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EFFECTIVENESS OF STABILITY BALL TRAINING, DEAD BUG EXERCISES, AND THEIR COMBINATION ON REDUCING SPECIFIC LOW BACK PAIN

Original Research

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ABSTRACT

Background: Low back pain (LBP) is a leading cause of disability worldwide and significantly impairs functional mobility and quality of life. Core stabilization exercises have gained attention for their non-invasive benefits in managing LBP. Stability ball training and dead bug exercises are commonly used approaches, yet their comparative and combined effects on pain reduction and quality of life require further investigation in individuals with acute LBP.

Objective: To evaluate and compare the effectiveness of stability ball training, dead bug exercises, and their combination on pain intensity and health-related quality of life in individuals with specific low back pain.

Methods: A single-blinded randomized controlled trial was conducted over six months at Sheikh Zayed Hospital, Lahore, and Alara Health Care Clinic. Sixty-nine participants aged 30–50 years with acute LBP and mild to moderate disc bulges were randomly assigned into three equal groups (n=21 each): Group A (stability ball exercises), Group B (dead bug exercises), and Group C (combined exercises). All participants received standard physiotherapy and performed supervised core interventions three times per week for eight weeks. Pain intensity was assessed using the Visual Analog Scale (VAS), and quality of life was measured using the Short Form-12 (SF-12) questionnaire. Statistical analysis was performed using SPSS version 22.

Results: At baseline, VAS scores were statistically similar across groups ($p = 0.166$). By the 8th week, Group C showed the most significant pain reduction (VAS = 2.78 ± 1.043) compared to Group A (VAS = 4.09 ± 1.125) and Group B (VAS = 3.74 ± 1.484), with $p = 0.001$. Physical health scores (PCS) at week 8 were highest in Group C (50.96 ± 4.695) versus Group A (43.96 ± 2.788) and Group B (45.91 ± 2.410), $p = 0.001$. Mental health scores (MCS) also favored Group C (57.00 ± 4.178), $p = 0.002$.

Conclusion: All core stabilization exercises were effective in managing acute LBP; however, combining stability ball and dead bug exercises produced superior outcomes in pain reduction and quality of life. This supports the integration of multimodal core training in LBP rehabilitation protocols.

Keywords: Exercise Therapy, Low Back Pain, Pain Management, Physical Therapy Modalities, Quality of Life, Rehabilitation, Trunk Muscles.

INTRODUCTION

Low back pain (LBP) is a prevalent and growing health concern worldwide, contributing significantly to disability, work absenteeism, and reduced quality of life (1). It is now recognized as one of the most common musculoskeletal conditions requiring rehabilitation, particularly in low- and middle-income countries where access to healthcare resources may be limited (2). LBP affects individuals across all age groups but has a particularly profound impact on the working population, with studies reporting that it accounts for 30% of long-term sick leaves exceeding six months and 20% of occupational injuries. In France, it ranks as the third most frequent cause of work-related disability, often forcing individuals out of the workforce before the age of 45 (3). Despite its high prevalence, LBP is a complex and multifactorial condition, often intertwined with psychological comorbidities such as depression, which can further impair rehabilitation outcomes (4). Clinically, LBP is classified into specific and non-specific types. Specific LBP is linked to identifiable pathological conditions such as herniated discs, spinal stenosis, or spondylolisthesis, and often involves radiating symptoms due to nerve root irritation (5). Conversely, non-specific LBP, which represents over 90% of all cases, lacks a definitive structural cause and is typically associated with mechanical factors like poor posture, muscle strain, joint dysfunction, and ligament injuries (6). These conditions are often exacerbated by poor physical conditioning and lifestyle-related factors, leading to a spectrum of symptoms that range from mild discomfort to severe, disabling pain (7). Chronic cases may evolve from initially acute episodes that fail to resolve, resulting in ongoing musculoskeletal deterioration, including disc degeneration, muscle atrophy, fat infiltration, and altered paraspinal muscle composition (8).

