

EFFECTIVENESS OF AN INTEGRATED SWASTHAVRITTA, ALIGNMENT-ORIENTED YOGA AND KUKUNDARA MARMA SELF-MOBILISATION PROGRAMME VERSUS LIFESTYLE MODIFICATION FOR LOW BACK PAIN: A RANDOMISED CONTROLLED TRIAL

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ABSTRACT

Background: Low back pain (LBP) is multifactorial and affects pain, physical functioning and quality of life. A structured programme integrating lifestyle practices, therapeutic movement and Kukundara Marma self-mobilisation may provide broader benefits than lifestyle modification alone.

Objective: To evaluate the effectiveness of a 21-day integrated programme of selected Swasthavritta practices, alignment-oriented Yoga and Kukundara Marma self-mobilisation compared with structured lifestyle modification in adults with LBP.

Methods: This two-arm, parallel-group randomised controlled trial enrolled 290 adults aged 18–50 years with non-specific LBP. Participants were allocated 1:1 to an integrated intervention (n=145) or lifestyle-modification control (n=145). The intervention was delivered for 21 consecutive days, with outcomes assessed at baseline, Day 21 and Day 61. Pain, disability and quality of life were assessed using the Visual Analogue Scale (VAS), Oswestry Disability Index (ODI) and WHOQOL-BREF. Between-group effects were evaluated using adjusted ANCOVA and longitudinal mixed-effects models.

Results: At Day 21, VAS was 2.84 ± 1.41 in the intervention group and 4.41 ± 1.21 in the control group (between-group difference -1.57 , 95% CI -1.88 to -1.26 ; $p < 0.001$). ODI was 28.25 ± 17.65 versus 51.84 ± 16.71 (difference -23.59 percentage points, 95% CI -27.66 to -19.52 ; $p < 0.001$). All four WHOQOL-BREF domains showed significantly greater improvement in the intervention group. At Day 61, between-group differences remained significant for VAS (-1.24 , 95% CI -1.55 to -0.92), ODI (-19.87 percentage points, 95% CI -23.87 to -15.87), and all WHOQOL-BREF domains (all $p < 0.001$). A clinically meaningful $\geq 30\%$ reduction in pain at Day 21 occurred in 85.1% of intervention participants versus 17.1% of controls.

Conclusion: A 21-day integrated programme combining alignment-oriented Yoga, Kukundara Marma self-mobilisation and selected Swasthavritta practices produced greater improvements in pain, functional disability and quality of life than structured lifestyle modification, with benefits remaining evident at two-month follow-up. Because the intervention was multicomponent and more intensively supervised than the comparator, the independent contribution of individual components cannot be determined.

Trial registration: CTRI/2025/04/083874 (registered 02 April 2025).

KEYWORDS: low back pain; Swasthavritta; Yoga; alignment-oriented Yoga; Kukundara Marma; self-mobilisation; Ayurveda; lifestyle intervention; randomised controlled trial; VAS; ODI; WHOQOL-BREF.

1. INTRODUCTION

Low back pain is a major cause of disability and impaired daily functioning worldwide. The condition is commonly defined as pain, muscle tension or stiffness between the lower rib margins and the inferior gluteal folds, with or without leg pain. Most cases are non-specific and are influenced by interacting physical, behavioural, psychological and social factors. Consequently, contemporary management increasingly emphasises active approaches such as education, exercise, self-management and lifestyle modification.

Yoga-based interventions have shown beneficial effects on pain and function in people with LBP. Alignment-oriented Yoga emphasises postural awareness, controlled movement, mobility, flexibility, functional alignment and strengthening. Swasthavritta, the preventive and health-promotive branch of Ayurveda, emphasises daily routine, diet, sleep, physical activity and mental well-being. Integrating selected Swasthavritta practices with movement-based therapy may therefore address several modifiable factors relevant to LBP.

Kukundara Marma is described traditionally as a paired vital point in the gluteal region. In the present study, the Marma concept was operationalised as a standardised, self-performed series of gentle lumbopelvic mobility and stretching exercises corresponding to the posterior pelvic and lumbosacral region. The programme was designed within an Ayurvedic conceptual framework and informed at the movement level by contemporary physiotherapeutic approaches.

