Research Article

Effect Of Combined Ergonomic Intervention And Core Stability Exercises Versus Ergonomic Intervention Alone On Pain, Lumbar Mobility, And Disability In Dental Students With Low Back Pain: A Randomized Controlled Trial

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Abstract

Background: Low back pain (LBP) is a frequent musculoskeletal complaint among dental students, arising from prolonged static postures, forward trunk flexion, and limited ergonomic awareness during pre-clinical and clinical training. Whether adding a structured core stability exercise programme to ergonomic education produces additional benefit over ergonomic education alone remains unclear in this population.

Objective: To compare the effect of a combined ergonomic intervention and core stability exercise programme with ergonomic intervention alone on pain intensity, lumbar mobility, and functional disability in dental students with LBP.

Methods: Sixty dental students (18–25 years) with LBP of more than one month's duration were allocated to Group A (ergonomic intervention alone, n = 30) or Group B (ergonomic intervention plus a progressive six-week core stability exercise programme, n = 30). Pain intensity (Numeric Pain Rating Scale, NPRS), lumbar mobility (Modified Schober Test), and disability (Oswestry Disability Index, ODI) were recorded at baseline and after six weeks. Within-group change was analysed with paired t-tests and between-group differences with independent-samples t-tests; significance was set at $p < 0.05$.

Results: Both groups improved significantly from baseline to week six on all three outcomes ($p < 0.001$ for all within-group comparisons). Mean pain reduction was 2.97 ± 1.22 points in Group A versus 2.43 ± 1.07 points in Group B; the between-group difference approached but did not reach conventional significance ($t = −1.80$, $p = 0.077$), while post-intervention pain scores were significantly lower in Group A (3.27 ± 1.28) than Group B (4.13 ± 1.70; $p = 0.030$). Gains in lumbar mobility (1.19 ± 0.39 cm vs 1.04 ± 0.31 cm; $p = 0.096$) and reduction in ODI scores (−12.13 ± 4.67% vs −12.07 ± 6.10%; $p = 0.962$) were statistically comparable between groups.

Conclusion: Both a stand-alone ergonomic education programme and a combined ergonomic-plus-core-stability programme produced large, clinically meaningful improvements in pain, lumbar mobility, and disability over six weeks in dental students with LBP. The addition of core stability exercises did not yield a statistically significant incremental benefit over ergonomic intervention alone within this short intervention window, and pain relief was numerically greater with ergonomic intervention alone. These findings should be interpreted cautiously given the small sample and short follow-up, and warrant confirmation in adequately powered trials with longer follow-up.

Keywords: low back pain; ergonomics; core stability exercise; dental students; Oswestry Disability Index; Modified Schober Test; randomized controlled trial.

Introduction

Low back pain (LBP) remains one of the most common musculoskeletal complaints encountered across occupational groups, and healthcare trainees who spend long hours in static, forward-flexed postures are a recognised at-risk population.[1] Dental education is a particularly demanding setting in this respect: pre-clinical and clinical training requires prolonged sitting, sustained neck and trunk flexion, and repeated fine-motor tasks performed in a confined working field, all of which increase spinal loading and predispose students to musculoskeletal strain long before they enter independent practice.[1,2] A recent systematic review and meta-analysis pooling data from more than 3,700 dental students reported a seven-day prevalence of low back symptoms of approximately 27%, comparable to the rates reported for the neck and upper back, and identified poor postural habits and limited ergonomic knowledge as consistent contributing factors.[5] Regional surveys of health-science students corroborate this picture, with LBP prevalence figures in the range of 27–37% and clear associations with body mass index and inadequate stretching or exercise habits.[6,3]

Musculoskeletal strain of this kind has been attributed to a combination of extrinsic and intrinsic factors. Extrinsically, awkward operator and patient positioning, poorly adjusted seating, and insufficient microbreaks accumulate mechanical load on the lumbar spine over a training day.[1] Intrinsically, sustained poor posture is thought to produce inhibition and delayed activation of the deep trunk stabilisers, particularly transversus abdominis and multifidus, reducing the dynamic control that normally protects the lumbar segments during flexion and loading tasks.[4] Ergonomic training programmes that address workstation set-up, neutral spine positioning, and scheduled postural breaks have shown consistent, if moderate, reductions in work-related musculoskeletal pain across occupational settings, including healthcare work.[7,9] Core stability exercise, which targets the deep stabilising musculature directly, has separately demonstrated benefit for pain and disability in people with chronic non-specific LBP in multiple randomized trials.[4,10,11]

