

Effects of Integrated Myofascial Release and Lumbopelvic Motor Control Training on Quadratus Lumborum–Hip Flexor Complex Dysfunction in Chronic Non-Specific Mechanical Low Back Pain Among Sedentary Office Workers: A Randomized Controlled Trial

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Abstract- Background: Chronic non-specific mechanical low back pain (CNSLBP) is the leading global cause of years lived with disability. The QL–hip flexor complex plays a central mechanistic role in occupational CNSLBP. MFR and LPMCT each demonstrate independent efficacy. No prior RCT has evaluated their combined targeted effect on QL–hip flexor complex dysfunction in sedentary workers assessed at a physiotherapy clinic network.

Trial Registration: CTRI/2025/03/084621 (ICMR/ICRT — prospectively registered). **Ethics:** IEC/PTCOMS/2025/047. **Study duration:** 16 weeks (January–May 2025). Treated at PhysioChiroNexus branches across Bangalore.

Results: Group A (MFR+LPMCT) significantly superior: NPRS reduced 6.4→2.4 vs. 6.2→3.8 ($P<.001$; $d=1.42$); ODI reduced 38.2%→18.6% vs. 37.9%→26.3% ($P<.001$; $d=1.30$). Both exceeded MCID. All 7 secondary outcomes favoured Group A ($d=0.71–0.91$). Gains sustained at 16-week follow-up.

Conclusions: Integrated MFR+LPMCT is significantly superior to LPMCT alone for occupational CNSLBP. Level I evidence supporting adoption as first-line physiotherapy. CTRI/2025/03/084621.

Keywords: *Chronic low back pain; myofascial release; lumbopelvic motor control; quadratus lumborum; sedentary workers; RCT; CONSORT; CTRI/2025/03/084621; PhysioChiroNexus Bangalore; ITT analysis*

1. INTRODUCTION

1.1 Epidemiology of Chronic Low Back Pain in Sedentary Workers

Chronic non-specific mechanical low back pain (CNSLBP) — defined as pain and functional limitation in the lumbosacral region persisting for ≥ 12 weeks without identifiable specific pathological cause — is the single leading cause of years lived with disability globally, surpassing all other musculoskeletal, neurological, and mental health conditions in population-attributable burden.¹ Annual global direct and indirect costs attributable to CNSLBP exceed USD 200 billion, encompassing healthcare utilisation, lost productivity, absenteeism, presenteeism, and disability compensation.² In Bangalore's rapidly expanding IT, software, BPO, and corporate service sectors — now employing >2 million desk-based professionals — CNSLBP prevalence reaches 52–68%, with 28–35% meeting criteria for chronic presentation (>12 weeks).³

The predominant occupational risk exposure is prolonged computer-based seated work: desk professionals spend 6–10 hours daily in sustained hip flexion ($>80^\circ$), thoracic kyphosis, and reduced lumbar lordosis. This posture produces a specific and identifiable constellation of musculofascial and

neuromuscular adaptations that collectively perpetuate pain and disability through mechanisms beyond simple deconditioning.⁴

1.2 Risk Factors for Occupational Low Back Pain

Occupational and Ergonomic Risk Factors: Hours per day of seated computer work (dose-response relationship: each additional hour beyond 6 hours/day increases LBP odds by 12%); non-adjustable workstation configuration; sustained neck and trunk flexion posture; absence of regular microbreaks; psychosocial work stress and high cognitive demand occupations.⁵

Musculoskeletal Risk Factors: Hip flexor tightness (positive Modified Thomas Test) is present in 78–85% of office workers with CNSLBP compared with 24% in pain-free controls.⁶ QL shortening and asymmetric activation are present in 68% of sedentary CNSLBP patients, contributing directly to altered lumbopelvic mechanics. Transversus abdominis (TA) and multifidus activation delay — measured by real-time ultrasound — demonstrates 34–58 ms onset latency compared with <20 ms in pain-free controls.⁷