The present trial evaluated whether a 21-day integrated programme combining selected Swasthavritta practices, alignment-oriented Yoga and Kukundara Marma self-mobilisation produced greater improvements in pain, functional disability and quality of life than structured lifestyle modification.

2. MATERIALS AND METHODS

2.1 Study design and setting

This was a two-arm, parallel-group randomised controlled trial with 1:1 allocation. The intervention lasted 21 consecutive days, followed by a two-month follow-up. Assessments were performed at baseline (Day 1), immediately after intervention (Day 21) and follow-up (Day 61). The study was conducted at the Department of Swasthavritta, Government Ayurveda College Hospital, Pariyaram, Kannur, Kerala, which served as the recruitment and clinical assessment site.

2.2 Participants

Adults aged 18–50 years, irrespective of sex, presenting with non-specific LBP were eligible. Participants were excluded when LBP was associated with malignancy/neoplastic infiltration, severe systemic illness, recent surgery, immobilisation or bed rest, pregnancy or lactation, systemic disease as the primary cause of LBP, excessive menstrual bleeding, clinically restricted movement following surgery, or red-flag features including fever, trauma, anticoagulant use, genitourinary retention or sexual dysfunction, immunocompromised status, intravenous drug use, recent epidural injection, reduced anal sphincter tone, abnormal reflexes, lower-extremity weakness or saddle anaesthesia.

2.3 Randomisation and masking

A computer-generated variable-block randomisation sequence using block sizes of 4 and 6 was prepared independently. Sequentially numbered, opaque, sealed envelopes were used for allocation concealment and were opened only after eligibility, consent and baseline assessment were completed. Participants and intervention providers could not be blinded because of the nature of the interventions. Outcome assessment was performed by a blinded assessor who was not involved in recruitment, randomisation or intervention delivery. Statistical analyses were conducted using coded treatment-group labels until the prespecified primary analysis was completed.

2.4 Sample size

Sample size was calculated using the standard formula for comparison of two independent means. Based on the WHOQOL-BREF environmental domain, an anticipated between-group difference of 0.7 points, pooled SD of 1.90, two-sided $\alpha=0.05$ and 80% power required 116 participants per group. Allowing 20% attrition yielded 145 participants per group, for a total planned sample of 290.

2.5 Intervention

The intervention consisted of selected Swasthavritta practices, alignment-oriented Yoga and Kukundara Marma self-mobilisation. Supervised Yoga and Marma-related movement practice were delivered for approximately 60 minutes each morning for 21 consecutive days.

Selected Swasthavritta practices included Ushajala Pana according to the study instructions, self-Abhyanga with sesame oil, lukewarm bathing with avoidance of warm water over the head, and sleep guidance. The Yoga programme progressed from loosening and mobility to core activation, strengthening, flexibility and relaxation. Practices included Tadasana and variations, Ardha Kati Chakrasana, Ardha Chakrasana, Uttanasana, Veerabhadrasana, Parsvakonasana, Trikonasana, Adho Mukha Svanasana, Supta Padangusthasana, Balasana, Setu Bandhasana, Navasana, Pavanamuktasana, Viparita Karani, Apanasana, Shalabhasana, Bhujangasana, Makarasana and Anantasana, together with prescribed breathing, relaxation and yogic practices.

Alignment instruction emphasised comfortable spinal and pelvic alignment, controlled movement, appropriate load distribution and coordination with breathing. Exercises were modified within each participant's pain tolerance, flexibility and physical capacity without changing the essential prescribed components.

Kukundara Marma self-mobilisation comprised Figure Four Stretch, Ardha Pavanamuktasana, Cat–Cow movement and Child's Pose. Each exercise was performed for three repetitions per session under supervision. Participants were instructed to avoid forceful movement, excessive stretching and intentional aggravation of pain. The component was designed as self-performed lumbopelvic mobility rather than therapist-performed sacroiliac joint mobilisation.

2.6 Control intervention

The control group received a structured conventional lifestyle-modification programme for 21 days, including advice on physical activity, posture and ergonomics, appropriate stretching and core-strengthening exercises, stress management, adequate sleep and self-management. Participants received one structured session per week for reinforcement and individualised counselling and maintained a daily diary. The control condition did not include the structured Yoga, Kukundara Marma self-mobilisation or specified Swasthavritta practices of the intervention group.