The diagnosis of LBP relies heavily on clinical history and physical examination, with imaging reserved for cases where structural abnormalities are suspected (9). Typical symptoms include dull, aching pain, stiffness, and functional limitations, which may be accompanied by sciatica—a sharp, radiating pain extending from the lower back to the legs (10). Management strategies for LBP prioritize pain reduction, restoration of function, and prevention of recurrence through individualized rehabilitation approaches (11). Among these, exercise-based interventions have emerged as a cornerstone of conservative treatment, with growing evidence supporting their role in improving core muscle strength, neuromuscular control, and spinal stability (12). Core stability exercises, in particular, have gained traction for their ability to engage deep trunk muscles such as the transversus abdominis, obliques, and multifidus, which are essential for postural support and effective force transmission. Deficits in core muscle strength can disrupt biomechanical efficiency, increasing spinal load and predisposing individuals to LBP. Young adults, especially those with poor hamstring flexibility or sedentary habits, are particularly susceptible due to muscular imbalances and altered body mechanics. Targeted training not only restores muscular coordination in the lumbopelvic region but also improves movement patterns and load distribution, thereby reducing injury risk and enhancing functional outcomes (13).

Among the commonly used rehabilitation tools, stability ball training and dead bug exercises (DBE) have shown promise in enhancing core activation and reducing LBP symptoms. Stability ball exercises provide an unstable surface that challenges balance and proprioception, engaging deep stabilizing muscles to maintain spinal alignment. These exercises improve motor control and coordination, making them beneficial for both prevention and rehabilitation (14). DBE, on the other hand, involves controlled limb movements while maintaining core engagement, offering an effective isometric challenge that promotes spinal stability and mimics functional tasks such as walking and running (15). When integrated into rehabilitation programs, these exercises have demonstrated improvements in trunk stability, pelvic alignment, and overall quality of life. Given the multifactorial nature of LBP, a multidisciplinary approach is essential for effective management. Physiotherapists play a key role in designing and implementing personalized rehabilitation plans that incorporate aerobic conditioning, flexibility training, and progressive strengthening. Adjunct therapies such as heat, ultrasound, and electrical stimulation may also be employed to support recovery. Incorporating core stability exercises into these programs can significantly enhance outcomes by addressing underlying neuromuscular deficits (16). Despite the growing body of evidence supporting core stability interventions, there remains a gap in comparative studies evaluating the isolated and combined effects of stability ball training and DBE on pain reduction and core muscle activation. Therefore, this study aims to assess and compare the efficacy of stability ball exercises, dead bug exercises, and their combination in improving clinical outcomes in individuals with low back pain. The objective is to develop evidence-based rehabilitation protocols that optimize functional recovery, minimize pain-related disability, and improve long-term musculoskeletal health.

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METHODS

This study employed a single-blinded randomized controlled trial (RCT) design to assess the comparative effectiveness of stability ball training, dead bug exercises, and their combination in individuals with low back pain. The trial was conducted over a six-month period at Sheikh Zayed Hospital, Lahore, and Alara Health Care Clinic. A total of 80 participants were assessed, 69 were randomized, and 63 (with 10% dropout accounted) participants were recruited and randomly allocated into three intervention groups, with 21 participants in each group. The groups included: (1) stability ball training, (2) dead bug exercises, and (3) a combination of both interventions. Randomization was performed using a computer-generated sequence to ensure equal distribution and minimize selection bias. Participants included in the study were aged between 30 and 50 years and had been diagnosed with acute low back pain (LBP) lasting less than three months, accompanied by mild to moderate lumbar disc bulges confirmed through imaging. Exclusion criteria encompassed individuals with chronic LBP, spinal deformities, recent spinal surgeries, vertebral fractures, malignancies, infections, pregnancy, or those using medications that could influence pain perception, such as opioids or corticosteroids. All participants were evaluated by qualified healthcare professionals prior to enrollment to confirm eligibility (2,3).