What remains comparatively unexplored is whether combining these two approaches confers additional benefit over ergonomic correction alone, particularly in a population — dental students — that is still forming its professional postural habits rather than managing an established occupational injury. Existing evidence on combined ergonomic and exercise-based programmes in other occupational groups is mixed: some workplace trials report added value from multi-component programmes,[9] while others find that participatory ergonomic measures alone, without a supervised exercise component, do not reliably outperform usual care.[8]

This uncertainty motivated the present trial, which compared a six-week combined ergonomic-plus-core-stability programme against ergonomic education alone in dental students with LBP, using the Numeric Pain Rating Scale (NPRS), the Modified Schober Test, and the Oswestry Disability Index (ODI) as outcome measures.

The primary hypothesis was that the combined programme would produce significantly greater improvement in pain and lumbar mobility than ergonomic intervention alone. The secondary aim was to describe the magnitude of change produced by each intervention individually, since both are inexpensive, low-risk, and readily implementable within a dental curriculum.

2. Materials and Methods

2.1 Study design and setting

This was a prospective, randomized, parallel-group experimental study conducted over six weeks in the Department of Physiotherapy in collaboration with the dental training programme at Krishna Vishwa Vidyapeeth, Karad, Maharashtra, India. A randomized controlled design was chosen because it minimises selection and allocation bias when comparing two active interventions, and it allowed within-group (pre–post) and between-group (Group A vs Group B) comparisons to be made with the same set of standardized outcome measures.

2.2 Participants

Sixty dental students aged 18–25 years, of either sex, who were currently enrolled in clinical or pre-clinical training and reported LBP of more than one month's duration, were recruited. Eligible participants had a body mass index (BMI) within the normal range (18.5–25.9 kg/m^2) and were willing to complete the full six-week programme. Students with a history of spinal surgery or fracture, a diagnosed neurological disorder, acute disc prolapse, or who were pregnant were excluded. All participants provided written informed consent prior to enrolment, and confidentiality of personal and clinical information was maintained throughout the study.

2.3 Sample size and randomization

The required sample size was estimated using the standard proportion formula ($n = z^2pq/l^2$), yielding a minimum of 60 participants, who were allocated in a 1:1 ratio to Group A (ergonomic intervention alone, n = 30) or Group B (combined ergonomic intervention and core stability exercise, n = 30) using a random allocation procedure. Outcome assessments at baseline and at six weeks were conducted by an assessor who did not participate in delivering either intervention, in a quiet, standardized clinical setting, to reduce measurement and expectation bias.

2.4 Interventions

Both groups received an identical ergonomic education component: instruction in maintaining a neutral spine during clinical tasks, correct operator chair height and patient positioning (elbow angle 90–100°, cervical flexion below 20°), use of a lumbar-support stool, correct alignment of magnification loupes and lighting, scheduled microbreaks with stretching every 20–30 minutes, and a self-audit ergonomic checklist. Group B received this same ergonomic package plus a supervised, progressive core stability exercise programme performed over six weeks: a 10-minute warm-up (free arm and neck movement, trunk rotation, marching in place) preceded each session, and a 10-minute cool-down (static stretching of the back and hamstrings, breathing exercises) followed it. The exercise component progressed in three two-week blocks — abdominal draw-in manoeuvres, pelvic tilts, bridging, and bird-dog and cat-camel patterns in weeks 1–2; single-leg bridging, side plank holds, and dead-bug variations in weeks 3–4; and longer-duration planks, side plank with hip abduction, hamstring curls, and Pallof press in weeks 5–6, with volume and hold times increased progressively across blocks.

2.5 Outcome measures

Pain intensity was recorded using the Numeric Pain Rating Scale (0 = no pain, 10 = worst imaginable pain). Lumbar mobility was assessed with the Modified Schober Test, in which the examiner marks a point over the L5 spinous process and a second point 10 cm above it, and records the increase in distance between the two marks during maximal forward flexion; the test is widely used clinically for its simplicity, though its criterion validity against radiographic measurement is only moderate (r ≈ 0.67) and its reliability is regarded as acceptable to good for detecting within-subject change.[12,13] Functional disability was assessed with the Oswestry Disability Index, a ten-item, self-administered questionnaire covering pain and activities of daily living, scored as a percentage; the ODI has good internal consistency (Cronbach's α ≈ 0.85–0.87) and high test–retest reliability (r ≈ 0.83–0.99) in populations with chronic LBP.[14]

2.6 Statistical analysis

Data were tabulated in Microsoft Excel and analysed using standard parametric statistics. Descriptive statistics (mean, standard deviation) were calculated for demographic and outcome variables. Within-group change from baseline to week six was analysed using paired-samples t-tests; between-group differences in the magnitude of change and in post-intervention scores were analysed using independent-samples t-tests. Baseline comparability between groups was confirmed for age, sex distribution, BMI, and all three baseline outcome scores before the intervention effects were examined. A two-tailed p-value below 0.05 was considered statistically significant.

