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Effect of individualized ergonomic intervention combined with progressive exercise therapy on pain and functional disability in individuals with chronic sedentary occupational low back pain

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Abstract
Background: Chronic low back pain (CLBP) associated with sedentary occupations is influenced by prolonged sitting, poor posture and physical deconditioning. Objective: To evaluate the effectiveness of individualized ergonomic intervention combined with progressive exercise therapy compared with conventional physiotherapy on pain intensity and functional disability. Methods: A two-arm, parallel-group, assessor-blinded randomized controlled trial was conducted in 60 sedentary employees aged 25–50 years with CLBP of more than 3 months. Participants were randomized equally to Group A, receiving individualized workstation correction combined with progressive strengthening and flexibility exercises, or Group B, receiving conventional physiotherapy, for 3 sessions/week for 8 weeks. VAS and ODI were assessed before and after intervention. Results: Group A VAS decreased from 7.13 ± 0.82 to 1.93 ± 0.78 and ODI from 40.40 ± 4.11 to 13.03 ± 2.63. Group B VAS decreased from 7.00 ± 0.74 to 3.83 ± 0.87 and ODI from 39.60 ± 3.73 to 23.60 ± 4.00. Between-group comparisons favoured Group A for both VAS and ODI ($p < 0.001$). Conclusion: Individualized ergonomic intervention combined with progressive exercise therapy was more effective than conventional physiotherapy exercise alone in reducing pain and functional disability in chronic sedentary occupational low back pain.

Keywords: Chronic low back pain, ergonomics, progressive exercise therapy, sedentary occupation, randomized controlled trial, VAS, ODI

Introduction

Low back pain (LBP) is the leading cause of disability worldwide, with non-specific mechanical LBP accounting for most cases encountered in clinical practice [1, 2]. It affects individuals and imposes a substantial socioeconomic burden through reduced work productivity, increased absenteeism escalating healthcare cost. The prevalence of chronic low back pain (CLBP) has increased alongside sedentary lifestyles and desk-based occupations, making it a major contributor to long-term disability, reduced work productivity, and increased healthcare costs [3, 4]. Sedentary work typically involves prolonged sitting, sustained poor posture, and reduced physical activity, all of which contribute to the onset and persistence of occupational LBP [3]. Extended sitting increases pressure on the intervertebral discs, reduces lumbar lordosis, and weakens the paraspinal and abdominal muscles, leading to decreased spinal stability over time [3]. Research has consistently shown that prolonged sitting, poor posture, and limited postural variation are strongly associated with a higher prevalence of low back pain among office workers.The development of chronic low back pain is multifactorial and involves mechanical, physical, behavioural, and psychosocial factors. Reduced activation and endurance of the deep trunk muscles stabilizing muscles, decreased flexibility of the hip and lumbar musculature, impaired movement control, and fear of movement contribute to persistence of symptoms. In addition, workplace-related factors such as inadequate chair support, inappropriate monitor height, incorrect keyboard and mouse positioning, prolonged uninterrupted sitting, and insufficient recovery breaks further increase the risk of chronic pain and disability. These factors highlight the importance of addressing both the individual and the work environment during rehabilitation.

Ergonomic interventions are designed to optimize the relationship between the worker, workstation, and work tasks, thereby minimizing mechanical stress on the lumbar spine. Individualized ergonomic modifications based on a person's anthropometric measurements have demonstrated greater effectiveness than general ergonomic advice [5, 6]. Several randomized controlled trials have also reported that workplace ergonomic programmes reduce musculoskeletal discomfort and improve comfort among office employees [8, 9].

