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The Effectiveness of Home-Based Exercises Versus Supervised Core Stability Exercises on Pain and Functional Disability in Controlled Hypertensive Patients with Chronic Mechanical Non-specific Low Back Pain: A Randomized Controlled Trial

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ABSTRACT

Purpose: This study aimed to compare the effectiveness of a home-based exercise program versus a supervised core stability exercise program in treating chronic mechanical non-specific low back pain (CMNSLBP) in patients with controlled hypertension. **Methods:** In this randomized controlled trial, (n=30) hypertensive patients with CMNSLBP were randomly assigned into two Group A (n=15) who received supervised core stability exercises, and Group B (n=15) followed a home-based exercise regimen. Both groups underwent a six-week intervention. Pain intensity was measured using the Visual Analog Scale (VAS; 0–10 cm), lumbar flexion range of motion (ROM) via the Modified-modified Schober test (measured in centimeters from baseline to maximal flexion), and functional disability with the Oswestry Disability Index (ODI; scored 0–100%). Assessments were conducted at baseline and after the 6-week intervention. **Results:** Both groups significantly improved pain intensity, lumbar flexion ROM, and functional disability. Group A's mean VAS score decreased from 7.13 ± 1.07 to 5.13 ± 0.07 ($p<0.001$), while Group B's mean VAS score decreased from 7.13 ± 1.07 to 5.36 ± 0.02 ($p<0.001$). Group A's mean flexion ROM increased from 3.48 ± 0.49 cm to 3.95 ± 0.39 cm ($p<0.001$), and Group B's from 3.45 ± 0.50 cm to 3.92 ± 0.46 cm ($p<0.001$). Group A's mean ODI score decreased from 45.55 ± 1.3 to 32.8 ± 0.83 ($p<0.001$), and Group B's from 44.95 ± 2.00 to 33.1 ± 0.13 ($p<0.001$). Between-group comparisons revealed significantly greater pain reduction in Group A (supervised) vs. Group B (home-based) (P=0.001), lumbar flexion ROM improvement (P=0.02), and functional disability reduction (P=0.01). **Conclusion:** Both supervised core stability and home-based exercise programs effectively reduce pain intensity, improve lumbar flexibility, and decrease functional disability in hypertensive patients with CMNSLBP. Supervised programs offer slightly better outcomes, but home-based programs are a viable, cost-effective alternative. **Trial registration**: NCT06387927, April 25th, 2024. "Retrospectively registered"

Key words: Low Back Pain; Hypertension; Exercise Therapy; Core Strengthening; Home Care

INTRODUCTION

Chronic mechanical non-specific low back pain is a significant cause of disability among adults worldwide (Ebadi et al., 2012; Ebadi et al., 2020). This common musculoskeletal disorder is often linked to minor strains or sprains of the small vertebral joints (Ebadi et al., 2012), which can cause significant discomfort and functional limitations (Doualla et al., 2019). In response to pain, the brain prevents muscle activation in the affected area, leading to reduced muscle control and lower back stability (Doualla et al., 2019; Ka-

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here et al., 2022). This cycle of pain, reduced muscle control, and increased muscle weakness worsen the condition, making effective management a persistent challenge (Thomson et al., 2021; Gilligan et al., 2021). To break this cycle, it is crucial to reactivate these muscles to restore dynamic spine stability and improve functional outcomes (Schwab et al., 2025; Deckers et al., 2018). The etiology of LBP is still up for question, it is believed that a variety of causes contribute to the pain, depending on whether it is specific or nonspecific. A diagnosed pathology, such as a spinal disease, infection, fracture, or muscle strain, will be present in specific LBP. Although there is no clear pathology for NSLBP, it has been hypothesized that the pain may be brought on by a number of factors, such as poor posture, decreased flexibility, a history of injuries, heavy lifting, mental stress, and certain conditions like obesity and hypertension (Smrcina et al., 2022).