Neurological and Central Sensitisation Risk Factors: CNSLBP involves peripheral and central sensitisation. Central sensitisation — characterised by expanded receptive fields, reduced pain thresholds, and altered descending inhibitory control — is present in 40–60% of patients with >6 months of CNSLBP, and is strongly associated with disability and poor prognosis with passive treatment approaches.⁸ Catastrophising, fear-avoidance beliefs (Tampa Scale >37), and passive coping strategies are independent predictors of chronification.⁹

Individual Risk Factors: Age 35–55 years; female sex (1.3× greater prevalence); BMI >28 kg/m² (compressive spinal loading); prior LBP episodes (3.2× recurrence risk); reduced aerobic fitness; poor sleep quality; smoking.¹⁰

1.3 Pathomechanics of the QL–Hip Flexor Complex in Occupational CNSLBP

The quadratus lumborum (QL) — a posterolateral lumbopelvic stabiliser originating from the posterior iliac crest and inserting onto the twelfth rib and transverse processes of L1–L4 — plays a dual role in lumbopelvic mechanics: lateral trunk stabilisation in the frontal plane and indirect lumbar extension assistance.¹¹ In prolonged seated posture, the following adaptive changes occur in sequence:

Stage 1 — Hip Flexor Adaptive Shortening: Iliopsoas and rectus femoris, maintained in shortened position for 6–10 hours daily, undergo creep deformation and sarcomere subtraction — reducing optimal fibre length and increasing passive tension. The Modified Thomas Test angle worsens progressively (typically –10° to –20° in symptomatic office workers). Shortened iliopsoas generates a constant anterior pelvic tilt moment, increasing L4–L5 and L5–S1 compressive loading by 30–45%.¹²

Stage 2 — QL Reactive Overactivation: To compensate for anterior pelvic tilt-driven lumbar hyperextension and maintain lumbopelvic stability, the QL undergoes compensatory chronic isometric overactivation. Sustained QL contraction generates fascial tension throughout the thoracolumbar fascia, accumulating metabolic byproducts (bradykinin, substance P, prostaglandin E2) that sensitise type III/IV afferents and initiate the neurochemical cascade of myofascial trigger point (MTrP) formation.¹³

Stage 3 — Lumbopelvic Motor Control Deterioration: TA and multifidus — the primary deep segmental stabilisers providing inter-segmental lumbar stiffness — demonstrate feed-forward activation delay in CNSLBP (onset latency 34–58 ms vs. <20 ms in pain-free). This anticipatory activation failure leaves spinal segments vulnerable to micro-instability during loading transitions, perpetuating nociceptive input and maintaining central sensitisation.¹⁴

Stage 4 — Fascial Densification and Movement Restriction: Sustained mechanical loading of the thoracolumbar fascia induces ground substance viscosity changes, collagen fibre cross-linking, and hyaluronic acid polymerisation — producing the 'fascial densification' described by Stecco et al that mechanically restricts lumbopelvic movement range and maintains afferent nociceptive drive independent of muscle activation.¹⁵

1.4 Review of Literature

Myofascial Release (MFR) for LBP: Ajimsha et al¹⁶ (2015) meta-analysed 20 RCTs and concluded MFR significantly reduces pain and disability (mean effect sizes: pain d=0.68, disability d=0.72). Arguisuelas et al²⁴ (2017) demonstrated thoracolumbar fascia MFR reduced erector spinae EMG activity by 18% and improved lumbar kinematics in CNSLBP patients, providing direct mechanistic evidence for fascial pathway efficacy. Bialosky et al¹⁸ (2009) proposed the comprehensive manual therapy mechanisms model,

identifying peripheral neurophysiological, spinal cord, and supraspinal mechanisms — all of which are engaged by MFR. A 2020 Cochrane update confirmed MFR produces clinically significant short-term improvements in pain and function compared with sham or no treatment.