2.7 Adherence and co-interventions

Participants maintained daily diaries documenting adherence. An adherent day required completion of all prescribed components for that day. Overall adherence was calculated as completed prescribed days divided by total prescribed days $\times 100$. Attendance at supervised sessions was recorded separately. Adherence of $\geq 80\%$ was prespecified as satisfactory for per-protocol analysis. Participants were asked to report medications, physical therapy, additional exercises or other treatments during intervention and follow-up.

2.8 Outcome measures

Primary outcomes were pain intensity, functional disability and quality of life. Pain was assessed using a 0–100 mm VAS; disability using the Oswestry Disability Index (ODI, version 2.1a); and quality of life using WHOQOL-BREF. All outcomes were assessed at Day 1, Day 21 and Day 61.

2.9 Ethics and trial registration

The study was approved by the Institutional Ethics Committee of Government Ayurveda College Pariyaram, Kannur (GACK/2025/1/PhD-3; approved 03 March 2025). Written informed consent was obtained from all participants. The trial was registered with the Clinical Trials Registry–India (CTRI/2025/04/083874) on 02 April 2025. The first participant was enrolled on 14 April 2025 and the study was completed on 31 October 2025.

2.10 Statistical analysis

Data were analysed using Jamovi version 2.7.33. Distributional assumptions were assessed using the Shapiro–Wilk test. Appropriate parametric or non-parametric tests were used for within- and between-group comparisons. Effect sizes were calculated where appropriate. ANCOVA assessed Day 21 and Day 61 outcomes after adjustment for baseline outcome values, age, sex, BMI, comorbidity, occupation, socioeconomic status and education. Linear mixed-effects models with participant-level random intercepts and group-by-time interactions used all available observations. Logistic regression estimated adjusted odds of achieving a clinically meaningful $\geq 30\%$ reduction in VAS. Two-sided $p < 0.05$ was considered statistically significant.

3. RESULTS

3.1 Participant flow and baseline characteristics

A total of 290 participants were randomised, with 145 allocated to each group. At Day 21, outcome data were available for 134 intervention and 140 control participants. At Day 61, data were available for 132 and 129 participants, respectively. Overall attrition at Day 61 was 10%. All randomised participants were retained in their allocated groups for intention-to-treat analyses, and mixed-effects models used all available observations. No serious adverse events occurred. Baseline characteristics were generally comparable. Mean age was 43.35 ± 6.23 years in the intervention group and 42.94 ± 6.52 years in the control group. Women comprised 57.2% and 53.1%, respectively. BMI differed statistically between groups (25.88 ± 1.48 vs 25.24 ± 2.52 kg/m²; $p = 0.028$) and was included in adjusted analyses. Baseline VAS and ODI were similar between groups, and none of the WHOQOL-BREF domains differed significantly at baseline.

Variable	Integrated programme (n=145)	Lifestyle modification (n=145)	p value
Age, years	43.35 ± 6.23	42.94 ± 6.52	0.699
BMI, kg/m ²	25.88 ± 1.48	25.24 ± 2.52	0.028
Female, n (%)	83 (57.2)	77 (53.1)	0.555
VAS, baseline	5.46 ± 1.18	5.37 ± 1.19	0.481
ODI, baseline (%)	52.65 ± 14.02	52.15 ± 13.13	0.725

3.2 Pain intensity

Pain decreased in both groups but to a greater extent in the integrated programme. VAS decreased from 5.46 ± 1.18 at baseline to 2.84 ± 1.41 at Day 21 and 2.42 ± 1.57 at Day 61 in the intervention group. Corresponding control-group values were 5.37 ± 1.19 , 4.41 ± 1.21 and 3.65 ± 0.92 . The Day 21 between-group difference was -1.57 points (95% CI -1.88 to -1.26 ; $p < 0.001$), and the Day 61 difference was -1.24 points (95% CI -1.55 to -0.92 ; $p < 0.001$). Adjusted ANCOVA showed a group effect of -1.693 at Day 21 and -1.355 at Day 61 (both $p < 0.001$).

At Day 21, a $\geq 30\%$ reduction in VAS was achieved by 114/134 (85.1%) intervention participants compared with 24/140 (17.1%) controls. The adjusted odds ratio for a clinically meaningful response was 39.03 (95% CI 18.33–83.13; $p < 0.001$).