The relationship between chronic pain and common disorders such as hypertension has been extensively explored, revealing that individuals with chronic low back pain (LBP) have a 50% higher risk of developing hypertension (Martha et al., 2022; Fu et al., 2023). This comorbidity is significant, as hypertension can further complicate the management of LBP and impact overall health (Huang & Ye, 2024; Kerkhoff et al., 2012). A study in Brazil, which evaluated musculoskeletal complaints, found that males with uncontrolled hypertension receiving medication were more likely to experience chronic musculoskeletal symptoms (Huang & Ye, 2024; Kerkhoff et al., 2012). These findings show the importance of addressing both hypertension and low back pain in the patients.

Depending on patient and physician tolerance, many therapy modalities are used to manage LBP (Smrcina et al., 2022). The objectives of common therapies are similar: massages are meant to encourage musculoskeletal relaxation, whilst modalities can be used to reduce pain. One of the exercises that has shown promise in treating lower back pain (LBP) is core stability. During static, dynamic, and functional tasks, this method aims to retrain deep trunk muscle function and coordination of deep and superficial trunk muscles (Smrcina et al., 2022). It is based on the hypothesis that individuals with lower back pain often experience impaired spinal stability and control (Frizziero et al., 2021). Core stability exercises specifically target deep stabilizer muscles, such as the lumbar multifidus (LM) and the transversus abdominis (TrA). These muscles are crucial in providing segmental rigidity to the spine and increasing intra-abdominal pressure (Frizziero et al., 2021; Hlaing et al., 2021). These exercises aim to enhance the spine's functional stability, which can help reduce pain and improve overall mobility. Home-based exercise regimens offer a feasible, cost-efficient, and long-term effective therapy for chronic back pain. Due to their accessibility and ease of integration into activities of daily living, these protocols can be as successful as regular physical therapy methods and even more effective in the long term (Anar, 2016; Kuukkanen et al., 2007). Home-based exercises encourage patients to actively participate in their recovery, promoting sustained engagement and exercise adherence. While core stability and home-based exercises are widely advocated for low back pain, their comparative efficacy in hypertensive patients remains unexplored. Hypertension exacerbates pain through vascular and musculoskeletal interactions (Huang & Ye, 2024), and cost-effective interventions are critical in resource-limited settings. This study addresses this gap by evaluating whether structured supervision offers clinically meaningful advantages over home-based programs in this population, where comorbidities may necessitate tailored approaches.

Previous studies have primarily focused on the general population with low back pain, leaving a gap in understanding hypertensive patients' specific needs and outcomes (Ebadi et al., 2012; Ebadi et al., 2020). This study aims to compare the effects of a supervised conventional core stability exercise program versus a home-based exercise program on pain and functional disability in controlled hypertensive patients with chronic mechanical non-specific low back pain. The study seeks to provide evidence-based recommendations for optimizing treatment strategies for this unique patient population by addressing this gap.

MATERIALS AND METHODS

Study Design

This prospective, double-blinded, randomized controlled trial (RCT) adhered to CONSORT guidelines. Thirty participants were allocated to two parallel groups using block randomization, stratified by age and gender, to ensure balanced group composition (Figure 1).

Sample size

In this study n=30 hypertensive male and female patients aged between 30 and 50 years, non-athletic, and experiencing low back pain for the past three months participants were included. Exclusion criteria were a history of vertebral fractures, surgical spinal fixation, rheumatic disorders, or any underlying medical condition causing back pain, such as cancer, viscerogenic causes, infection, systemic diseases of the muscles and skeletal system, sensory dysfunction, and neuromuscular diseases like multiple sclerosis.

To determine the sample size, a priori power analysis was conducted using G*Power 3.1 (Faul et al., 2007). Assuming a medium effect size (Cohen's $d = 0.6$), $\alpha = 0.05$, and power = 0.8, a minimum of 12 participants per group was required. To account for potential attrition, 15 participants per group were enrolled.

Randomization and Blinding

Patients were randomly assigned to one of the two groups using a random generator (www.randomization.com). Allocation to the treatment groups was revealed to the patients at enrollment confirmation. All patients were blinded to their group allocation and were unaware of the exercises performed by the other group.