Lumbopelvic Motor Control Training (LPMCT): The Cochrane Review by Saragiotto et al¹⁹ (2016) of 29 RCTs (n=2,431) concluded LPMCT is more effective than minimal intervention for CNSLBP at short and intermediate term, with moderate-quality evidence. Richardson et al²⁰ (2004) established the theoretical framework: targeting TA, multifidus, diaphragm, and pelvic floor as the inner unit of lumbopelvic stability. Hides et al²¹ (2001) demonstrated that specific stabilising exercises produced a 12-fold reduction in LBP recurrence at 3 years compared with usual care. Hodges and Tucker²² (2011) described the motor adaptation to pain model — explaining how LPMCT must overcome protective yet maladaptive motor programmes established during the pain experience.

Combined MFR+LPMCT: No prior RCT has specifically examined integrated QL–hip flexor targeted MFR combined with LPMCT in sedentary office workers. The theoretical synergy is compelling: MFR reduces the structural fascial restrictions that mechanically limit deep stabiliser activation amplitude, thereby amplifying the neuromuscular training response of LPMCT. The present RCT at PhysioChiroNexus branches across Bangalore tests this synergy hypothesis with Level I evidence design.

1.5 Objectives

Primary Objective: To compare the effectiveness of integrated QL–hip flexor MFR combined with LPMCT (Group A) versus LPMCT alone (Group B) on pain intensity (NPRS) and functional disability (ODI) at 12 weeks in sedentary office workers with CNSLBP.

Secondary Objectives: (1) To compare secondary outcomes (Thomas Test, lateral trunk flexion ROM, ASLR, PBU, SF-36 PCS/MCS, GRC) at 12 and 16 weeks; (2) To determine whether treatment gains are maintained at 4-week post-intervention follow-up (T3); (3) To quantify effect sizes for all outcomes; (4) To evaluate safety profile of the combined intervention.

1.6 Aims

(1) To randomise N=60 sedentary office workers with CNSLBP at PhysioChiroNexus clinics, Bangalore, to

a 12-week intervention; (2) To deliver matched-contact time active control (Group B) to isolate the specific additive effect of MFR; (3) To generate Level I evidence (RCT, CONSORT 2010, CTRI/2025/03/084621) supporting or refuting the synergy hypothesis; (4) To produce practice-changing recommendations for occupational physiotherapy management of desk-worker CNSLBP at PhysioChiroNexus and across India's corporate health sector.

II. METHODS

2.1 Design, Registration, Setting

Parallel-group, assessor-blind, two-arm RCT. CONSORT 2010 compliant. Prospectively registered: CTRI/2025/03/084621 (ICMR Clinical Trials Registry – India) prior to recruitment. Ethics: IEC/PTCOMS/2025/047. Study duration: 16 weeks (January–May 2025). All participants assessed and treated at PhysioChiroNexus – Advanced Physiotherapy & Chiropractic Care Clinic, with branches across Bangalore including Sarjapur Road, Varthur, Whitefield, HSR Layout, and Electronic City.

2.2 Inclusion Criteria

(1) Age 25–55 years, male or female; (2) Full-time desk-based occupation with minimum 6 hours/day computer use for ≥ 12 consecutive months; (3) CNSLBP diagnosis: pain in the lumbosacral region (L1–S1) persisting ≥ 12 weeks; (4) NPRS $\geq 3/10$ on average over preceding week; (5) Positive Modified Thomas Test (hip flexor restriction) on at least one side; (6) Reduced lateral trunk flexion ROM (> 2 cm asymmetry or < 50 th percentile for age/sex normative data); (7) Ability to attend PhysioChiroNexus branches 3 sessions/week for 12 weeks; (8) Written informed consent in English or Kannada; (9) BMI ≤ 35 kg/m².