Ethical approval for the study was obtained from the relevant institutional ethics review board in accordance with the Declaration of Helsinki. Informed written consent was obtained from all participants after a detailed explanation of the study objectives, procedures, risks, and potential benefits. All participants initially received standard baseline therapy including the application of hot packs, transcutaneous electrical nerve stimulation (TENS), and piriformis muscle stretching. Following this, participants engaged in their assigned intervention protocols three times per week for eight consecutive weeks. Each session incorporated rest intervals of one minute between exercises to minimize fatigue and ensure consistent performance. Pain intensity was assessed using the Visual Analog Scale (VAS), a validated tool for subjective pain measurement. Health-related quality of life was evaluated using the Short Form-12 Health Survey (SF-12), which covers both physical and mental health components. These outcome measures were recorded at baseline and after the completion of the intervention period. Data collection was carried out by assessors blinded to group assignments to reduce observational bias. Statistical analysis was conducted using SPSS version 22. Descriptive statistics were used to summarize participant demographics and baseline characteristics. Inferential analyses, including paired t-tests and analysis of variance (ANOVA), were applied to assess within-group and between-group differences. A significance level of $p < 0.05$ was set for all statistical tests, and effect sizes were calculated to determine the clinical relevance of observed changes.

RESULTS

The study included 63 participants diagnosed with acute low back pain, of which 31.75% were male (n=20) and 68.25% were female (n=43). Participants were evenly allocated across three intervention groups—stability ball exercise, dead bug exercise, and a combined program—with 21 individuals in each group. Normality testing using the Shapiro-Wilk method indicated that variables such as age, baseline VAS, and MCS followed a normal distribution ($p > 0.05$), while all other outcome variables also met normality assumptions, supporting the application of parametric analyses. Demographic comparison revealed a higher proportion of female participants in all groups, ranging from 60.9% to 73.9%. Significant variation in age was observed among the groups, with the mean age being 38.35± 4.923 years in the stability ball group, 43.74± 4.059 years in the dead bug group, and 31.43±7.223 years in the combined group ($p = 0.001$). The severity of lumbar radiculopathy was relatively consistent across groups, with a majority classified as mild in each group (approximately 66.7%).

Pain reduction, as measured by the Visual Analog Scale (VAS), demonstrated statistically significant improvement over time within all intervention groups. At baseline, mean VAS scores were 6.67 ± 0.6470 for the stability ball group, 6.513 ± 0.3571 for the dead bug group, and 6.40 ± 0.3717 for the combined group, with no significant difference among them ($p = 0.166$). However, by the 4th week, the combined group exhibited the most notable pain reduction (4.74 ± 0.864), followed by the dead bug (5.04 ± 1.065) and stability ball groups (5.61 ± 1.118), with between-group differences reaching statistical significance ($p = 0.018$). At the 8th week, the combined exercise group maintained the greatest reduction in pain (2.78 ± 1.043), compared to 3.74 ± 1.484 in the dead bug group and 4.09 ± 1.125 in the stability ball group ($p = 0.001$). In terms of quality of life, physical health outcomes assessed by the Physical Component Summary (PCS) of the SF-12 showed progressive improvements. At baseline, PCS scores were comparable across groups ($p = 0.956$). By the 8th week, the combined exercise group had the highest PCS score (50.96 ± 4.695), followed by the dead bug (45.91 ± 2.41) and stability ball (43.96 ± 2.788) groups, with a highly significant between-group difference ($p = 0.001$). Similarly, the Mental Component Summary (MCS) showed significant improvements over time. At baseline, MCS scores were 51.57 ± 3.342 in the stability ball group, 52.17 ± 3.676 in the dead bug group, and 53.70 ± 1.941 in the combined group ($p = 0.061$). At week 8, the combined group reached a

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score of 57.00 ± 4.178, compared to 55.22 ± 2.907 in the dead bug and 53.17 ± 3.055 in the stability ball group (p = 0.002). All three interventions demonstrated statistically significant within-group improvements across all VAS, PCS, and MCS measures (p = 0.001), underscoring the overall effectiveness of the exercise-based rehabilitation. However, the combined exercise group consistently outperformed the individual interventions in terms of both pain reduction and enhancements in physical and mental quality of life.