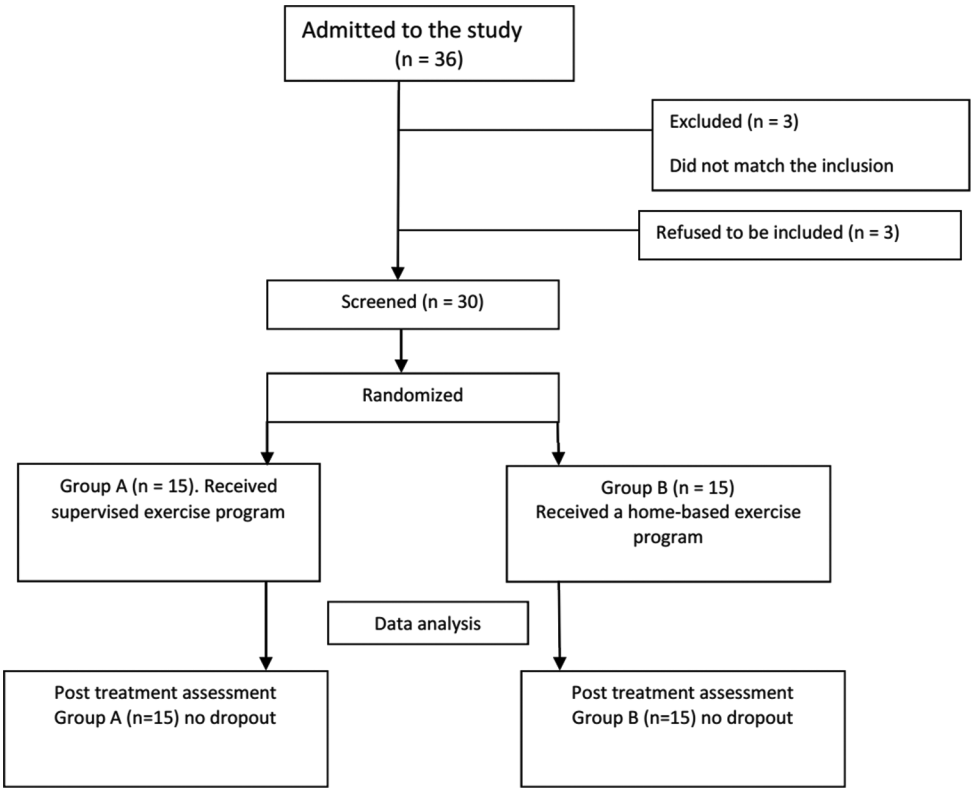

Figure 1. The flow of participants throughout the trial

Interventions

Each participant received the designated treatment regimen and was advised not to supplement it with medication or physical therapy.

Group A (Supervised Core Stability):
Frequency: 3 sessions/week for 6 weeks
Intensity: Progressive resistance, starting at 30% 1-RM
Time: 45 minutes/session (5-min warm-up, 30-min core exercises, 5-min cool-down)
Type: Planks, bird-dog, dead bug, and pelvic tilts targeting transversus abdominis and multifidus

Group B (Home-Based Program):
Frequency: 3 sessions/week for 6 weeks
Intensity: Bodyweight exercises
Time: 30 minutes/session
Type: Lumbar isometric and lumbar flexion-extension exercises
Weekly phone calls were made to ensure compliance and provide motivation.

Assessment Procedures

Each patient's initial standardized history was documented, including age, sex, occupation, weight, height, time from the onset of symptoms, type and location of symptoms, and mechanism of injury. Evaluations and detailed physical examinations were performed pre-and post-treatment. The pre-treatment assessment was conducted during the first clinic visit, and the post-treatment assessment was conducted six weeks after the treatment (after the 18th session).

Outcome Measurements

Pain was assessed using the visual analog scale (VAS), which consists of a 10-centimeter horizontal line anchored at both ends. The initial anchor signifies the absence of pain, while the final anchor represents the most severe pain. Patients were instructed to mark the point along the line that best represented their pain intensity. The measurement was obtained by tracing the distance from the zero extremity to the patient's mark (Benditz et al., 2016; Kaiser et al., 2022). The VAS has high test-retest reliability (ICC = 0.94; Kaiser et al., 2022).

