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Effects of a Combined Iyengar Yoga and Yoga Nidra Intervention on Pain, Physiological, and Psychological Outcomes in Older Men with Chronic Low Back Pain: A Randomized Controlled Trial

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Abstract

Chronic low back pain (CLBP) is a leading cause of disability worldwide, particularly affecting older adults. Mind-body interventions show promise for pain management, but evidence for comprehensive yoga programs specifically targeting older men remains limited. The aim of the study was to assess the effects of a 3-month combined Iyengar yoga and Yoga Nidra (IY+YN) intervention on pain and associated outcomes in older men with chronic low back pain (CLBP). In this randomised controlled study (RCT) conducted in Dhenkanal, Odisha, India, we enrolled 60 men aged 55–65 years with CLBP lasting ≥3 months and pain intensity ≥4 on a 10-point Visual Analog Scale (VAS). Between Jan–Mar 2024, 55 participants were randomized (intervention n=28; control n=27) to either a 3-month IY+YN intervention (three 60-min yoga sessions plus 20–30 min YN weekly) or standard care (prescribed pain management and physical therapy). Primary outcome was change in pain intensity (VAS) at 3 months. Secondary outcomes included lumbar ROM, systolic BP, attention (Stroop test), anxiety (Beck Anxiety Inventory), and QoL (SF-36). Assessments were conducted at baseline, 6 weeks, and 3 months by blinded assessors. At 3 months, the intervention group showed significantly greater pain reduction compared with controls (mean diff. -2.6, 95% CI -3.3 to -1.9; p<0.001). Improvements were also seen in lumbar flexion (mean diff. 8.3°, p<0.001), systolic BP (mean diff. -7.5 mmHg, p<0.001), Stroop score (mean diff. -8.3

sec, p<0.001), anxiety (mean diff. -8.7, p<0.001), and SF-36 physical and mental scores. Five minor adverse events were reported, resolving within 48 hours. In conclusion, a 3-month combined IY+YN significantly reduced pain and improved physical, psychological, and quality-of-life outcomes in older men with chronic low back pain. The program was safe and well tolerated, supporting its use as an effective adjunct to standard care.

Keywords: *yoga, relaxation, back pain, range of motion, quality of life*

Introduction

Chronic low back pain (LBP) represents one of the leading causes of disability worldwide, affecting approximately 7.5% of the global population and imposing substantial economic and healthcare burdens (Safiri et al., 2023). The prevalence of chronic LBP increases with age, particularly among men in their sixth and seventh decades of life, with epidemiological studies indicating that up to 40% of men aged 55-65 years experience persistent low back symptoms (Lo et al., 2021). Despite the significant impact of this condition, conventional treatment approaches including pharmacotherapy, physical therapy, and surgical interventions often provide suboptimal outcomes, with a substantial proportion of patients reporting persistent pain and disability (Alperovitch-Najenson et al., 2023).

The multidimensional nature of chronic LBP, encompassing physical, psychological, and neurophysiological components, suggests the need for integrative approaches that address these interconnected aspects simultaneously (Shi & Wu, 2023). Mind-body interventions have gained increasing attention in recent years as potentially valuable complements or alternatives to conventional treatment modalities (Islam et al., 2022; Maheshkumar et al., 2022). Among these interventions, yoga has shown promise in managing chronic pain conditions, with systematic reviews suggesting moderate evidence for its effectiveness in reducing pain intensity and improving function in patients with chronic LBP (Mann, 2024).

Iyengar yoga, a form of Hatha yoga distinguished by its emphasis on precise anatomical alignment, detailed instructions, and the use of props to support proper positioning, may be particularly suitable for individuals with chronic LBP (Amin & Goodman, 2014). The methodical approach of Iyengar yoga allows for modifications tailored to individual limitations and has demonstrated efficacy in improving pain, disability, and quality of life in mixed-gender populations with chronic LBP (Shapiro & Cline, 2004). However, most studies have included predominantly female participants, leaving uncertainty about the effectiveness of this approach specifically for men, who may present with different pain patterns, biomechanical factors, and psychological responses to pain.

Yoga Nidra, a systematic form of guided meditation that induces deep relaxation while maintaining awareness, represents another promising approach for life style management (Vanitha et al., 2018). This practice has been associated with reduced sympathetic activation, improved stress response, and modulation of pain perception through enhanced interoceptive awareness (Ragavee et al., 2024). Preliminary studies suggest that Yoga Nidra may complement physical yoga practices by addressing psychological dimensions of chronic pain, including anxiety, catastrophizing, and pain-related fear, which are recognized as important factors in pain chronicity (Moszeik et al., 2022).

