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Research Article

EFFECT OF YOGA THERAPY ON SPINAL FLEXIBILITY IN PATIENTS UNDERGOING CONVENTIONAL TREATMENT FOR CHRONIC LOW BACK ACHE: AN RCT

Yogitha Bali ^{*1}, John Ebnezar ², Rakesh John ³

¹Chief Ayurveda & Yoga Consultant, AAYUSH -An Ayurveda Integrated Multispeciality Hospital, Bangalore & Reader, Sushrutha Ayurvedic Medical College, Bangalore, India

²Consulting Orthopedic and Spine Surgeon, Ebnezar Orthopedic Centre, Parimala health care services, Bangalore, India

³Senior Resident, Ebnezar Orthopedic Centre, Parimala health care services, Bangalore, India

*Corresponding Author Email: baliyogitha@gmail.com

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ABSTRACT

The objective of this study was to evaluate the role of Integrated Approach of Yoga Therapy (IAYT) as an add-on on pain and spinal flexibility in patients undergoing conventional treatment for chronic low back ache. One hundred and twenty patients suffering from chronic low back ache (CLBA) aged between 18yrs to 75yrs Yoga (41.29±15.87) and Control (41.63±13.48) from Ebnezar orthopedic center, Bengaluru were randomly assigned into two groups; yoga group (YG) and control group (CG) to receive IAYT or Therapeutic exercises after Intermittent lumbar traction and ultrasound (20 minutes per day). Both the groups practiced supervised interventions (40 minutes per day) for 3 weeks at the center and later for 12 weeks at their residences after the completion of treatment. 57 (yoga) and 55 (control) subjects were available for the final analysis. Both the groups were assessed for pain and spinal flexibility on the 1st day in the pretest and on the 21st day in the post test. Data were analyzed using repeated measures analysis of variance (RMANOVA). There were significant differences within (RMANOVA, P<0.001) and between the groups (RMANOVA, P<0.001) on pain and spinal flexibility with better improvements in the yoga group than the control group. Pain in the yoga (39.9%, 66%, 85%, and 98.9 %) and control (25.5%, 45%, 63% and 74%), movements- flexion in yoga (77%, 126%, 183%, 232%) and control (33%, 64%, 99%, 132%), Extension in yoga (75%, 113%, 130%, 132%) and control (34%, 68%, 102%, 121%), right lateral flexion in yoga (78%, 113%, 126%, 129%) and control (32%, 66%, 99%, 117%), left lateral rotation in yoga (76%, 109%, 119%, 120%) and control (33%, 67%, 100%, 113%), right lateral rotation in yoga (70%, 107%, 136%, 143%) and control (29%, 58%, 89%, 114%), left lateral rotation in yoga (66%, 103%, 129%, 130%) and control (28%, 55%, 84%, 107%). All these improved in the yoga group better than the control group on the 21st day, 3rd month, 6th month and 1year respectively. Integrated approach of yoga therapy (IAYT) as an add-on with the conventional physiotherapy provides significantly better improvement in reducing pain and improving spinal flexibility than the therapeutic exercises in patients suffering from chronic low back ache.

Keywords: chronic low back ache, integrated approach of yoga therapy, therapeutic exercises, physiotherapy.

INTRODUCTION

Low back pain was identified by the Pan American Health Organization as one of the top three occupational health problems to be targeted by surveillance within the WHO Region of the Americas. Worldwide 37%, and in South East Asia including India and China 39%, of CLBP, is attributable to occupational ergonomic stressors, both physical and psychosocial.¹ Campbell et al, report that in the United States the estimated annual cost to society of back pain is between £13 billion (\$20 billion) and £33 billion (\$50 billion).² As part of the Global Burden of Disease 2010 Study (GBD 2010), the global burden of musculoskeletal conditions was estimated using updated methods that address methodological limitations of previous GBD studies. Burden was expressed in disability-adjusted life years (DALYs).³ The lifetime prevalence of low back pain is estimated at 60-85%, while the annual prevalence in the general population is ranging from 15-45%.⁴ Back pain patients incur up to 75% more medical expenditures than patients without back pain.⁵ Although there are a wide variety of treatments for back pain, including medications, exercise, education, self-care, injections, life-style aids, manual therapies, complementary and alternative medicine (CAM) therapies, minimally invasive treatments and surgery, there is surprisingly little consistent evidence to support most of these treatments, due to unavailable, insufficient or conflicting evidence.

However, low back pain patients are relatively dissatisfied with their medical care, especially in comparison to care provided by non-physician's. Eisenberg found that most people with back problems considered CAM care to be superior to conventional medical care for back pain.⁶ Data from the National Center for Complementary and Alternative Medicine (NCCAM) show that the usage of complementary and alternative medicine (CAM) treatments for all conditions is on the rise in the US.⁷ Reviews and meta-analyses^{8,9,10} and practice guidelines from the American Pain Society and the American College of Physicians¹¹ support yoga as an evidence-based treatment for cLBP with at least moderate benefit. Previous studies have reported that performing regular yoga exercises enhanced the functioning of various organs and systems of the body, improved physical fitness, and in particular, increased flexibility, static strength, equilibrium of body motion, and body posture and contributed to a reduction chronic low back pain or prevented its recurrence.¹² Five large (n=90-313) and five smaller randomized controlled trials (RCTs) (n=20-60) support yoga's effectiveness for reducing pain and improving function in adults with cLBP.⁵ The present study was planned to study the effects of yoga as an adjunct to physiotherapy, the standard conventional treatment in the management of chronic low back ache, as there were no studies on chronic low back ache that has compared to Yoga and Physiotherapy.¹³

METHODOLOGY

One hundred and twenty (120) patients with chronic low back ache (CLBA) from the outpatient department of Ebnezar Orthopedic Center, Parimala Health Care Services, Bengaluru were recruited for the study. A sample size of 120 was obtained by calculating the effect sizes based on the mean and standard deviation of an earlier published interventional study.¹⁴ Table 1 includes the baseline characteristics. One hundred and twenty (120) patients of both genders in the age group of 18–75 years in the yoga group and (41.29±15.87) in the control group (41.63±13.48) with Chronic low back ache were included.