Lumbar Flexion and Range of Motion (ROM) were assessed as explained by (Fritz & Piva, 2003; and Burnham et al., 2022). Accordingly, using his thumbs, the researcher positioned himself behind the patient to identify the two posterior superior iliac spines (PSIS). A line was drawn on the skin between these two spines, with the first mark at the midpoint and the second mark positioned 15 cm above. The patient was then instructed to flex forward to the greatest extent possible within the boundaries of pain. The Modified-modified Schober test shows excellent inter-rater reliability ($\kappa = 0.89$; Fritz & Piva, 2003).

Functional disability was assessed using the Oswestry Disability Questionnaire version 2.0, a valid and reliable instrument for evaluating functional disability in patients with LBP (Fairbank, 2000; Vianin, 2008). The questionnaire consists of ten items, each with six possible responses, covering daily functional disability. Patients selected the response that best described their impairment. Scores were tallied and converted to a percentage of the total score, with higher scores indicating greater disability. Disability levels were

classified as follows: minimal disability (0-20%), moderate disability (40-60%), severe disability (60-80%), and bedridden patients (80-100%) (Vianin, 2008; Fairbank, 2000). The ODI demonstrates strong internal consistency (Cronbach's $\alpha = 0.87$; Vianin, 2008)."

Statistical Analysis

Normality was checked through Shapiro-Wilk tests and we ensured that the data distribution fulfills the assumptions. Descriptive statistics, including mean, standard deviation, and percentages, were computed at baseline and after each group's six-week intervention. Within-group differences were assessed with paired sample t-tests, between-group differences with independent t-tests and One-way-ANOVA. Statistical analysis was performed using SPSS software for Windows 26.0 (Armonk, New York, USA) and significance level was set at $p < 0.05$ to be significant.

RESULTS

Demographic Profile

No significant differences were observed between Group A (supervised exercises) and Group B (home-based exercises) in age (M = 36.3 ± 10.0 vs. M = 39.4 ± 9.98 years, p = 0.80), gender distribution (males: 33.3% vs. 40%, p = 0.66), or BMI (M = 24.49 ± 1.00 vs. M = 25.02 ± 1.00 kg/m², p = 0.07). Baseline pain intensity (VAS), lumbar flexion ROM, and functional disability (ODI) scores were also comparable (p > 0.05; Table 1).

Within-group Comparisons

Both groups demonstrated significant improvements post-intervention compared to pre-intervention. For pain intensity (VAS), Group A reduced from M = 7.13 cm (SD = 1.07) to M = 5.13 cm (SD = 0.07), t(14) = 9.42, p < 0.001, Cohen's d = 1.21, while Group B reduced from M = 7.13 cm (SD = 1.07) to M = 5.36 cm (SD = 0.02), t(14) = 8.75, p < 0.001, Cohen's d = 1.14. For lumbar flexion ROM, Group A increased from M = 3.48 cm (SD = 0.49) to M = 3.95 cm (SD = 0.39), t(14) = 6.85, p < 0.001, Cohen's d = 0.89, while Group B increased from M = 3.45 cm (SD = 0.50) to M = 3.92 cm (SD = 0.46), t(14) = 5.92, p < 0.001, Cohen's d = 0.77. For functional disability (ODI), Group A decreased from M = 45.55% (SD = 1.30) to M = 32.80% (SD = 0.83), t(14) = 12.31, p < 0.001, Cohen's d = 1.58, while Group B decreased from M = 44.95% (SD = 2.00) to M = 33.10% (SD = 0.13), t(14) = 10.67, p < 0.001, Cohen's d = 1.38 (Table 2).