Despite the potential synergistic benefits of combining physical yoga practice with meditation techniques, few studies have evaluated integrated approaches specifically targeting older men with chronic LBP. This population may face unique challenges related to pain perception, body awareness, and adherence to mind-body interventions that have traditionally attracted predominantly female participants (Nikolis et al., 2024). A meta-analysis by Anheyar et al. (2022) of 29 randomized trials (n=2,702) found moderate effects on function (SMD -0.48) and pain (SMD -0.40) at 3-6 months, but noted considerable heterogeneity (I^2=64-79%) across studies. Tilbrook et al. (2011) demonstrated 2.2-point improvement in disability scores among 313 adults, but their sample was 71% female with mean age 47 years. Chang et al. (2016) demonstrated in a 12-week trial among 150 adults with chronic LBP that Hatha yoga practice reduced pain scores from 6.8±1.2 to 3.4±1.5 on a 0-10 visual analog scale, with improvements persisting at 6-month follow-up, though their sample included only 28% male participants. Critically, these studies have predominantly enrolled middle-aged women, typically excluded individuals with significant disability, and rarely examined Iyengar yoga specifically among older men, representing a notable evidence gap.

The present study addresses these gaps by evaluating the effects of a structured program combining Iyengar yoga and Yoga Nidra on pain intensity, functional mobility, autonomic function, cognitive attention, anxiety, and quality of life in men aged 55-65 years with chronic LBP. By focusing on this specific demographic and employing rigorous methodology, this research aims to provide evidence for an integrative approach that may more comprehensively address the complex nature of chronic LBP in a population with significant unmet treatment needs.

Methods

Participant characteristics

Between January and March 2024, 87 men with chronic low back pain were assessed for eligibility, of whom 60 met the inclusion criteria and were randomly assigned to either the intervention group (n=30) or the control group (n=30). Five participants (two from the intervention group, three from the control group) withdrew from the study, resulting in 55 participants (28 intervention, 27 control) completing the 3-month protocol (Figure 1B).

Study design

This study was conducted as a prospective, randomized, parallel-group, controlled trial with a 1:1 allocation ratio. Participants were randomly assigned to either the intervention group (Iyengar yoga combined with Yoga Nidra) or the control group (standard care) using computer-generated random numbers. The study followed the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Ethics and dissemination

This study was approved by Meenakshi Medical College Hospital & Research Institute (approval number: MAHER/IEC/PhD/36/Nov24). Written informed consent was obtained from all participants.

Sample size determination

Sample size calculation was based on detecting a clinically significant difference in VAS pain scores between groups (Williams et al., 2009). Assuming a medium effect size (Cohen's d=0.5), 80% power, a two-sided alpha of 0.05, and an anticipated attrition rate of 15%, we calculated a required sample size of 60 participants (30 per group). This calculation was performed using G*Power software version 3.1.

Setting

The study was conducted at Saundarya (NGO) in Dhenkanal, Odisha, India from 3rd January 2025 to 3rd April 2025. All yoga sessions were conducted in a standardized environment under the supervision of certified yoga instructors.

Participants eligibility criteria

Eligible participants were men aged fifty-five to sixty-five years with CLBP persisting for at least three months. Additional inclusion criteria required self-reported pain intensity of four or greater on a ten-point Visual Analog Scale (VAS) at baseline, ability to attend regular Iyengar yoga and Yoga Nidra sessions over a three-month period, medical clearance to participate in moderate physical activity, and capacity to provide written informed consent.

We excluded men with history of psychosis, depression, mania, or brain damage, as well as those with history of suicidal ideation or significant aggression and violence. Additional exclusion criteria included active clinically significant disorder or disease requiring surgical intervention, prior lumbar surgery, presence of neurological deficit, history of spinal operation, vertebral fracture or dislocation, presence of any tumor causing varicose veins, blood clotting disorders, and current use of prolonged anticoagulant medication

Randomization and blinding

Randomization was performed using a computer-generated random number sequence created by a statistician not involved in participant recruitment or assessment. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes. Due to the nature of the intervention, participants and yoga instructors could not be blinded; however, outcome assessors and data analysts were blinded to group assignment.