Table: Frequency distribution of gender for diagnosed acute low back pain

Gender	Frequency	Percent
Male	20	31.75
Female	43	68.25
Total	63	100.0

Table: Frequency distribution across different exercise interventions for acute low back pain

Variables	Frequency	Percent
Stability ball Exercise	21	33.3
Dead bug exercise	21	33.3
Both stability ball and Dead ball training	21	33.3
Total	63	100.0

Table: tests of normality for age, pain, and quality of life variables in acute low back pain study

	Shapiro Wilk Statistic	df	Sig.
Age	.963	63	.317
VAS Baseline	.801	63	.254
VAS Post 4 Week	.910	63	.316
VAS Post 8 Week	.936	63	.278
PCS Baseline	.959	63	.234
PCS Post 4 Week	.946	63	.156
PCS Post 8 Week	.961	63	.132
MCS Baseline	.977	63	.219
MCS Post 4 Week	.971	63	.110
MCS Post 8 Week	.963	63	.317

Table: Inferential statistics of the demographical characteristics across different exercise interventions for acute low back pain

		Stability Ball Exercise	Dead bug Exercise	Stability Ball and Dead ball Training	Between Group P-Value
Gender	Male	7(33.3%)	5(23.8%)	8(38.1%)	0.599
	Female	14(66.7%)	16(76.2%)	13(61.9%)	
Age		38.35±4.923	43.74±4.059	31.43±7.223	0.001*
Lumbar Radiculopathy	Mild	14(66.7%)	13(64.4%)	14(66.7%)	0.770
	Moderate	7(33.3%)	8(35.4%)	7(33.3%)	

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Table: Inferential statistics of the pain reduction and quality of life across different exercise interventions for acute low back pain

Variables			Groups			Between-group P-Value
			Stability ball Exercise	Dead bug exercise	Both stability ball and dead bug training	
VAS at baseline (0-10)			6.670±0.6470	6.513±.3571	6.400±.3717	0.166*
VAS at 4th-week follow-up			5.61±1.118	5.04±1.065	4.74±0.864	0.018*
VAS at 8th week follow-up			4.09±1.125	3.74±1.484	2.78±1.043	0.001*
Quality of life	Physical Component Summary (PCS)	Baseline	34.96±1.894	35.09±2.043	35.13±2.222	0.956*
		At 4th week follow-up	41.52±2.745	44.61±3.448	48.30±5.094	0.001*
		At 8th week follow-up	43.96±2.788	45.91±2.410	50.96±4.695	0.001*
	Mental Component Summary (MCS)	Baseline	51.57±3.342	52.17±3.676	53.70±1.941	0.061*
		At 4th week follow-up	52.91±3.190	54.91±2.827	55.43±3.11	0.016*
		At 8th week follow-up	53.17±3.055	55.22±2.907	57.00±4.178	0.002*

Table: Comparison of pain reduction and quality of life across different exercise interventions for acute low back pain

Variables			Groups		
			Stability ball Exercise	Dead bug exercise	Stability ball and dead bug training
VAS at baseline (0-10)			6.670±0.6470	6.513±.3571	6.400±.3717
VAS at 4th-week follow-up			5.61±1.118	5.04±1.065	4.74±0.864
VAS at 8th-week follow-up			4.09±1.125	3.74±1.484	2.78±1.043
Within group P-value			0.001	0.001	0.001
Quality of life	Physical Component Summary (PCS)	Baseline	34.96±1.894	35.09±2.043	35.13±2.222
		At 4th week follow-up	41.52±2.745	44.61±3.448	48.30±5.094
		At 8th week follow-up	43.96±2.788	45.91±2.410	50.96±4.695
	Within group P-value		0.001	0.001	0.001
	Mental Component Summary (MCS),	Baseline	51.57±3.342	52.17±3.676	53.70±1.941
		At 4th week follow-up	52.91±3.190	54.91±2.827	55.43±3.11
		At 8th week follow-up	53.17±3.055	55.22±2.907	57.00±4.178
	Within group P-value		0.001	0.001	0.001