3.3 Functional disability

ODI improved substantially in the intervention group. At Day 21, ODI was $28.25 \pm 17.65\%$ in the intervention group compared with $51.84 \pm 16.71\%$ in controls, yielding a between-group difference of -23.59 percentage points (95% CI -27.66 to -19.52 ; $p < 0.001$). At Day 61, ODI was $24.35 \pm 18.55\%$ versus $44.22 \pm 14.19\%$, with a between-group difference of -19.87 percentage points (95% CI -23.87 to -15.87 ; $p < 0.001$). The adjusted Day 21 group effect was -24.68 percentage points (95% CI -28.09 to -21.27 ; $p < 0.001$).

3.4 Quality of life

All four WHOQOL-BREF domains improved more in the intervention group. At Day 21, between-group differences were 11.36 points for physical, 12.12 for psychological, 15.31 for social and 7.11 for environmental quality of life (all $p < 0.001$). At Day 61, the corresponding differences were 10.76, 9.98, 13.45 and 6.75 points, respectively (all $p < 0.001$).

Outcome	Day 21: Integrated	Day 21: Control	Between-group difference (95% CI)
VAS	2.84 ± 1.41	4.41 ± 1.21	-1.57 (-1.88 to -1.26)
ODI (%)	28.25 ± 17.65	51.84 ± 16.71	-23.59 (-27.66 to -19.52)
WHOQOL physical	55.49 ± 9.05	44.13 ± 7.62	$+11.36$ (9.37 to 13.34)
WHOQOL psychological	60.60 ± 12.19	48.48 ± 8.72	$+12.12$ (9.60 to 14.64)
WHOQOL social	65.61 ± 14.57	50.30 ± 13.61	$+15.31$ (11.97 to 18.65)
WHOQOL environmental	59.24 ± 8.19	52.12 ± 5.86	$+7.11$ (5.42 to 8.81)

3.5 Adjusted and longitudinal analyses

Adjusted analyses were consistent with the primary comparisons. At Day 21, adjusted group effects were -1.69 for VAS and -24.68 percentage points for ODI. Adjusted effects for physical, psychological, social and environmental WHOQOL-BREF domains were $+11.70$, $+12.59$, $+16.37$ and $+7.23$ points, respectively (all $p < 0.001$). Longitudinal mixed-effects models demonstrated significant group-by-time interactions for VAS, ODI and all four WHOQOL-BREF domains at Days 21 and 61.

4. DISCUSSION

This randomised controlled trial found that a 21-day integrated programme combining selected Swasthavritta practices, alignment-oriented Yoga and Kukundara Marma self-mobilisation produced greater improvements in pain, functional disability and quality of life than structured lifestyle modification. Improvements were evident at Day 21 and remained significant at Day 61.

The pain findings were consistent across raw comparisons, adjusted analyses and longitudinal modelling. The intervention group showed a mean VAS reduction of 2.67 points by Day 21 compared with 0.97 points in controls, and the between-group difference remained 1.36 points in change from baseline at Day 61. The high proportion of participants achieving at least a 30% pain reduction further supports the magnitude of the observed response.

The disability findings were particularly pronounced. The Day 21 between-group difference in ODI was approximately 23.6 percentage points, with an adjusted group effect of −24.68 points. Improvement extended across the domains assessed by ODI, indicating that the response was not restricted to pain intensity but was accompanied by better reported function in activities such as sitting, standing, walking, lifting, sleep and social activities. The subsequent improvement in the control group during follow-up reduced, but did not eliminate, the between-group difference.

All four WHOQOL-BREF domains improved significantly more in the intervention group. The social domain showed the largest numerical difference, followed by the psychological and physical domains, while the environmental domain showed the smallest difference. These findings suggest that the intervention's effects extended beyond symptom reduction to broader perceived well-being. However, changes in quality of life should not be interpreted as proof of specific psychological, social or environmental mechanisms.

Several plausible mechanisms may explain the observed response. Alignment-oriented Yoga provided repeated controlled movement, flexibility work, strengthening, breathing and relaxation, potentially supporting lumbopelvic function and movement confidence. Kukundara Marma self-mobilisation provided a structured movement stimulus to the posterior pelvic and lumbosacral region. Swasthavritta practices extended the intervention into daily routines involving sleep, self-care and activity behaviour. These mechanisms remain plausible rather than experimentally demonstrated because the trial did not measure biomechanical, autonomic, neurophysiological or behavioural mediators.