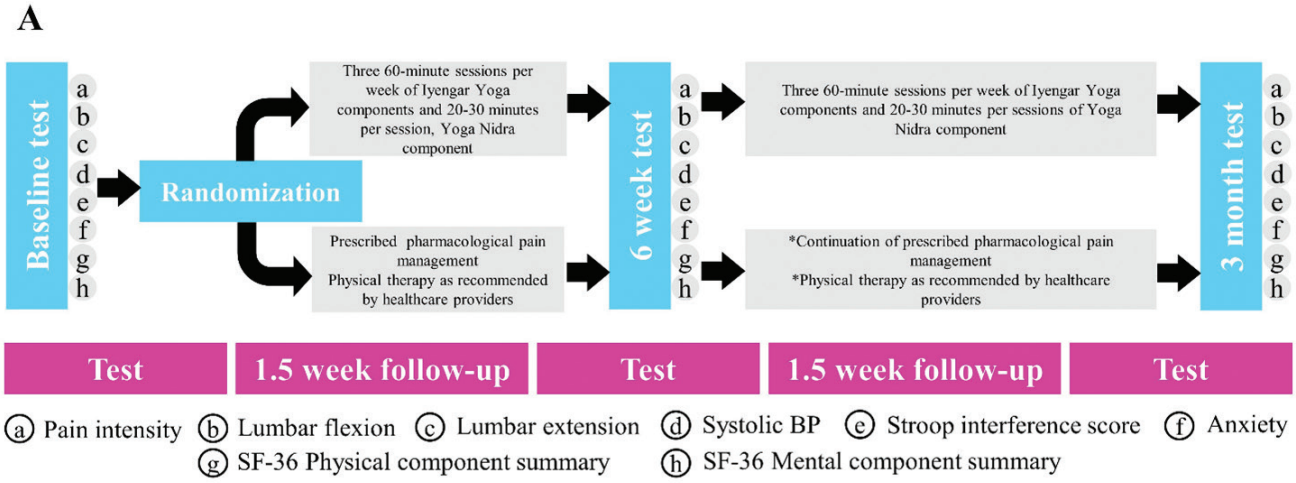

Figure 1. (A) Semantic representation of research study, (B) Consort flow chart. Interventions

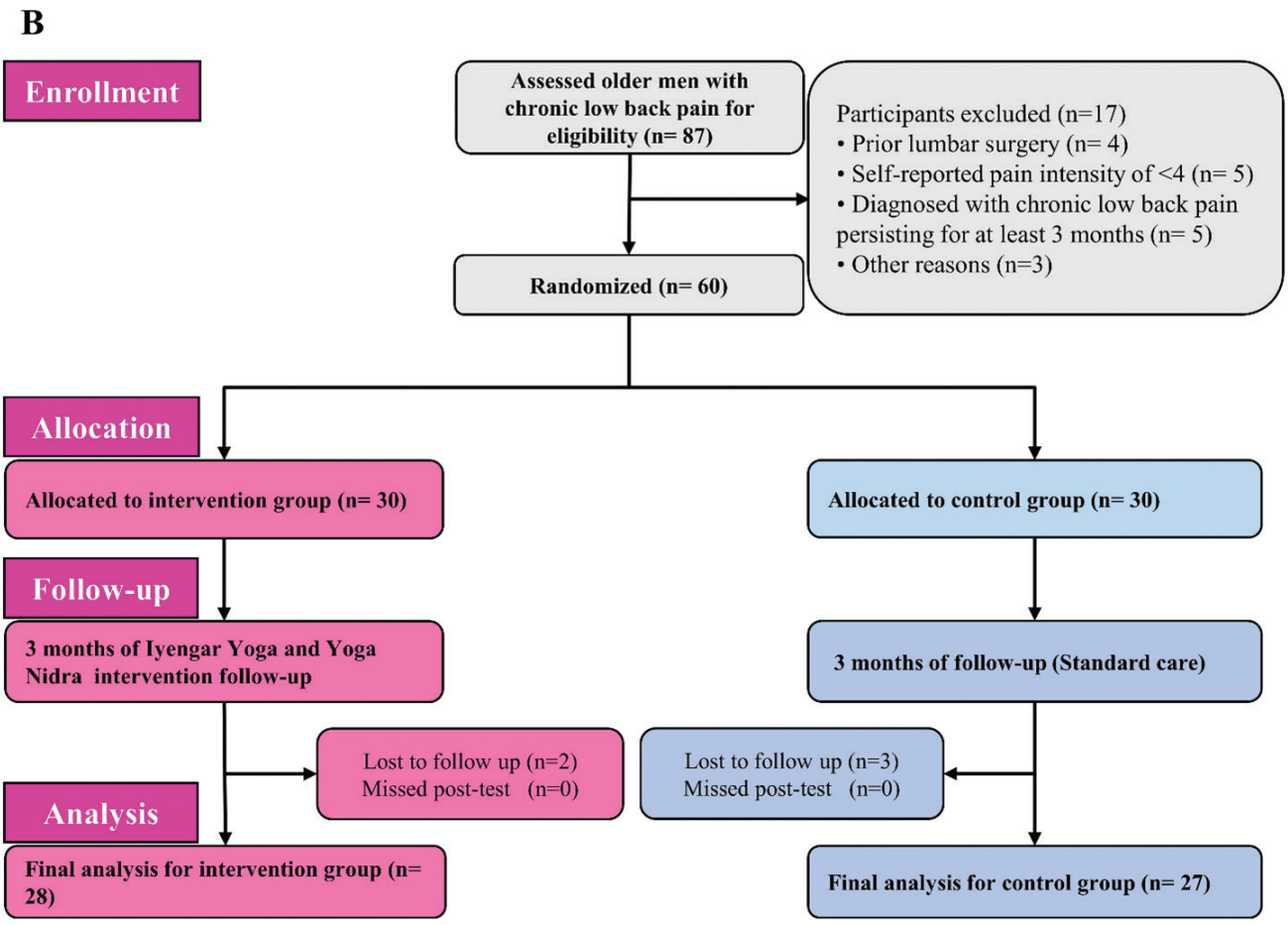

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Figure 1. (A) Semantic representation of research study, (B) Consort flow chart.