Exercise therapy remains one of the most strongly recommended conservative treatments for CLBP according to international clinical guidelines [13, 15]. Progressive exercise programmes, which gradually increase exercise intensity and complexity based on individual tolerance, have shown superior improvements in pain reduction and functional recovery compared with non- progressive exercise approaches [16, 17].Physiotherapy is a safe, non-invasive treatment that helps reduce dependence on medication and surgery, promotes early return to normal activities, and lowers the risk of recurrence. Progressive exercise therapy involves gradual advancement of strengthening, flexibility, motor control, endurance, and functional exercise according to the patient's tolerance and clinical progress. This approach enhance spinal stability, improves muscular endurance, restores movement control, and facilitates return to normal functional activities [17, 18, 19]. Ergonomic correction primarily addresses workplace and postural risk factors, where progressive exercise therapy improves physical conditioning and spinal stability. Together, these interventions target complementary mechanisms involved in chronic low back pain, as described by the biopsychosocial model [20]. Therefore, combining individualized ergonomic intervention with progressive exercise therapy may provide greater clinical benefits than either intervention alone [20, 21].Despite this rationale, only a limited number of randomized controlled trials have investigated the combined effect of individualized ergonomic intervention and progressive exercise therapy specifically in individuals with chronic sedentary occupational low back pain. Most previous studies have either focused on general musculoskeletal discomfort or evaluated exercise therapy without individualized workstation correction [21]. This highlights the need for further research to determine the effectiveness of this combined intervention in reducing pain and improving functional disability among sedentary workers with chronic low back pain.

Materials and Methods

Study design and participants: This was a two-arm, parallel-group, assessor-blinded. Sixty sedentary employees aged 25–50 years with chronic non-specific mechanical low back pain for more than 3 months were included and randomized equally into two groups. Intervention: Group A received individualized workstation assessment and correction together with progressive strengthening and flexibility exercises, 3 sessions/week for 8 weeks. Group B received conventional physiotherapy including moist heat, lumbar mobility, stretching, basic strengthening, walking/cool-down and home exercise advice, 3 sessions/week for 8 weeks. Outcome measures: VAS was used to assess pain intensity and ODI to assess functional disability. Assessments were performed before and after the intervention. Statistical analysis: VAS and ODI data were normally distributed. Paired-samples t-tests were used for within-group comparisons and independent-samples t-tests for between-group post-test and change-score comparisons. Statistical significance was set at $p < 0.05$.

Results

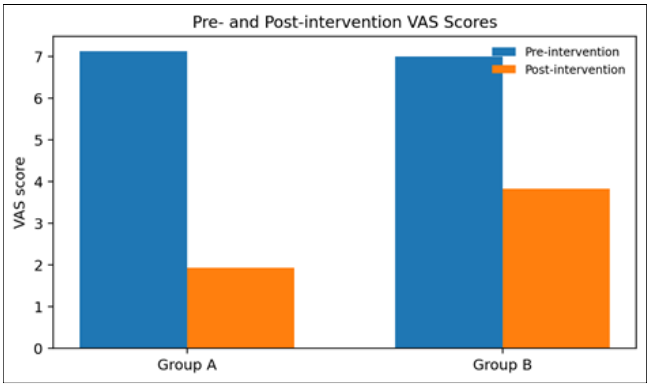
Baseline characteristics: The groups were comparable at baseline. Mean age was 38.43 ± 7.59 years in Group A and 37.10 ± 7.81 years in Group B; gender distribution was also comparable. Pain (VAS): Group A improved from 7.13 ± 0.82 to 1.93 ± 0.78, a mean reduction of 5.20 ± 0.99 points (72.93%; $t = 21.52$, $p < 0.001$; Cohen's $d = 3.93$). Group B improved from 7.00 ± 0.74 to 3.83 ± 0.87, a reduction of 3.17 ± 1.23 points (45.29%; $t = 14.05$, $p < 0.001$; Cohen's $d = 2.57$). The between-group change-score comparison was significant ($t = 6.154$, $p < 0.001$), and post-test VAS also favoured Group A ($t = 8.86$, $p < 0.001$). Functional disability (ODI): Group A improved from 40.40 ± 4.11 to 13.03 ± 2.63, a reduction of 27.37 ± 4.59 points (67.75%; $t = 32.66$, $p < 0.001$; Cohen's $d = 5.96$). Group B improved from 39.60 ± 3.73 to 23.60 ± 4.00, a reduction of 16.00 ± 4.59 points (40.40%; $t = 19.11$, $p < 0.001$; Cohen's $d = 3.49$). The between-group change-score comparison was significant ($t = 9.595$, $p < 0.001$), and post-test ODI favoured Group A ($t = 12.09$, $p < 0.001$; effect size = 3.12).