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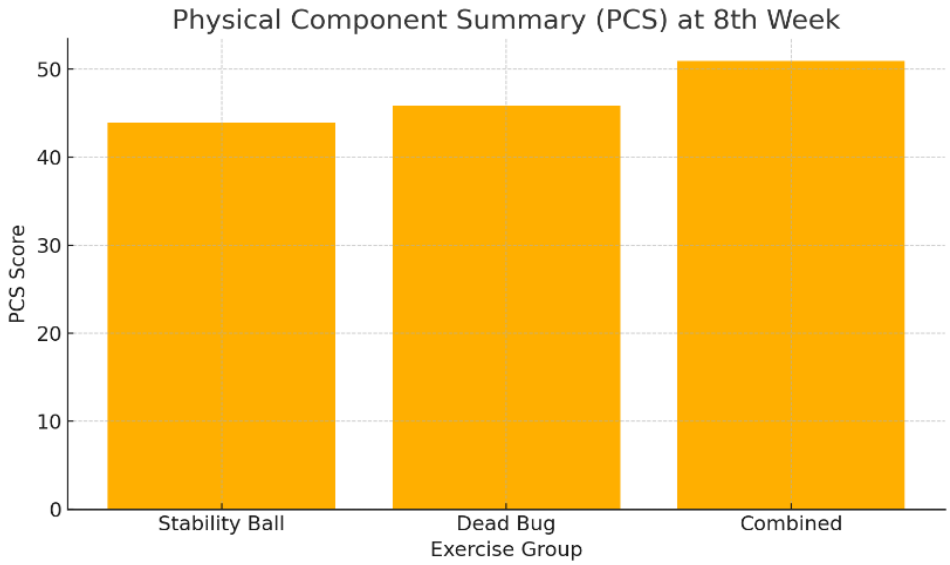