Interventions

Intervention group

Participants received a 3-month combined Iyengar yoga and Yoga Nidra program. The intervention comprised three weekly sixty-minute group sessions of Iyengar yoga led by certified instructors. Sessions followed structured sequences incorporating nine poses (Adhomukha Svanasana, Uttanasana, Viparita Dandasana, Marichyasana, Parsva Virasana, Supta Padangusthasana, Setubandha Sarvangasana, Viparita Karani, and Savasana) with props including blocks, straps, and bolsters to accommodate individual limitations. Poses were introduced progressively with modifications as needed. Each session integrated twenty to thirty minutes of Yoga Nidra using standardized audio-recorded instructions focusing on body awareness, breath regulation, and visualization. Participants received illustrated handouts and audio recordings to support daily fifteen to twenty minute home practice, with adherence tracked through practice logs.

Control group

Control participants continued standard care including prescribed pharmacological management and recommended physical therapy, with no yoga or meditation interventions during the study period. Monthly telephone calls maintained engagement.

Outcome measures

All assessments were conducted at baseline, 6 weeks, and 3 months by trained assessors blinded to group assignment. Standardized testing protocols were followed for each measure to ensure reliability and validity of the data collected. Semantic representation of this study was presented in figure 1 A.

Primary outcome

Pain Intensity: Pain was measured using the Visual Analog Scale (VAS), a widely validated instrument for pain assessment (Begum & Hossain, 2019). Participants marked their perceived pain level on a 100mm horizontal line anchored with "no pain" (0) and "worst pain imaginable" (10). The distance in millimeters from the "no pain" anchor to the participant's mark was measured and converted to a 0-10 scale. Higher scores indicated greater pain intensity, with a reduction of ≥1.5 points or 30% from baseline considered clinically significant. Participants completed the VAS independently at each assessment timepoint, rating both their current pain and

average pain experienced over the previous week (Begum & Hossain, 2019).

Secondary outcomes

Range of Motion (ROM) of the Lumbar Spine: Lumbar spine mobility was assessed using the dual inclinometer method (MIE Medical Research Ltd, model J-Tech) following American Medical Association guidelines (MacDermid et al., 2014). Measurements were taken for flexion (normal range 0-60 degrees), extension (normal range 0-25 degrees), and lateral flexion (normal range 0-25 degrees bilaterally). Three measurements were taken for each movement, and the average was recorded. Improvements of ≥5 degrees in any direction were considered clinically meaningful. All measurements were performed by the same trained physical therapist to minimize inter-rater variability.

Systolic blood pressure: Blood pressure was measured using an automated oscillometric device (Omron HEM-7320-LA) following American Heart Association protocols. Participants were seated quietly for at least 5 minutes before measurement, with the arm supported at heart level. Three consecutive readings were taken at 1-minute intervals, and the average of the last two readings was recorded. Measurements were taken at the same time of day for each assessment period to control for diurnal variations. A reduction of ≥5 mmHg in systolic blood pressure was considered clinically significant.

Attention: Cognitive attention was assessed using the Stroop Color and Word Test, a neuropsychological assessment that measures selective attention, cognitive flexibility, and processing speed (Scarpina & Tagini, 2017). The test consisted of three trials: word reading, color naming, and color-word interference. The time to complete each trial and number of errors were recorded. The interference score was calculated as the difference between the time taken for the interference trial and the predicted color naming time. Lower scores indicated better selective attention and cognitive control. Age-adjusted norms were used for interpretation (Begum & Hossain, 2019).

Anxiety levels: Anxiety was measured using the Beck Anxiety Inventory (BAI), a 21-item self-report questionnaire (Fydrich et al., 1992). Participants rated how much they had been bothered by each symptom over the past week on a 4-point scale ranging from 0 (not at all) to 3 (severely, I could barely stand it). Total scores ranged from 0-63, with 0-7 indicating minimal anxiety, 8-15 mild anxiety, 16-25 moderate anxiety, and 26-63 severe anxiety. A reduction of ≥7 points from baseline was considered clinically significant. The BAI has demonstrated high internal consistency (α=0.92) and test-retest reliability (r=0.75) in previous studies with similar populations.

Health-related Quality of Life: Quality of life was assessed using the SF-36 Health Survey, a multi-purpose health survey consisting of 36 questions(Hays et al., 2002). The SF-36 yields an 8-scale profile of functional health and well-being scores (physical functioning, role limitations due to physical health, role limitations due to emotional problems, energy/fatigue, emotional well-being, social functioning, pain, and general health) as well as physical and mental health summary components. Each scale is directly transformed into a 0-100 scale, with higher scores indicating better health status. A change of ≥5 points in any domain or ≥3 points in summary measures was considered clinically meaningful. The SF-36 has been extensively validated in chronic pain populations with excellent psychometric properties.