Table 1: Pre- and post-intervention VAS scores

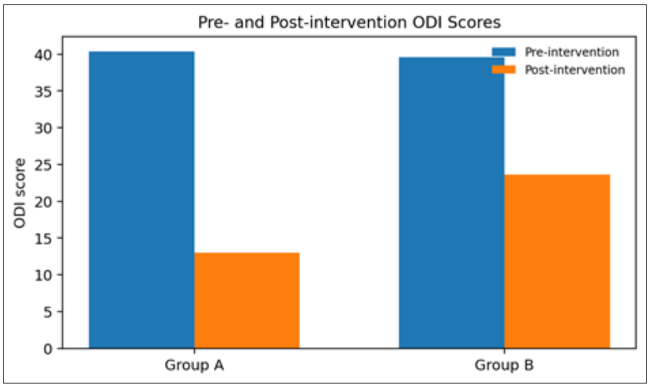
Group	Pre VAS	Post VAS	Reduction	p-value
Group A	7.13 ± 0.82	1.93 ± 0.78	5.20 (72.93%)	<0.001
Group B	7.00 ± 0.74	3.83 ± 0.87	3.17 (45.29%)	<0.001

Table 2: Pre- and post-intervention ODI scores

Group	Pre ODI	Post ODI	Reduction	p-value
Group A	40.40 ± 4.11	13.03 ± 2.63	27.37 (67.75%)	<0.001
Group B	39.60 ± 3.73	23.60 ± 4.00	16.00 (40.40%)	<0.001



Graph 1: Graphical representation of reduction of pain on VAS.



Graph 2: Graphical representation of reduction of functional disability on ODI.

Discussion

The present randomized controlled trial demonstrated significant improvement in both pain and functional disability following 8 weeks of treatment, with substantially greater improvement in the individualized ergonomic plus progressive exercise group. Baseline similarity between groups supports the interpretation that the observed post-intervention differences were primarily associated with the treatment protocols. The marked reduction in VAS in Group A is consistent with evidence supporting structured exercise and individualized ergonomic strategies for chronic low back pain. Shariat et al. reported beneficial effects of ergonomic modifications combined with exercise among office workers, while Searle et al. demonstrated meaningful improvements in pain with exercise interventions. Qaseem et al. recommended exercise and other non-pharmacological interventions as important components of chronic low back pain management. The greater reduction in ODI in Group A suggests that the combined intervention may have improved functional capacity as well as pain. Individualized workstation modification addresses occupational and postural contributors, while progressive strengthening, flexibility and movement-control exercises address physical deconditioning and spinal stability. This multimodal approach is consistent with the broader biopsychosocial and active-management principles described in the literature. These findings also align with evidence that individualized ergonomic approaches may be more useful than general ergonomic advice alone. However, because the study did not include long-term follow-up or broader outcomes such as quality of life, endurance, psychosocial status and work productivity, the durability and wider occupational impact of the intervention require further investigation.

Conclusion

Individualized ergonomic intervention combined with progressive exercise therapy was significantly more effective than conventional physiotherapy exercise alone in reducing pain intensity and functional disability among individuals with chronic sedentary occupational low back pain. The greater reductions in VAS and ODI in Group A support the use of an individualized, active and workplace-focused physiotherapy approach.

Limitations and Future Scope

The study had a limited geographical recruitment area; long-term follow-up was not performed; occupational and psychosocial factors were not evaluated; and outcomes were limited mainly to pain intensity and functional disability. Future multicentre trials should include recurrence, quality of life, work productivity, psychological status and longer follow-up.

Conflict of Interest

The authors declare that they have no conflict of interest.

Funding Support

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Informed Consent

Informed consent was obtained from the participants.

Ethical Clearance

Ethical clearance was obtained from the Institutional Ethics Committee of Rashtrasant Janardhan Swami College of Physiotherapy Kokamthan, (MUHS, Nashik)

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