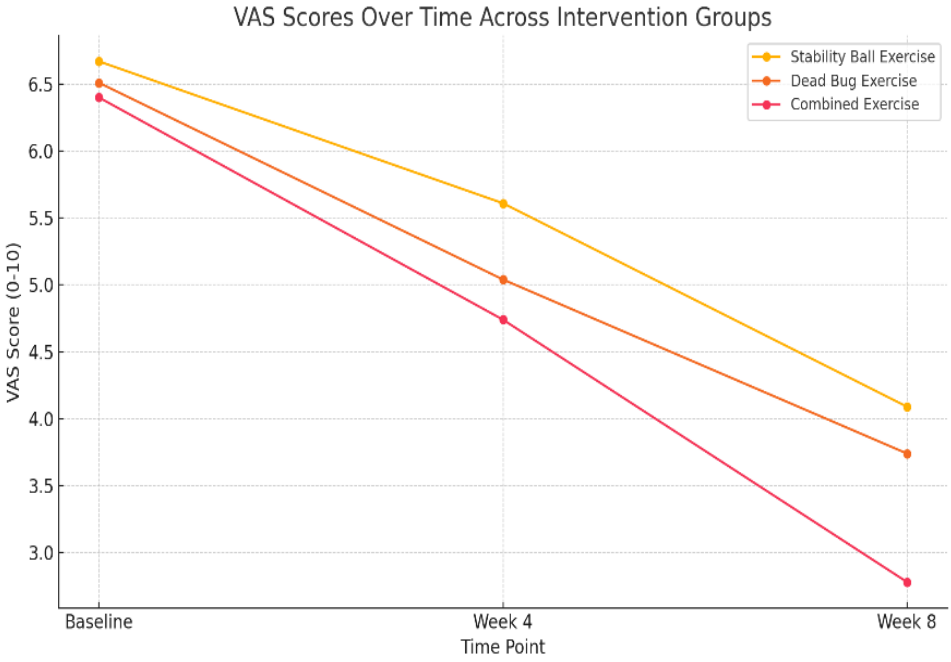

DISCUSSION

The present study demonstrated that targeted core stabilization exercises—specifically stability ball training, dead bug exercises, and their combination—resulted in significant improvements in pain reduction and quality of life among individuals with acute low back pain. These findings underscore the clinical utility of incorporating focused core interventions into rehabilitation protocols. The most pronounced outcomes were observed in the group receiving a combined intervention, which exhibited the lowest pain scores and highest physical and mental component summary scores by the end of the eight-week program (17). These results align with existing literature supporting the role of core stability training in managing low back pain and enhancing functional outcomes in musculoskeletal rehabilitation. A critical aspect of the findings lies in the consistency of improvement across all intervention groups, with each group achieving statistically significant within-group changes (18). However, the combined intervention group outperformed the others in both

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pain relief and functional recovery, indicating a synergistic effect when exercises are integrated. This outcome supports the rationale for multimodal rehabilitation strategies that concurrently engage different core muscle groups, optimizing neuromuscular control and postural stability (19). Previous studies examining core exercises, including dead bug and Swiss ball training, have similarly reported significant reductions in pain and improved function across various populations, including young adults, postpartum women, and individuals with chronic non-specific low back pain (20). The current study extends this evidence by highlighting the added benefit of combining these modalities.

One of the key strengths of the study was its randomized controlled trial design, which enhances internal validity and reduces the likelihood of selection bias. Equal distribution of participants across the three groups and the use of standardized outcome measures such as the Visual Analog Scale and SF-12 ensured objective assessment of intervention effects (21). Furthermore, the inclusion of both physical and mental health metrics allowed for a comprehensive evaluation of quality of life, an often-underemphasized aspect in musculoskeletal rehabilitation research. While improvements in VAS, PCS, and MCS scores suggest enhanced core function, these are indirect indicators and cannot definitively attribute benefits to specific muscle engagement. Additionally, the variation in baseline age across the groups, particularly the significantly younger mean age in the combined intervention group, may have introduced confounding effects on the outcomes, given that age influences recovery rate and exercise tolerance.

The short duration of follow-up limits the generalizability of the results to long-term rehabilitation and recurrence prevention. Pain and quality-of-life improvements were measured only up to the eighth week, and no data were captured on adherence, functional capacity beyond daily living, or recurrence rates post-intervention. Moreover, the study did not stratify results based on the severity of disc pathology or radiculopathy symptoms, which could influence responsiveness to exercise-based interventions. Future studies should consider incorporating objective biomechanical assessments, extended follow-up periods, and stratified subgroup analyses to better understand differential treatment effects. Comparative literature supports the superior effectiveness of core stabilization programs over conventional exercise routines in improving trunk endurance, motor control, and functional performance (22). The addition of gamified or home-based delivery formats, as explored in recent research, offers promising directions for improving engagement and adherence in real-world settings (23). Integrating such innovations into clinical practice, alongside traditional supervised interventions, could enhance long-term outcomes and reduce the healthcare burden associated with chronic low back pain.

In conclusion, the findings of this study reinforce the clinical relevance of core stabilization exercises, particularly when applied in combination, for the rehabilitation of acute low back pain. The observed improvements in pain and quality of life emphasize the importance of integrating multimodal exercise interventions into routine physiotherapy care. However, further research is warranted to substantiate these results with objective muscle activation data and to explore long-term sustainability and adherence to exercise-based management strategies.

CONCLUSION

This study concluded that both stability ball training and dead bug exercises are effective strategies for managing low back pain, but their combined application offers superior benefits in reducing pain and improving overall quality of life. The findings highlight the practical value of incorporating a diverse range of core stabilization exercises into rehabilitation programs, supporting a more comprehensive and effective approach to physical therapy. By addressing both pain relief and functional enhancement, this research contributes meaningful evidence to guide clinical practice in the treatment of low back pain.

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AUTHOR CONTRIBUTION

Author	Contribution
Sadia Tariq	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Qurba Kiran	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Nayab Shahid	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Shahroz Qayyum	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Hafiz Zohaib Shahid Rana	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Kinza Arif*	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Ayesha Mohsin	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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