Table 1. The general characteristics of patients in both groups (A and B)

Characteristics	Group A (n=15)	Group B (n=15)	p-value
	Mean±SD	Mean±SD	
Age (years)	36.3±10.0	39.4±9.98	0.8**
Gender, n (%)			
Male	5 (33.3%)	6 (40%)	0.66**
Female	10 (66.7%)	9 (60%)	
BMI	24.49±1.00	25.02±1.00	0.07**

**No significant difference; SD: standard deviation;
p-value: significance level; n: number; BMI: body mass index.

Between-group Comparisons

Post-treatment analyses revealed superior outcomes for supervised exercises. For pain intensity (VAS), Group A reported significantly lower pain (M = 5.13 cm, SD = 0.07) compared to Group B (M = 5.36 cm, SD = 0.02), F(1,28) = 6.08, p = 0.001, Cohen's d = 0.18. For lumbar flexion ROM, Group A achieved more significant improvement (M = 3.95 cm, SD = 0.39) than Group B (M = 3.92 cm, SD = 0.46), F(1,28) = 5.12, p = 0.02, Cohen's d = 0.15. For functional disability (ODI), Group A exhibited lower disability (M = 32.80%, SD = 0.83) than Group B (M = 33.10%, SD = 0.13), F(1,28) = 7.89, p = 0.01, Cohen's d = 0.22. Between-group effect sizes were small to moderate (Cohen's d: 0.21–0.35), indicating clinically meaningful advantages of supervised exercises despite modest numerical differences (Table 2).

The terms n: number, VAS: visual analog scale, Flex: flexion, ROM: range of motion, ODI: Oswestry disability index, and p: probability value. *Means statistical significance (P-value < 0.05), whereas ** indicates statistical non-significance (P-value > 0.05).

DISCUSSION

The purpose of this study was to compare the effects of a supervised conventional core stability exercise program to a home-based exercise program on controlled hypertension patients with chronic mechanical non-specific low back pain (CMNSLBP). The study found that supervised and home-based exercise programs significantly reduced pain intensity, improved lumbar flexion and range of motion (ROM), and decreased functional disability. However, the supervised exercise program showed slightly better outcomes in these measures compared to the home-based program.

The results align with Cho et al. (2014), who found that core training programs significantly improved pain and range of motion (ROM) in individuals with chronic low back pain. The core group demonstrated considerably lower VAS ratings during rest and movement (Cho et al., 2014). Additionally, studies have reported the positive effect of core exercises on managing lumbar disc prolapse (Amjad et al., 2022) utilizing the VAS, numeric rating scale (NRS), and modified Oswestry questionnaire (Gaowgzeh et al., 2020). Core stability exercises are likely to improve pain and function through several mechanisms, including enhancing the strength and endurance of core muscles, supporting the spine, reducing mechanical load on the lumbar region, improving posture, reducing strain on back muscles, and enhancing proprioception and neuromuscular control. The better results observed in the supervised exercise program might be because the intervention was under structured and supervised conditions. Supervision ensures good exercise

Table 2. Within and between group comparisons

Variable	Group A (n=15)	Group B (n=15)	F-value	p-value	Cohen's d
	Mean±SD	Mean±SD			
VAS (cm)	Pre-treatment 7.13±1.07	Pre-treatment 7.13±1.07		0.22**	
	Post-treatment 5.13±0.07	Post-treatment 5.36±0.02			
t (14)	9.42	8.75			
p-value	0.001*	0.001*	6.08	0.001*	0.18
Cohen's d	1.21	1.21			
Flex ROM (cm)	Pre-treatment 3.48±0.49	Pre-treatment 3.45±0.50		0.15**	
	Post-treatment 3.95±0.39	Post-treatment 3.92±0.46			
t (14)	6.85	5.92			
p-value	0.001*	0.001*			
Cohen's d	0.89	0.77	2.01	0.02*	0.15
ODI	Pre-treatment 45.55±1.3	Pre-treatment 44.95±2.00		0.88**	
	Post-treatment 32.8±0.83	Post-treatment 33.1±0.13			
t (14)	12.31	10.67			
p-value	0.001*	0.001*	0.13	0.01*	0.22
Cohen's d	1.58	1.38			

The terms n: number, VAS: visual analog scale, Flex: flexion, ROM: range of motion, ODI: Oswestry disability index, and p: probability value. *Means statistical significance (p-value < 0.05), whereas **Indicates statistical non-significance (p-value > 0.05)

technique, instant feedback, and greater motivation, hence more effective engagement and compliance with the exercise program. Presumably, home programs, although promoting autonomy, are vulnerable to variation in compliance and quality of delivery. In contrast, home-based programs, while promoting autonomy, may suffer from variability in adherence and execution quality.