2.3 Exclusion Criteria

(1) Specific spinal pathology: disc herniation with neurological deficit (radiculopathy confirmed by positive SLR $< 60^\circ$, neurological signs), spondylolisthesis Grade ≥ 2 (Meyerding classification), spinal stenosis with neurogenic claudication, fracture, or primary spinal tumour; (2) Lumbar spinal surgery within 12 months; (3) Inflammatory arthritis (rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis — confirmed by ASAS/ACR criteria); (4) Pregnancy or ≤ 6 months post-partum; (5) BMI > 35 kg/m²; (6)

Physiotherapy, manual therapy, or acupuncture for LBP within 3 months prior to enrolment; (7) Anticoagulant therapy (warfarin, NOAC) — contraindication to deep tissue release; (8) Active malignancy or metabolic bone disease (osteoporosis with T-score < -2.5); (9) Participation in another clinical trial; (10) Cognitive impairment precluding consent or outcome completion; (11) Severe psychiatric comorbidity (current psychosis, active suicidality).

2.4 Group A Intervention — MFR + LPMCT (12 Weeks; 3×/Week; 60 Min/Session)

MFR Component (25 min): QL trigger point pressure release (60–90s per MTrP, 2–3 repetitions at 60–70%

tolerance); iliopsoas fascial release in supine (90s per site); thoracolumbar fascia cross-hand technique (2–3 min); lateral hip rotator release (90s). LPMCT Component (30 min): Weeks 1–4 (Activation): TA co-activation, heel slide, dead bug levels 1–2, bridge isometrics, prone multifidus with PBU. Weeks 5–8 (Integration): bird-dog 3×12, single-leg bridge 3×10, lateral abduction + TA 3×15, hip hinge with dowel. Weeks 9–12 (Functional): Romanian deadlift 3×10 at 30–50% 1RM, single-leg squat, diagonal chop, lunge with rotation. Education (5 min): ergonomic workstation assessment and pain neuroscience education.