Statistical analysis

All statistical analyses were conducted using SPSS software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation (SD). Baseline characteristics were compared between groups using independent t-tests for continuous variables and chi-square tests for categorical variables.

The primary analysis employed mixed-model analysis of variance (ANOVA) with repeated measures to examine the effects of the intervention on outcome variables across the three assessment points (baseline, 6 weeks, and 3 months). The mixed-model included group (intervention vs. control) as the between-subjects factor and time (baseline, 6 weeks, 3 months) as the within-subjects factor. The primary hypothesis test focused on the group × time interaction, which indicates whether changes over time differed between groups. When significant interactions were detected, post-hoc pairwise comparisons with Bonferroni correction were conducted to identify specific time points at which groups differed. Effect sizes were calculated as partial eta-squared (ηp^2) for ANOVA main effects and interactions, with values of 0.01, 0.06, and 0.14 interpreted as small, medium, and large effects, respectively. For post-hoc comparisons, Cohen's d was calculated using pooled standard deviations. Statistical significance was set at two-tailed $\alpha=0.05$ for all analyses.

Results

Baseline demographic and clinical characteristics were similar between groups (Table 1).

Table 1. Baseline characteristics of study participants

Characteristic	Intervention group (n=30)	Control group (n=30)
Demographics		
Age (years)	59.3 (4.7)	60.1 (4.3)
BMI (kg/m²)	27.2 (3.8)	26.8 (4.1)
Education (years)	13.6 (3.5)	13.2 (3.7)

Table 1. Baseline characteristics of study participants

Characteristic	Intervention group (n=30)	Control group (n=30)
Pain characteristics		
Duration of low back pain (months)	42.5 (28.3)	45.2 (30.1)
Pain intensity (VAS 0-10)	6.8 (1.3)	6.7 (1.4)
Clinical measures		
Lumbar flexion ROM (degrees)	32.1 (9.7)	31.8 (9.3)
Lumbar extension ROM (degrees)	12.6 (4.3)	12.3 (4.5)
Systolic BP (mm Hg)	142.3 (12.7)	143.1 (13.2)
Diastolic BP (mm Hg)	86.8 (7.9)	87.3 (8.1)
Psychological measures		
Anxiety (BAI 0-63)	18.7 (8.5)	19.1 (8.2)
Health status		
SF-36 Physical component summary	36.4 (7.3)	35.9 (7.5)
SF-36 Mental component summary	42.1 (8.6)	41.8 (8.4)
Current treatments		
Pain medication use, n (%)	24 (80.0)	25 (83.3)
NSAIDs	18 (60.0)	19 (63.3)
Acetaminophen	16 (53.3)	17 (56.7)
Muscle relaxants	8 (26.7)	7 (23.3)
Opioids	5 (16.7)	6 (20.0)
Prior treatments, n (%)		
Physical therapy	22 (73.3)	23 (76.7)
Chiropractic care	11 (36.7)	12 (40.0)
Massage therapy	13 (43.3)	15 (50.0)
Acupuncture	7 (23.3)	6 (20.0)
Comorbidities, n (%)		
Hypertension	16 (53.3)	17 (56.7)
Type 2 diabetes	8 (26.7)	7 (23.3)
Osteoarthritis	11 (36.7)	12 (40.0)
Sleep disorders	14 (46.7)	13 (43.3)

Note. Data are mean (SD) unless specified otherwise. BMI=Body Mass Index. VAS=Visual Analog Scale. ROM=Range of Motion. BP=Blood Pressure. BAI=Beck Anxiety Inventory. SF-36=36-Item Short Form Health Survey. NSAIDs=Non-steroidal Anti-inflammatory Drugs

Primary outcome

Mixed-model ANOVA revealed a significant group × time interaction for pain intensity measured by the Visual Analog Scale ($F(2,106)=28.45$, $p<0.001$, $\eta p^2=0.35$), indicating that changes in pain over the three-month period differed significantly between groups. The main effect of time was significant ($F(2,106)=47.23$, $p<0.001$, $\eta p^2=0.47$), as was the main effect of group ($F(1,53)=32.18$, $p<0.001$, $\eta p^2=0.38$).

Post-hoc pairwise comparisons with Bonferroni correction revealed that the intervention group showed significantly greater pain reduction than the control group at 6 weeks (mean difference -1.8 points difference , 95% CI: -2.4 to -1.2; $p<0.001$, Cohen's d=1.12) and at 3 months (mean difference -2.6 points, 95% CI: -3.3 to -1.9; $p<0.001$, Cohen's d=1.68). Within-group analyses showed that the intervention group experienced significant pain reduction from baseline to 6 weeks (mean change -2.5 points, $p<0.001$) and from 6 weeks to 3 months (mean change -1.6 points, $p<0.001$), whereas the control group showed only modest reduction from baseline to 6 weeks (mean change -0.8 points, $p=0.012$) with no further change from 6 weeks to 3 months (mean change -0.6 points, $p=0.098$).