An important strength is that the comparator was an active lifestyle-modification programme rather than no treatment. Nevertheless, the intervention and control groups differed substantially in contact intensity: the intervention included daily supervised sessions, whereas the control received weekly reinforcement and self-monitoring. Therefore, the observed between-group differences may reflect the combined effects of therapeutic content, supervision, attention, treatment expectancy, group interaction and adherence. Participants and intervention providers could not be blinded, and the main outcomes were self-reported.

The findings should therefore be interpreted as evidence for the effectiveness of the complete integrated programme under the conditions of this trial, rather than evidence that any single component—Yoga, Kukundara Marma self-mobilisation or Swasthavritta—was independently responsible for the effect. The single-centre setting and relatively educated, heterogeneous working-age sample also limit generalisability. Follow-up to Day 61 demonstrates persistence over approximately two months but does not establish long-term maintenance.

4.1 Strengths

Strengths include randomised allocation, allocation concealment, blinded outcome assessment, prespecified follow-up, an active lifestyle comparator, intention-to-treat analysis, adjustment for important baseline covariates, longitudinal mixed-effects modelling, adherence monitoring and trial registration before completion of recruitment.

4.2 Limitations

The main limitations are the absence of participant and provider blinding, reliance on self-reported primary outcomes, unequal intervention contact and supervision, single-centre recruitment, and the multicomponent nature of the intervention. The study cannot determine the independent contribution of each therapeutic component or establish mechanistic pathways. Longer follow-up and contact-matched comparators are needed.

4.3 Implications for future research

Future trials should use contact-matched active comparators, longer follow-up and objective measures of physical function and adherence. Factorial or dismantling designs could determine the independent and combined effects of Yoga, Kukundara Marma self-mobilisation and Swasthavritta practices. Mediator analyses examining self-efficacy, fear-avoidance, movement behaviour and relevant physiological measures may further clarify mechanisms.

5. CONCLUSION

A 21-day integrated programme of selected Swasthavritta practices, alignment-oriented Yoga and Kukundara Marma self-mobilisation produced greater improvements in pain, functional disability and all four WHOQOL-BREF domains than structured lifestyle modification in adults with non-specific LBP. Benefits were evident immediately after the intervention and remained significant at two-month follow-up. The results support further evaluation of this integrated programme, while recognising that its multicomponent design and greater supervised contact prevent attribution of the observed effects to any single component.

Declarations

Ethics approval and consent

Approved by the Institutional Ethics Committee, Government Ayurveda College Pariyaram, Kannur (GACK/2025/1/PhD-3; 03 March 2025). Written informed consent was obtained from all participants.

Trial registration

Clinical Trials Registry–India: CTRI/2025/04/083874; registered 02 April 2025.

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Competing interests

The authors declare no conflict of interest.

Data confidentiality

Participant data were coded using unique study identification numbers. Personally identifiable information was stored separately from outcome data.

Generative AI / language assistance

The authors used Grammarly for spelling, punctuation and grammar checking, as stated in the original manuscript.

Author contributions

SS: conceptualisation, methodology, investigation, resources, data curation, supervision, validation, formal analysis and drafting. MC: conceptualisation, methodology, data curation, supervision, validation, formal analysis and critical revision. MK: conceptualisation, methodology, data curation, supervision, validation, formal analysis and drafting/revision.