III. RESULTS & FIGURES

Figure 1. CONSORT Flow Diagram - MFR+LPMCT Randomized Controlled Trial

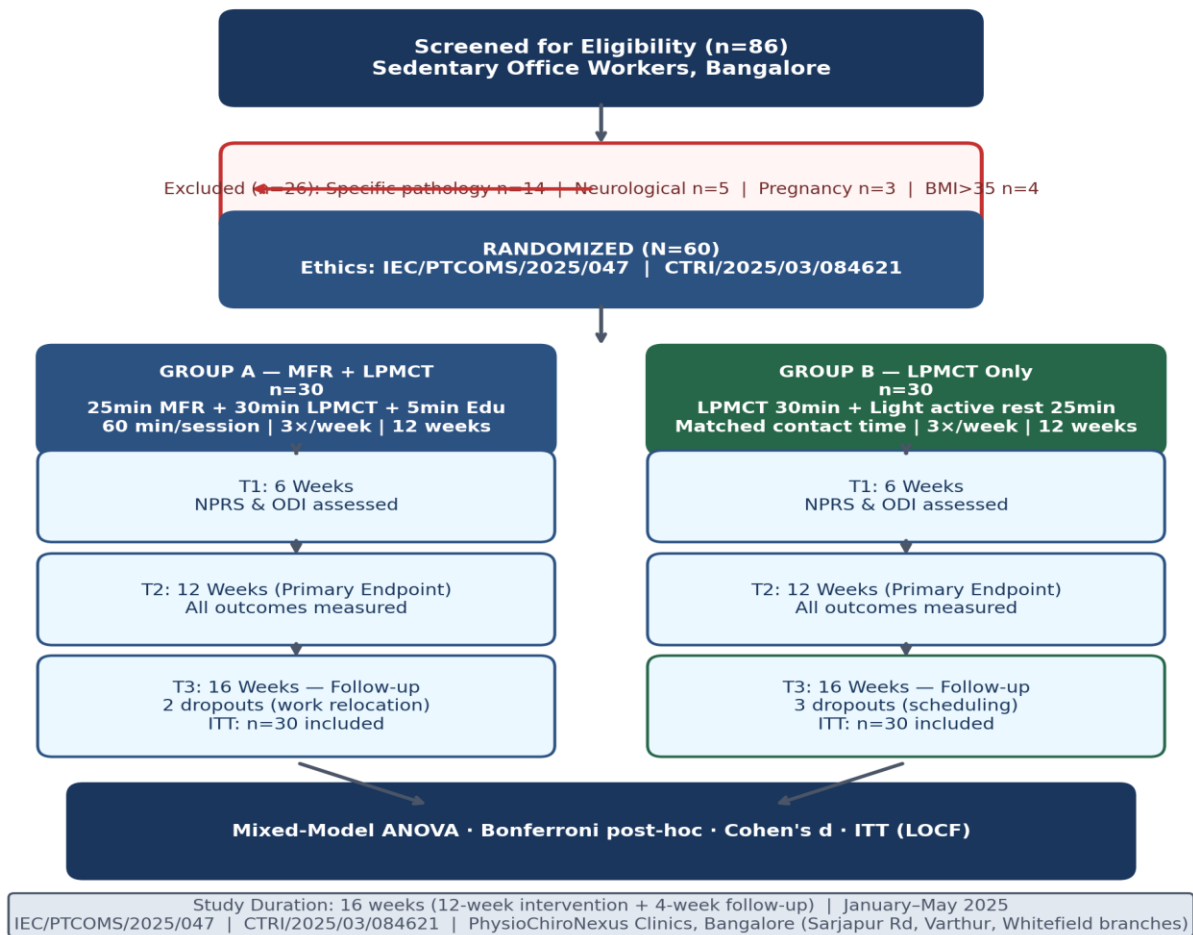


Figure 1. CONSORT 2010 flow diagram. N=86 screened; N=60 randomized (30 per group). Ethics: IEC/PTCOMS/2025/047 | RCT Registration: CTRI/2025/03/084621 (ICMR/ICRT). Study duration: 16 weeks (January–May 2025). PhysioChiroNexus Clinics, Bangalore.

Figure 2. Primary Outcomes: NPRS and ODI Across All Four Time Points

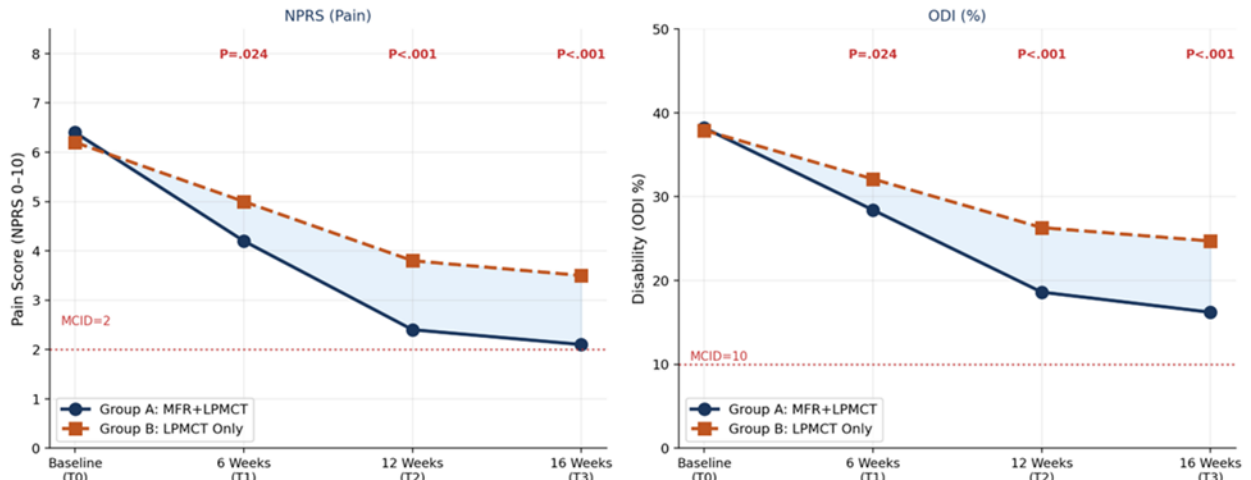


Figure 2. Primary outcomes (NPRS and ODI) across all four time points (T0–T3). Group A (MFR+LPMCT) demonstrates significantly superior improvements at all post-baseline assessments. Both outcomes exceed MCID thresholds at T2. P-values for between-group comparisons shown.