The proportion of participants achieving clinically mean-

ingful pain reduction (≥30% from baseline) at 3 months was significantly higher in the intervention group (23 [82.1%] of 28) than in the control group (7 [25.9%] of 27; χ^2=17.42, p<0.001).

Secondary outcomes

Range of motion: Mixed-model ANOVA demonstrated significant group × time interactions for both lumbar flexion (F(2,106)=18.67, p<0.001, ηp^2=0.26) and lumbar extension (F(2,106)=12.34, p<0.001, ηp^2=0.19). Post-hoc comparisons at 3 months showed the intervention group had significantly greater improvements in flexion (mean difference 8.3°, 95% CI: 5.9 to 10.7; p<0.001, Cohen's d=0.91) and extension (mean difference 4.2°, 95% CI: 2.8 to 5.6; p<0.001, Cohen's d=0.94) compared with the control group.

Systolic blood pressure: The group × time interaction was significant (F(2,106)=9.87, p<0.001, ηp^2=0.16), with the intervention group showing significantly greater reduction at 3 months (mean difference -7.5 mm Hg, 95% CI -10.8 to -4.2; p<0.001, Cohen's d=0.69).

Attention: Stroop Color and Word Test interference scores showed a significant group × time interaction (F(2,106)=8.45, p<0.001, ηp^2=0.14), with the intervention group demonstrating greater improvement at 3 months (mean difference -8.3 seconds, 95% CI: -12.1 to -4.5; p<0.001, Cohen's d=0.64).

Anxiety: Beck Anxiety Inventory scores demonstrated a significant group × time interaction (F(2,106)=15.23, p<0.001, ηp^2=0.22), with significantly greater reduction in the intervention group at 3 months (mean difference -8.7 points, 95% CI: -11.4 to -6.0 p<0.001, Cohen's d=1.21).

Quality of life: SF-36 showed significant group × time interactions for both physical component summary (F(2,106)=11.76, p<0.001, ηp^2=0.18; 3-month difference 6.4 points, 95% CI 4.2 to 8.6; p<0.001, Cohen's d=0.82) and mental component summary (F(2,106)=9.34, p<0.001, ηp^2=0.15; 3-month difference 5.8 points, 95% CI 3.7 to 7.9; p<0.001, Cohen's d=0.71).

Table 2. Primary and secondary outcomes at baseline, 6 weeks, and 3 months

Outcome	Time	Intervention (n=28) Mean (SD)	Control (n=27) Mean (SD)	Group × Time ANOVA F, p, ηp^2	3-Month Mean Difference (95% CI)	p	Cohen's d
Pain intensity (VAS)	Baseline	6.8 (1.3)	6.7 (1.4)				
	6 weeks	4.3 (1.6)	5.9 (1.5)	F(2,106)=28.45			
	3 months	2.7 (1.4)	5.3 (1.7)	p<0.001, ηp^2=0.35	−2.6 (−3.3 to −1.9)	<0.001	1.68
Lumbar flexion (°)	Baseline	32.1 (9.7)	31.8 (9.3)				
	6 weeks	38.4 (10.2)	34.7 (9.5)	F(2,106)=18.67			
	3 months	45.8 (9.6)	37.5 (9.9)	p<0.001, ηp^2=0.26	8.3 (5.9 to 10.7)	<0.001	0.91
Lumbar extension (°)	Baseline	12.6 (4.3)	12.3 (4.5)				
	6 weeks	15.8 (4.7)	13.6 (4.4)	F(2,106)=12.34			
	3 months	18.7 (4.5)	14.5 (4.8)	p<0.001, ηp^2=0.19	4.2 (2.8 to 5.6)	<0.001	0.94
Systolic BP (mmHg)	Baseline	142.3 (12.7)	143.1 (13.2)				
	6 weeks	136.5 (11.8)	141.2 (12.4)	F(2,106)=9.87			
	3 months	132.4 (10.6)	139.9 (11.7)	p<0.001, ηp^2=0.16	−7.5 (−10.8 to −4.2)	<0.001	0.69
Stroop interference (s)	Baseline	42.6 (15.3)	41.9 (14.7)				
	6 weeks	36.2 (14.1)	39.5 (14.2)	F(2,106)=8.45			
	3 months	30.4 (12.8)	38.7 (13.4)	p<0.001, ηp^2=0.14	−8.3 (−12.1 to −4.5)	<0.001	0.64
Anxiety (BAI)	Baseline	18.7 (8.5)	19.1 (8.2)				
	6 weeks	12.6 (7.4)	16.8 (7.8)	F(2,106)=15.23			
	3 months	8.2 (6.3)	16.9 (7.6)	p<0.001, ηp^2=0.22	−8.7 (−11.4 to −6.0)	<0.001	1.21
SF-36 Physical	Baseline	36.4 (7.3)	35.9 (7.5)				
	6 weeks	41.7 (7.8)	38.1 (7.6)	F(2,106)=11.76			
	3 months	46.2 (8.1)	39.8 (7.9)	p<0.001, ηp^2=0.18	6.4 (4.2 to 8.6)	<0.001	0.82
SF-36 Mental	Baseline	42.1 (8.6)	41.8 (8.4)				
	6 weeks	46.3 (8.2)	43.5 (8.3)	F(2,106)=9.34			
	3 months	50.7 (7.8)	44.9 (8.5)	p<0.001, ηp^2=0.15	5.8 (3.7 to 7.9)	<0.001	0.71

