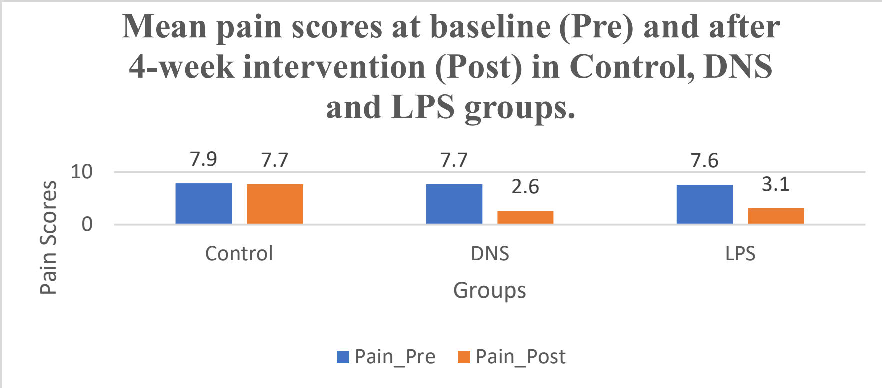


Figure 2: Mean pain scores at baseline (Pre) and after 4-week intervention (Post) in Control, DNS, and LPS groups. DNS and LPS show marked reductions in chronic lumbopelvic pain compared with the control group.

(mean change ≈ −4.50, $p < 0.001$), robust gains in pressure biofeedback (mean change ≈ +5.90, $p < 0.001$), with a smaller yet significant BMI decrease (mean change ≈ −0.52, $p < 0.001$). The direction and magnitude of these within-group changes are visually evident in the pre–post pain trajectories shown in Figure 2

Between-group differences in change scores of (Pre-Post) values (ANOVA) (Table-2): One-way ANOVA on change scores (Pre-Post) revealed significant main

Table 2. One-way ANOVA on change scores (Post – Pre) for BMI, pain, pressure biofeedback

Variable	F statistic	p value	Mean Δ Control	Mean Δ DNS	Mean Δ LPS
BMI	64.92	<0.001	0.00	−0.87	−0.52
Pain	148.36	<0.001	−0.20	−5.10	−4.50
Pressure biofeedback	358.67	<0.001	0.10	8.60	5.90

Note:

- Abbreviations: F statistic – value from the one-way analysis of variance (ANOVA) on change scores
- Δ – Change score, calculated as post-intervention minus pre-intervention for each participant.
- p value – probability associated with the F statistic, with values < 0.05 considered statistically significant.

effects of group for all variables. For pain, the effect of group on change was highly significant ($F \approx 148.36$, $p < 0.001$), with mean pain reductions of −5.10 in DNS and −4.50 in LPS compared to only −0.20 in the control group.

Post-hoc pairwise comparisons of change scores between groups (Table 3): Post-hoc pairwise comparisons (Bonferroni-adjusted) of change scores further clarified which groups differed significantly from one another (Table 3). For all variables, DNS and LPS each differed significantly from the control group (adjusted $p < 0.001$ for Control vs DNS and Control vs LPS across BMI, pain, pressure biofeedback, and pelvic asymmetry), confirming that both exercise-based interventions were superior to lifestyle advice alone (Table 3). When comparing DNS and LPS directly, the magnitude of pain reduction did not differ significantly after correction (adjusted $p \approx 0.327$), despite DNS showing a slightly larger mean decrease, indicating that both protocols produced comparable analgesic effects within the limits of this pilot sample. In contrast, DNS outperformed LPS for BMI and pressure biofeedback, with Bonferroni-adjusted p values indicating significant differences in change scores for these outcomes (e.g., BMI: adjusted $p \approx 0.005$; pressure biofeedback and pelvic asymmetry: adjusted $p < 0.001$). These post-hoc findings have concluded that DNS has consistently exhibited the largest mean improvements, LPS showing intermediate gains, and the control group remains essentially minimally changed.