2.7 Ethical considerations

The study protocol, participant information sheet, and informed consent form were reviewed prior to data collection. Participation was voluntary, informed consent was obtained from every participant, and confidentiality and anonymity of participant data were maintained throughout data collection, analysis, and reporting; the aggregated data presented here do not identify individual participants.

3. Results

All 60 recruited participants (30 per group) completed the six-week programme and were included in the analysis; there were no dropouts.

3.1 Baseline characteristics

Group A and Group B were closely matched at baseline for age, sex distribution, BMI, and all three primary outcome measures, with no statistically significant between-group differences (Table 1). This confirms that the two groups were comparable before the intervention period began, supporting the validity of subsequent between-group comparisons.

Variable	Group A (Ergonomic intervention alone) n = 30	Group B (Combined ergonomic intervention + core stability exercise) n = 30	p-value
Age (years), mean ± SD	22.27 ± 1.57	22.40 ± 1.25	0.72
Sex, n (M/F)	10 / 20	10 / 20	1.00
BMI (kg/m²), mean ± SD	23.24 ± 3.28	24.10 ± 3.23	0.31
Baseline pain, NPRS (0–10)	6.23 ± 1.36	6.57 ± 1.45	0.36
Baseline lumbar mobility, Modified Schober (cm)	4.17 ± 0.47	4.20 ± 0.46	0.78
Baseline disability, ODI (%)	30.97 ± 5.57	28.97 ± 5.97	0.19

3.2 Within-group change from baseline to six weeks

Both groups showed large, statistically significant improvements on all three outcomes over the six-week intervention period (Table 2). In Group A, mean pain scores fell from 6.23 to 3.27 (a reduction of roughly 48%), Modified Schober distance increased from 4.17 cm to 5.36 cm, and ODI scores fell from 30.97% to 18.83%. In Group B, mean pain scores fell from 6.57 to 4.13 (a reduction of roughly 37%), Modified Schober distance increased from 4.20 cm to 5.24 cm, and ODI scores fell from 28.97% to 16.90%. All within-group paired comparisons were highly significant ($p < 0.001$), corresponding to very large within-group effect sizes (Cohen's dz ranging from approximately 2.0 to 3.4 across outcomes and groups).

Outcome	Pre-intervention (mean ± SD)	Post-intervention (mean ± SD)	Paired t	p-value
Group A — Pain (NPRS)	6.23 ± 1.36	3.27 ± 1.28	13.35	<0.001
Group A — Modified Schober (cm)	4.17 ± 0.47	5.36 ± 0.64	−16.71	<0.001
Group A — ODI (%)	30.97 ± 5.57	18.83 ± 6.62	14.24	<0.001
Group B — Pain (NPRS)	6.57 ± 1.45	4.13 ± 1.70	12.43	<0.001
Group B — Modified Schober (cm)	4.20 ± 0.46	5.24 ± 0.49	−18.63	<0.001
Group B — ODI (%)	28.97 ± 5.97	16.90 ± 7.63	10.84	<0.001

3.3 Between-group comparison

When the magnitude of change (post minus pre) was compared between groups, Group A showed a numerically greater reduction in pain (−2.97 ± 1.22) than Group B (−2.43 ± 1.07), a difference that approached but did not reach conventional statistical significance ($t = -1.80$, $p = 0.077$; Cohen's $d = 0.47$, a small-to-moderate effect favouring Group A). Post-intervention pain scores were significantly lower in Group A than Group B (3.27 ± 1.28 vs 4.13 ± 1.70; $p = 0.030$). Gains in lumbar mobility were also numerically larger in Group A (1.19 ± 0.39 cm) than Group B (1.04 ± 0.31 cm), again a non-significant trend ($t = 1.69$, $p = 0.096$; $d = 0.44$). Reduction in ODI scores was almost identical between groups (−12.13 ± 4.67% vs −12.07 ± 6.10%; $p = 0.962$) (Table 3).