Note. Mixed-model ANOVA tested group × time interaction. All interactions were significant (p<0.001), indicating greater improvement in the intervention group compared with controls. Post-hoc comparisons at 3 months were Bonferroni-corrected. ηp^2 = partial eta-squared; d = Cohen's d

Adherence and Adverse Events

Adherence to the yoga intervention was high, with participants attending a mean of 31.4 (SD 4.8) of 36 sessions (87.2%). Home practice adherence, defined as completing at least 15 minutes of the prescribed exercises, was reported on a mean of 68.3 (SD 14.7) of 90 days (75.9%).

Five minor adverse events were reported in the intervention group (muscle soreness [n=3] and temporary increase in back pain [n=2]), all of which resolved within 48 hours without need for additional medical attention. No serious adverse events were recorded in either group.

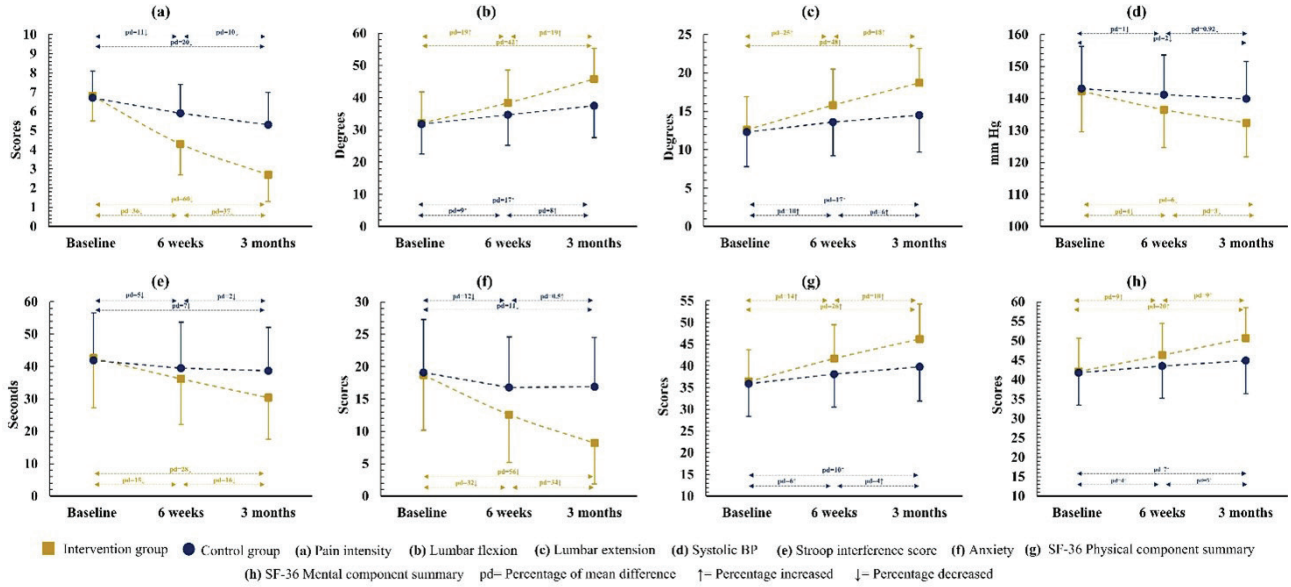

Figure 2. Means and percentage differences in the intervention and control groups of primary and secondary outcome measures between three tests

Discussion

In this randomized clinical trial, a 3-month program combining Iyengar yoga and Yoga Nidra significantly reduced pain intensity, improved lumbar spine mobility, decreased systolic blood pressure and anxiety levels, enhanced attention, and improved health-related quality of life in men aged 55-65 years with chronic low back pain compared with standard care. The magnitude of these improvements was both statistically significant and clinically meaningful.