Conclusion

This Pilot randomized controlled trial has finally concluded the effectiveness of both the Dynamic neuromuscular Stabilization exercise protocol as well as Lumbopelvic Stabilization exercise protocol, which are specifically designed for post-menopausal women to manage chronic lumbopelvic pain for a longer time. Along with the effectiveness of these exercises, the results indicate that the exercise protocol designs are completely safe and effective for menopausal women. Thus, the findings of this study validate both the exercise protocol design. All the exercises are meticulously designed by considering the joint health

Table 3. Post-hoc pairwise comparisons (Bonferroni-adjusted p values) for change scores (Pre– Post treatment)				
Variable	Group means (Δ)	Comparison	'p' value	Bonferroni-adjusted p value
BMI	Control: 0.00 DNS: −0.87 LPS: −0.52	Control vs DNS	<0.001	<0.001
		Control vs LPS	<0.001	<0.001
		DNS vs LPS	0.002	0.005
Pain	Control: −0.20 DNS: −5.10 LPS: −4.50	Control vs DNS	<0.001	<0.001
		Control vs LPS	<0.001	<0.001
		DNS vs LPS	0.109	0.327
Pressure biofeedback	Control: 0.10 DNS: 8.60 LPS: 5.90	Control vs DNS	<0.001	<0.001
		Control vs LPS	<0.001	<0.001
		DNS vs LPS	<0.001	<0.001

Note:

- Abbreviations: Δ denotes the change score calculated as post-intervention minus pre-intervention for each participant.
- Group means (Δ) are reported for descriptive purposes.
- Post-hoc p values based on pairwise comparisons of change scores between groups using independent-samples t-tests, with Bonferroni adjustment applied for three comparisons per variable (Control vs DNS, Control vs LPS, DNS vs LPS).
- Adjusted p values:
  For Control vs DNS and Control vs LPS (all variables), Bonferroni-adjusted p values < 0.001.
  For DNS vs LPS, the adjusted p values by variable were:
  BMI: raw p ≈ 0.0016 → Bonferroni-adjusted p ≈ 0.0047 (still significant).
  Pain: raw p ≈ 0.1091 → Bonferroni-adjusted p ≈ 0.3272 (not significant).
  Pres. Biofeedback: raw p so small that even after ×3 it remains < 0.001.

as well as muscle laxity and weakness, along with decreased bone strength produced in this population due to the hormonal influence of decreased estrogen [], ultimately deteriorating the musculoskeletal health. Even the mental health and Psychological well-being were taken into consideration to ensure that women can perform all the exercises with ease as well as enable them to perform the loads of responsibilities that a woman has to endure. The prerequisites for any exercise demonstration in this high-risk population is safety, as well as ease of performing it, without any financial overload or any instrumental need in the comfort of home as per their own convenience.

Both interventions improved the key clinical outcomes while control group did not show significant improvement is suggestive of that exercise-based rehabilitation can play a crucial role in the alleviation of chronic lumbopelvic pain in this population. DNS performed better in terms of pain than LPS group due to the emphasis on neuromuscular control and reflexive stabilization. DNS improved the coordination of deep trunk muscles as well as enhanced the central motor control eventually contributing to spinal stability and nociceptive input reduction.

BMI on the other hand did not demonstrated any statistical difference as the exercise protocol were designed to induce weight loss but rather improve the neuromuscular function and stabilization. But the exercises were meant to restore the proper biomechanical alignment of the spine by restoring the lumbopelvic rhythm. The increased abdominal muscle strength is indicative of its implication in the long-term use for regaining the proper lumbopelvic mechanical structure by strengthening the weakened musculature.

To conclude, both exercises are effective for chronic lumbopelvic pain management in menopausal women with DNS, demonstrating superior outcomes and results, as a better long-term rehabilitation approach for the chronic lumbopelvic pain in post-menopausal women.

Limitation- The study needs to be conducted with a large sample population for a longer duration of exercise protocol to verify its effectiveness.

Conflict of interest- There is no conflict of interest between authors or any third party.

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