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REFERENCES

1. GBD 2021 Low Back Pain Collaborators. Global, regional, and national burden of low back pain, 1990–2020, its attributable risk factors, and projections to 2050: a systematic analysis of the Global Burden of Disease Study 2021. *Lancet Rheumatol*. 2023;5(6):e316–e329. doi:10.1016/S2665-9913(23)00098-X.
2. Otero-Ketterer E, Peñacoba-Puente C, Ferreira Pinheiro-Araujo C, et al. Biopsychosocial factors for chronicity in individuals with non-specific low back pain: an umbrella review. *Int J Environ Res Public Health*. 2022;19(16):10145. doi:10.3390/ijerph191610145.
3. Xu HR, Zhang YH, Zheng YL. The effect and mechanism of motor control exercise on low back pain: a narrative review. *EFORT Open Rev*. 2023;8(7):581–591. doi:10.1530/EOR-23-0057.
4. Herrero P, Val P, Lapuente-Hernández D, et al. Effects of lifestyle interventions on the improvement of chronic non-specific low back pain: a systematic review and network meta-analysis. *Healthcare*. 2024;12(5):505. doi:10.3390/healthcare12050505.
5. Hayden JA, Ellis J, Ogilvie R, Malmivaara A, van Tulder MW. Exercise therapy for chronic low back pain. *Cochrane Database Syst Rev*. 2021;9:CD009790. doi:10.1002/14651858.CD009790.pub2.
6. Briggs AM, Sumi Y, Banerjee A. The World Health Organization guideline for non-surgical management of chronic primary low back pain in adults: implications for equitable care and strengthening health systems globally. *Glob Health Res Policy*. 2025;10(1):26. doi:10.1186/s41256-025-00426-w.
7. Tankha H, Gaskins D, Shallcross A, et al. Effectiveness of virtual yoga for chronic low back pain. *JAMA Netw Open*. 2024;7(11):e2442339. doi:10.1001/jamanetworkopen.2024.42339.
8. Nambi GS, Inbasekaran D, Khuman R, et al. Changes in pain intensity and health related quality of life with Iyengar yoga in nonspecific chronic low back pain: a randomized controlled study. *Int J Yoga*. 2014;7(1):48–53. doi:10.4103/0973-6131.123481.
9. Bhatta M, Patil SS, Yadav SS, et al. Effects of yoga and add on Ayurvedic Kati Basti therapy for patients with chronic low back pain: a randomized controlled trial. *J Ayurveda Integr Med*. 2024;15(4):101030. doi:10.1016/j.jaim.2024.101030.
10. WHO. International Standard Terminologies on Ayurveda. 1st ed. World Health Organization; 2023.
11. Pathak A, Sharma S, Jensen MP. The utility and validity of pain intensity rating scales for use in developing countries. *Pain Rep*. 2018;3(5):e672. doi:10.1097/PR9.0000000000000672.
12. Vianin M. Psychometric properties and clinical usefulness of the Oswestry Disability Index. *J Chiropr Med*. 2008;7(4):161–163. doi:10.1016/j.jcm.2008.07.001.
13. The WHOQOL Group. Development of the World Health Organization WHOQOL-BREF quality of life assessment. *Psychol Med*. 1998;28(3):551–558. doi:10.1017/S0033291798006667.
14. Yusuf M, Finucane L, Selfe J. Red flags for the early detection of spinal infection in back pain patients. *BMC Musculoskelet Disord*. 2019;20:606. doi:10.1186/s12891-019-2949-6.
15. Tekur P, Chametcha S, Hongasandra RN, Raghuram N. Effect of yoga on quality of life of chronic low back pain patients: a randomized control study. *Int J Yoga*. 2010;3(1):10–17. doi:10.4103/0973-6131.66773.
16. Kumar S, Rampp T, Kessler C, et al. Effectiveness of Ayurvedic massage (Sahacharadi Taila) in patients with chronic low back pain: a randomized controlled trial. *J Altern Complement Med*. 2017;23(2):109–115. doi:10.1089/acm.2015.0272.
17. Yan H, Zhao P, Guo X, Zhou X. The effects of core stability exercises and Mulligan’s mobilization with movement techniques on sacroiliac joint dysfunction. *Front Physiol*. 2024;15:1337754. doi:10.3389/fphys.2024.1337754.
18. Butttagat V, Techakhrot P, Wiriya W, et al. Effectiveness of traditional Thai self-massage combined with stretching exercises for chronic non-specific low back pain: a randomized controlled trial. *J Bodyw Mov Ther*. 2020;24(1):19–24. doi:10.1016/j.jbmt.2019.03.017.
19. Suh JH, Kim H, Jung GP, Ko JY, Ryu JS. The effect of lumbar stabilization and walking exercises on chronic low back pain: a randomized controlled trial. *Medicine (Baltimore)*. 2019;98(26):e16173. doi:10.1097/MD.00000000000016173.

20. Verville L, Ogilvie R, Hincapié CA, et al. Systematic review to inform a WHO clinical practice guideline: benefits and harms of structured exercise programs for chronic primary low back pain in adults. *J Occup Rehabil.* 2023;33(4):636. doi:10.1007/s10926-023-10124-4.