The substantial reduction in pain intensity observed in this study (mean difference of 2.6 points on the VAS at 3 months) exceeds the commonly accepted threshold for clinically significant improvement in chronic pain (1.5 points or 30% reduction). This finding aligns with previous research on yoga interventions for chronic low back pain, although the effect size in our study appears larger than those reported in meta-analyses of conventional yoga programs (typically 0.5-1.5 points on comparable scales) (Cramer et al., 2017; Holtzman & Beggs, 2013; Zhu et al., 2020).

The improvements in range of motion were similarly noteworthy. The mean increase of 8.3° in lumbar flexion exceeds the minimal clinically important difference of 5° (Parker et al., 2012) suggesting functional benefits that could translate to improved activities of daily living for these men. Previous studies have demonstrated modest improvements in spinal mobility with yoga practice (Neyaz et al., 2019; Tankha et al., 2024), but few have specifically quantified changes using standardized dual inclinometer measurements in older men (Dabhi, 2023).

The observed reduction in systolic blood pressure (mean difference of 7.5 mmHg) is consistent with previous research on mind-body interventions for hypertension and represents a clinically meaningful change that could reduce cardiovascular risk in this population (Wankhar et al., 2024; Yang et al., 2021). This finding is particularly relevant as hypertension frequently co-exists with chronic pain in older adults and may share underlying pathophysiological mechanisms related to autonomic dysfunction and systemic inflammation (Shobana et al., 2022; Thanalakshmi et al., 2020).

The improvements in cognitive attention, as measured by the Stroop test, suggest potential benefits beyond physical parameters. This finding adds to emerging evidence that yoga practices may enhance cognitive function in older adults (Jagadeesan et al., 2021), potentially through mechanisms including improved cerebral blood flow, reduced inflammation, and enhanced vagal tone (Abirami et al., 2024; Lalitha et al., 2021; Padmavathi et al., 2023).

The significant reduction in anxiety (mean difference of 8.7 points on the BAI) exceeds the established clinically meaningful threshold of 7 points and highlights the psychological benefits of this integrated approach. This is consistent with previous research demonstrating anxiolytic effects of both yoga and meditative practices (Padmavathi et al., 2023), though few studies have specifically addressed anxiety in men with chronic pain.

Quality of life improvements across both physical and mental domains of the SF-36 reflect the broad impact of the

intervention on overall well-being. The magnitude of these improvements (6.4 and 5.8 points for physical and mental component summaries, respectively) exceeds established thresholds for clinical significance (3 points) and suggests that benefits extend beyond symptom reduction to enhanced functional capacity and psychological well-being (Malarvizhi et al., 2019).

The high adherence rates observed in this study (87.2% for supervised sessions and 75.9% for home practice) are noteworthy, particularly given that men typically demonstrate lower participation rates in mind-body interventions. This suggests that the structured, physically engaging nature of Iyengar yoga, combined with the accessible, restorative qualities of Yoga Nidra, may appeal to this demographic. The low rate of minor adverse events supports the safety of this approach when properly implemented with appropriate modifications.

Strengths

Key strengths of this study include the use of blinded assessors for objective outcome measures including range of motion and blood pressure, reducing detection bias despite the inability to blind participants to intervention assignment. The comprehensive assessment battery spanning physical (pain, mobility), physiological (blood pressure), cognitive (attention), and psychological (anxiety, quality of life) domains provides a multidimensional evaluation of intervention effects in an understudied population of older men with chronic low back pain. The high retention and adherence rates (eighty-seven percent for supervised sessions and seventy-six percent for home practice) combined with standardized intervention delivery using audio-recorded Yoga Nidra instructions support both the feasibility and replicability of this integrated approach.

Limitations

The intervention combined sixty minutes of Iyengar yoga with twenty to thirty minutes of Yoga Nidra in each session, making it impossible to determine which component contributed most to observed outcomes, and the specific emphasis on nine therapeutic asanas limits extrapolation to other yoga styles. The control group received standard care with monthly telephone calls but no active intervention matched for the three supervised sessions weekly, preventing separation of specific intervention effects from nonspecific factors including instructor attention and group participation. We did not assess disability using condition-specific instruments such as the Roland-Morris Disability Questionnaire or Oswestry Disability Index, nor did we evaluate cost-effectiveness or collect qualitative data on participant experiences.

Conclusions

This study provides evidence that a combined Iyengar yoga and Yoga Nidra program is an effective intervention for reducing pain, improving physical function, and enhancing psychological well-being in middle-aged and older men with chronic low back pain. The substantial effects observed across multiple domains suggest this approach may address the complex, multidimensional nature of chronic pain more comprehensively than conventional single-modality treatments. The high adherence rates and minimal adverse events, combined with clinical improvements, support the feasibility and safety of implementing this three-month program in clinical settings serving older men with chronic low back pain. These findings support the integration of structured yoga and meditation practices into comprehensive pain management programs for men with chronic low back pain.

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Conflicts of interest

The authors declare that there are no conflict of interest.

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