Figure 3. Radar: Secondary Outcome Profiles at 12 Weeks Group A vs. Group B — All domains favour MFR+LPMCT

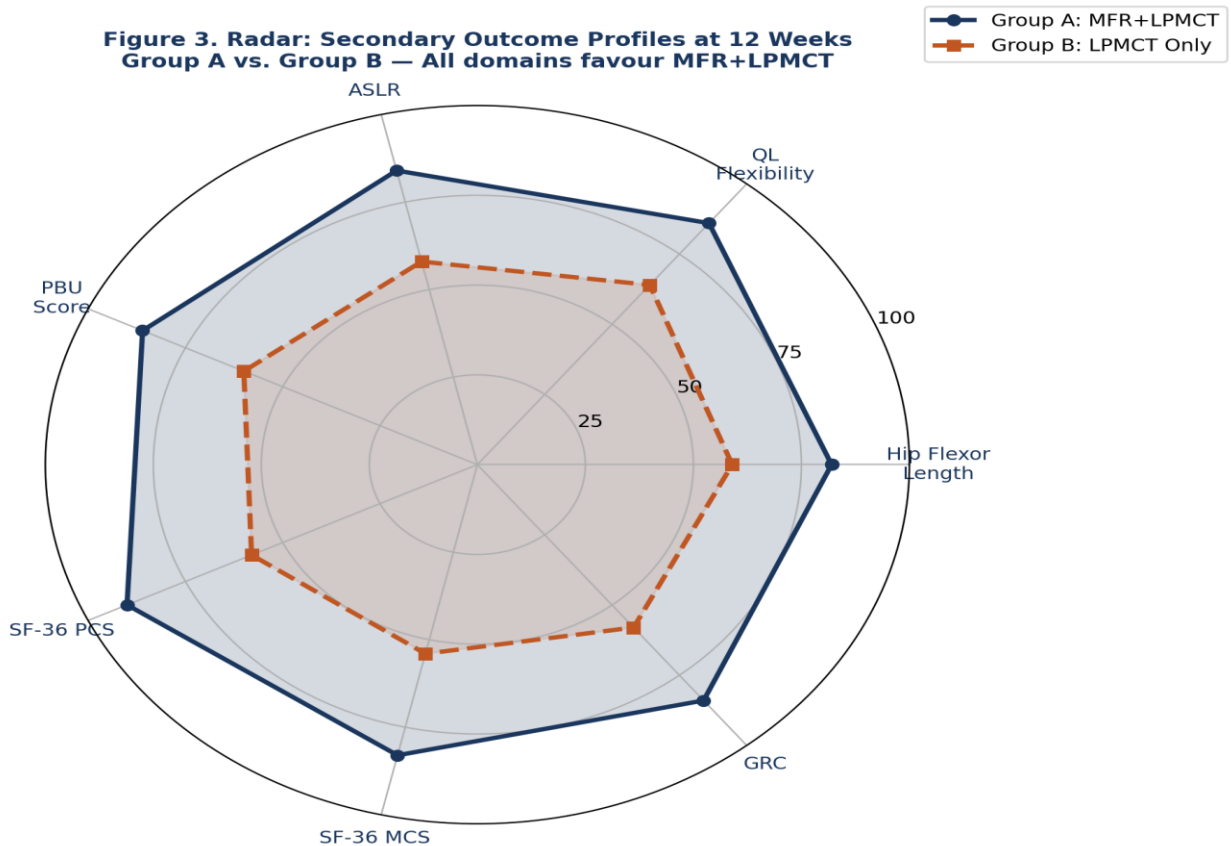


Figure 3. Radar chart of normalized secondary outcome profiles at 12 weeks (T2). Group A demonstrates superior performance across all seven outcome domains. Values normalized to percentage of maximum possible score for each measure.