Outcome (Δ = post − pre)	Group A Δ (mean ± SD)	Group B Δ (mean ± SD)	t	p
Pain (NPRS)	−2.97 ± 1.22	−2.43 ± 1.07	−1.80	0.077
Modified Schober (cm)	1.19 ± 0.39	1.04 ± 0.31	1.69	0.096
ODI (%)	−12.13 ± 4.67	−12.07 ± 6.10	−0.05	0.962

In summary, both interventions produced clinically important improvement across all three outcomes, but the hypothesised additional benefit of combining core stability exercise with ergonomic intervention was not observed within this six-week trial; if anything, the ergonomic-alone group showed a slightly greater reduction in pain.

4. Discussion

This trial found that both a six-week ergonomic education programme and a combined ergonomic-plus-core-stability programme produced large, statistically significant reductions in pain and disability and improvements in lumbar mobility among dental students with LBP. This confirms, in a student population, what has been shown previously in dentists and other healthcare workers: ergonomic correction targeting posture, workstation set-up, and scheduled breaks can meaningfully reduce musculoskeletal pain over a relatively short period.[7,9] The magnitude of within-group change observed here — roughly 37–48% reduction in pain scores and 12-percentage-point reductions in ODI — is consistent with, and in some respects larger than, the effects reported for ergonomic and exercise-based interventions in broader occupational musculoskeletal pain literature, where pooled mean differences are typically more modest.[9]

The absence of a significant incremental benefit from adding core stability exercise is, on its face, at odds with the substantial body of evidence supporting core stabilization training for chronic non-specific LBP in adult populations, where such programmes reliably outperform no-treatment or general-exercise controls.[4,10,11] Several features of the present trial may explain this divergence. First, the comparison here was not core stability exercise versus no treatment, but combined ergonomic-plus-exercise versus ergonomic intervention alone; because the ergonomic component itself was already an active and apparently effective intervention in this population, it may have left comparatively little additional variance for the exercise component to explain, particularly over only six weeks. Second, dental students with LBP of relatively short duration (as short as one month, per the inclusion criteria) differ from the chronic, treatment-seeking populations in which most core-stability trials have been conducted;

postural correction alone may address a larger share of the mechanical contribution to pain in this younger, less chronic group. Third, a six-week window may simply be too brief for the neuromuscular adaptations associated with core stabilization training — improved trunk endurance, motor control, and reduced provocation of pain during dynamic loading — to translate into a pain advantage detectable with a sample of this size; several core-stability trials demonstrating clear benefit have used longer intervention periods.[10,15] Finally, home-based or supplementary strengthening exercise introduces an adherence and dosage variable that a purely educational and workstation-based ergonomic intervention does not, and any variability in exercise technique or session completion in Group B could have diluted the expected additional effect.

The finding that ergonomic intervention alone produced numerically greater short-term pain relief than the combined programme should not be read as evidence against core stability training in general; broader systematic evidence continues to support its use for chronic LBP.[4,10,11] It is, however, consistent with mixed findings on multi-component workplace interventions, where some trials show clear added benefit from combining ergonomic and exercise elements[9] while others find that ergonomic measures alone perform comparably, or that a supervised exercise or education addition does not reliably outperform ergonomic correction alone in the short term.[8] Taken together, this suggests that the relative contribution of ergonomic correction versus targeted exercise may depend heavily on the chronicity of symptoms, the population studied, and the duration of follow-up, rather than being a fixed hierarchy of effectiveness.

From a practical standpoint, both interventions tested here are low-cost, low-risk, and readily deliverable within a dental training curriculum. Given that ergonomic education alone produced comparable or numerically better short-term outcomes than the combined programme, dental institutions with limited resources for supervised exercise instruction could reasonably prioritise structured ergonomic education and workstation correction as a first-line, scalable measure, while considering core stability exercise as an adjunct for students whose symptoms persist beyond the initial ergonomic intervention period.

4.1 Limitations

This study has several limitations that temper the interpretation of its findings. The sample size, while adequate for detecting the large within-group effects observed, was modest for detecting the comparatively smaller between-group differences with confidence, and the near-significant trends observed for pain and mobility ($p = 0.077$ and $p = 0.096$) may reflect a true small effect that a larger trial would confirm as significant, or may represent chance variation. The six-week follow-up window, while pragmatic for an academic term, is too short to establish whether the improvements observed — or any differential effect of the combined programme — are sustained over time; a longer follow-up period would help distinguish a genuine short-term ceiling effect from a delayed benefit of core stability training. Adherence to the home and supervised exercise components in Group B was not independently quantified in this report, which limits the ability to distinguish a true lack of additional benefit from inadequate dosage or fidelity. The Modified Schober Test, while simple and widely used, has only moderate criterion validity against radiographic gold standards,[13] and self-reported outcome measures such as the NPRS and ODI are subject to recall and social-desirability influences despite assessor blinding to group allocation. Finally, the single-centre design and the specific characteristics of this student population (age 18–25 years, normal BMI range) limit generalisability to older or more chronic LBP populations, or to other clinical training settings.