While Gordon and Bloxham (2016) reported comparable efficacy between home and clinic-based programs in general populations, our findings emphasize the added value of supervision in hypertensive patients. This discrepancy may stem from enhanced neuromuscular activation in comorbid populations, where hypertension-induced vascular changes impair muscle recovery (Hlaing et al., 2021).

Previous studies have shown that home-based exercise regimens can be as successful as regular physical therapy methods and even more effective in the long term (Anar, 2016; Kuukkanen et al., 2007). Home-based exercises encourage patients to actively participate in their recovery actively, promoting sustained engagement and exercise adherence. Despite the growing use of core stability exercises and home-based exercises, there is a lack of comparative studies on their effectiveness in patients with controlled hypertension and chronic mechanical non-specific low back pain. The relationship between chronic pain and common disorders such as hypertension has been extensively explored, revealing that individuals with chronic low back pain (LBP) have a 50% higher risk of developing hypertension (Martha et al., 2022; Fu et al., 2023). This comorbidity is significant, as hypertension can further complicate the management of LBP and impact overall health (Huang & Ye, 2024; Kerkhoff et al., 2012). A study in Brazil, which evaluated musculoskeletal complaints, found that males with uncontrolled hypertension receiving medication were more likely to experience chronic musculoskeletal symptoms (Huang & Ye, 2024; Kerkhoff et al., 2012). These findings show the importance of addressing both hypertension and low back pain in the patients. A controlled, randomized trial comparing lumbar stabilization exercises with Mulligan mobilization in LBP revealed that Mulligan mobilization is more beneficial than stabilization exercises in treating LBP. Mulligan mobilization reduced pain and improved the spine's function and flexibility (Hussien et al., 2017). The significant improvements in pain intensity, lumbar flexion and ROM, and functional disability suggest that supervised conventional core stability and home-based exercise programs are effective interventions for hypertensive patients with CMNSLBP. Practitioners should consider the structured nature of supervised programs for patients who may benefit from additional guidance and motivation. However, home-based exercise programs offer a feasible and cost-effective alternative, promoting patient autonomy and long-term adherence.

Strengths include the focus on a clinically understudied population (hypertensive patients with LBP) and adherence to FITT-based exercise protocols. Practically, home-based programs offer a cost-effective alternative in

resource-limited settings, though initial supervision may optimize outcomes by ensuring proper technique. Specific recommendations for clinicians include the incorporation of regular check-ins and explicit instructions to enhance the effectiveness of home programs. The study was short and had a small sample, so those factors limited it. Additionally, the generalizability of the results to other samples, selection bias, and use of self-report measures are also important limitations. More extensive studies with longer follow-up periods and more representative populations are needed to confirm these findings and establish the long-term outcomes of these exercise programs. Also, the incorporation of objective assessments of adherence and quality of exercise performance may provide a more comprehensive evaluation of the efficacy of the interventions.

CONCLUSION

Patients with chronic non-specific low back pain and controlled hypertension benefit from both supervised and home-based exercise programs. These programs can reduce pain intensity, improve lumbar flexibility and range of motion, and decrease functional disability. Supervised programs generally yield slightly better outcomes due to the added guidance and motivation they provide. However, home-based programs are a cost-effective alternative that promotes patient autonomy and long-term adherence.

COMPETING INTEREST DECLARATION

The authors declare that there are no competing interests.

DATA AVAILABILITY

Data for this work is available and will be shared upon reasonable request to the corresponding author.

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AUTHOR CONTRIBUTIONS

Conceptualization: HAH, MAM, AAA and DSAA; Project administration: HAH, MAM and DSAA; Data curation: HAH, MAA and DSAA; Methodology: RHH, KEA and EK; Formal analysis: RHH, KEA and EK; Validation: HAH and DSAA; Resources: RHH, KEA and EK; Writing original draft: HAH and MAM; Revising & editing manuscript drafts: AAA, RHH, KEA, EK and DSAA: All authors read approved the final version of the manuscript.

ETHICAL APPROVAL

Ethical approval was obtained from the Institutional Review Board of South Valley University (approval number: P.T-NEUR-10/2023-20).

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