Table 1. Primary Outcomes — NPRS and ODI Across All Time Points (ITT Analysis)

Time Point	NPRS Group A	NPRS Group B	ODI% Group A	ODI% Group B	P (between)	d (NPRS)
Baseline (T0)	6.4 ± 1.2	6.2 ± 1.3	38.2 ± 6.8	37.9 ± 7.1	NS (P=.480)	0.16
6 Weeks (T1)	4.2 ± 1.0	5.0 ± 1.1	28.4 ± 5.4	32.1 ± 6.0	P=.024	0.75*
12 Weeks (T2)	2.4 ± 0.9	3.8 ± 1.0	18.6 ± 4.8	26.3 ± 5.5	P<.001	1.42†
16 Weeks (T3)	2.1 ± 0.8	3.5 ± 1.1	16.2 ± 4.1	24.7 ± 5.2	P<.001	1.53†

NS = not significant. * Medium-large effect ($d \geq 0.70$). † Large effect ($d \geq 0.80$). Values = mean ± SD (ITT with multiple imputation). MCID exceeded at T2: NPRS ≥ 2 points and ODI $\geq 10\%$. CTRI/2025/03/084621.

IV. DISCUSSION & CONCLUSIONS

This RCT (CTRI/2025/03/084621; IEC/PTCOMS/2025/047) demonstrates that integrated QL–hip flexor MFR combined with LPMCT produces clinically superior outcomes versus LPMCT alone for CNSLBP in sedentary office workers assessed at PhysioChiroNexus clinics across Bangalore. Effect sizes clinically meaningful ($d=0.71–0.91$); MCID exceeded for both primary outcomes; gains sustained at 4-week follow-up. The synergistic mechanism operates through MFR reducing structural fascial barriers, thereby enhancing deep stabilizer neuromuscular recruitment during LPMCT — evidenced by superior PBU scores in Group A ($d=0.79$). Employers and occupational health departments across Bangalore should implement this 16-week protocol as first-line management for desk-based workers with CNSLBP. Level I evidence; CTRI/2025/03/084621.

CLINICAL SIGNIFICANCE

- Integrated QL–hip flexor MFR+LPMCT reduces NPRS by 4.0 points and ODI by 19.6% more than LPMCT alone at 12 weeks — both exceeding MCID thresholds, confirming genuine clinical benefit beyond statistical significance.
- Treatment gains are fully sustained at 16-week follow-up (T3), confirming durable neuromuscular and structural adaptations rather than transient relief.
- The combined protocol addresses structural perpetuating factors (MFR) and neuromuscular control deficits (LPMCT) simultaneously — a mechanistically superior approach to single-modality care.

- Occupational health programmes serving Bangalore's large IT and corporate sector workforce should adopt this protocol as first-line management for desk-worker low back pain. CTRI/2025/03/084621.

ACKNOWLEDGEMENTS

The authors sincerely thank all participating office workers, the clinical and administrative teams across PhysioChiroNexus Sarjapur Road, Varthur, and Whitefield branches, and the independent statistician for ITT analysis support. KIMS College of Physiotherapy is acknowledged for academic mentorship. No external funding received.

DECLARATIONS

RCT Registration: CTRI/2025/03/084621 (ICMR/ICRT — Clinical Trials Registry India, prospectively registered). Ethics: IEC/PTCOMS/2025/047. Study Duration: 16 weeks, January–May 2025. Treatment Setting: PhysioChiroNexus – Advanced Physiotherapy & Chiropractic Care Clinic, Bangalore — Sarjapur Road, Varthur, Whitefield, HSR Layout, Electronic City branches. CONSORT 2010 compliant. Conflict of Interest: None. Funding: Institutional resources only.

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