5. Conclusion

Both ergonomic intervention alone and combined ergonomic intervention with core stability exercise produced large and statistically significant improvements in pain, lumbar mobility, and disability over six weeks in dental students with low back pain. Contrary to the study hypothesis, adding core stability exercise to ergonomic education did not confer a statistically significant additional benefit over ergonomic intervention alone within this timeframe, and pain reduction was numerically greater with ergonomic intervention alone. These findings support ergonomic education as an effective, low-cost first-line measure for LBP in dental students and highlight the need for larger, longer-duration trials to clarify whether and when core stability exercise adds meaningful value to ergonomic correction in this population.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgements

The authors thank the participating dental students and the Department of Musculoskeletal Sciences, Krishna College of Physiotherapy, for institutional support during data collection.

References

1. Valachi B, Valachi K. Mechanisms leading to musculoskeletal disorders in dentistry. J Am Dent Assoc. 2003;134(10):1344-1350.
2. Kumar DK, et al. Ergonomic interventions in dental professionals: a randomized trial. Indian J Occup Ther. 2014;46(3).
3. Singh R, et al. Postural correction and strengthening in healthcare workers. Indian J Med Res. 2017;145(4).
4. Alghadir AH, et al. Effect of core stability training on pain and mobility in chronic low back pain. BMC Musculoskelet Disord. 2021.
5. Almeida MB, Póvoa R, Tavares D, Alves PM, Oliveira R. Prevalence of musculoskeletal disorders among dental students: a systematic review and meta-analysis. Heliyon. 2023;9(10):e19956.
6. Aljohani AA, Alarawi SM, Alhusayni YM, Alanazi RA, Alkonani AA, Alatawi BE, et al. Prevalence of low back pain among university attendants in Tabuk City during 2023: a cross-sectional study in Saudi Arabia. Cureus. 2023;15(12):e50357.
7. Kawtharani AA, Chemeisani A, Salman F, Haj Younes A, Msheik A. Neck and musculoskeletal pain among dentists: a review of the literature. Cureus. 2023;15(1):e33609.
8. Krishnanmoorthy G, Rampal S, Karuthan SR, Baharudin F, Krishna R. Effectiveness of participatory ergonomic interventions on work-related musculoskeletal disorders, sick absenteeism, and work performance among nurses: systematic review. JMIR Hum Factors. 2025.
9. Santos W, Rojas C, Isidoro R, Lorente A, Dias A, Mariscal G, et al. Efficacy of ergonomic interventions on work-related musculoskeletal pain: a systematic review and meta-analysis. J Clin Med. 2025;14(9):3034.
10. Khaledi A, Gheitasi M. Isometric vs isotonic core stabilization exercises to improve pain and disability in patients with non-specific chronic low back pain: a randomized controlled trial. Anesth Pain Med. 2024.
11. Riaz S, et al. Effectiveness of core stabilization exercises and routine exercise therapy in management of pain in chronic non-specific low back pain: a randomized controlled clinical trial. J Pak Med Assoc. 2017.
12. Williams RM, Binkley J, Bloch R, Goldsmith CH, Minuk T. Reliability of the modified-modified Schöber and double inclinometer methods for measuring lumbar flexion and extension. Phys Ther. 1993;73(1):26-37.
13. Rezvani A, Ergin O, Karacan I, Oncu M. Validity and reliability of the metric measurements for the assessment of lumbar spine motion in patients with ankylosing spondylitis. Spine. 2012.
14. Lee CP, Fu TS, Liu CY, Hung CI. Psychometric evaluation of the Oswestry Disability Index in patients with chronic low back pain: factor and Mokken analyses. Health Qual Life Outcomes. 2017;15:192.
15. Fuming Z, Weihui X, Jiajia Y, Shufeng L, Yiyi Z, Wenjian L, et al. Effect of m-health-based core stability exercise combined with self-compassion training for patients with non-specific chronic low back pain: study protocol for a randomized controlled trial. Trials. 2022;23:271.