The inclusion criterions were: a) patients of chronic low back ache (CLBA) with persistent pain > three months prior to recruitment due to common causes like muscle sprain, spinal stenosis, facet joint arthritis, occupational causes, unaccustomed activities, improper posture b) degenerative diseases (lumbar spondylitis) c) IVDP with or without neurological involvement, recurrent back aches, including both males and females aged between 18 years to 75 years who were advised physiotherapy by the consulting orthopedician were included in the study. It was ensured that these patients had no previous exposure to yoga. In exclusion, a) patients of chronic low back ache (CLBA) with persistent pain < three months, b) LBA's caused due to uncommon causes like congenital, traumatic, infective, inflammatory, neoplasm, metabolic and degenerative conditions, c) patients who underwent surgeries, d) referred LBA pain caused due to gynecological diseases, genitourinary problems and gastrointestinal conditions. e) Post-traumatic conditions and patients who were not willing to be the part of the study were excluded. The study was approved by the institutional ethical committee and signed informed consent was obtained from all the participants.

Design

This was a prospective randomized, parallel, active controlled study on patients with Chronic Low Back Ache (CLBA) in the age range of 18-75 years. Patients attending the outpatient department of Ebnezar Orthopedic Center who satisfied the inclusion criteria were recruited for the study. After the initial screening for selection criteria, they were assigned to either the yoga group or control group. A computer-generated random number table (www.randomization.org) was used for randomization. Numbered envelopes were used to conceal the sequence until the intervention was assigned. 120 patients suffering from chronic low back ache (CLBA) were randomized into two groups; yoga group (YG) and control group (CG).

Both groups were given the conventional physiotherapy for 20 minutes using intermittent lumbar traction and ultrasound for 3 weeks. Control group received therapeutic exercises and supine guided rest (SR) for 40 minutes. Study group, in addition received Integrated approach of yoga therapy (IAYT) for 40 minutes which consists of shithilikarana vyayamas (loosening practices), shakti vikasaka vyayamas (strengthening practices), yogasanas, pranayama, meditation and relaxation techniques.

The study group was taught integrated yoga and the control group was taught the non-yogic, back specific physiotherapy exercises by certified therapists. Both the groups were assessed for pain and spinal flexibility on the 1st day in the pretest and on the 21st day in the post test. After this, they were asked to practice daily at home for the next 3 months. Patients were asked to mark the practices daily in the diary provided for the

maintenance of the practice at home. Compliance was supervised by telephone calls once in 3 days and a weekly review was conducted once a week for 12 weeks. The daily review cards were checked for the regularity and doubts if any were clarified. The evaluation was conducted by the senior research fellow. All patients were asked to mark the practices daily after the home practice in the diary provided for the purpose; at every visit their clinical progress and therapy received on the day were documented. All assessments were carried out on 1st day, 21st day, 3rd month, 6th month and after 1 year.

Intervention For The Yoga Group

The schedule practiced at the center in the yoga group included 40 min of integrated approach of yoga therapy (IAYT) practice after 20 min of physiotherapy with intermittent lumbar traction and ultrasound for 3 weeks. The integrated approach of yoga therapy practice (IAYT) included shithilikarana vyayamas (loosening practices), saktivikasaka (strengthening practices) followed by yogasanas and relaxation techniques. Later patients were advised to continue the integrated approach of yoga therapy (IAYT) practice for 40 min at home for the next 12 weeks. The concept used to develop a specific module of an integrated approach of yoga therapy (IAYT) for chronic low back ache was taken from the traditional yoga scriptures (patanjali yoga sutras, yoga vasishta, and upanishads) that highlight a holistic lifestyle for positive health at physical, mental, emotional, and intellectual levels.²⁰ (Table 2) of Yoga group module.

Yogic sukshma vyayamas (loosening and strengthening practices): These are safe, rhythmic, repetitive stretching movements synchronized with breathing. These practices mobilize and strengthen joints and the muscles. Relaxation techniques: Three (3) types of guided relaxation techniques were interspersed between the physical practices of sukshma vyayamas and asanas. Asanas (physical postures): Asanas are characterized by effortless maintenance in the final posture by internal awareness. Asanas were selected in standing, supine and prone positions that would relax and strengthen the back. Pranayama: The practice of voluntary regulated breathing while the mind is directed to the flow of breath is called pranayama. These practices promote autonomic balance through mastery over the mind. Meditation: Patanjali defines meditation (dhyana) as effortless flow of a single thought in the mind without distractions (pratyaya ekataana dhyanam). This has been shown to offer physiologic benefits through alertful rest to the mind-body complex. Counseling: Yogic concepts of health and disease, yama, niyama, bhakti yoga, Jnana yoga, and karma yoga were addressed in the counseling classes. These sessions were aimed at understanding the need for lifestyle change, weight management and preventing early aging by yogic self-management of psychosocial stresses.

Intervention For The Control Group

The routine schedule of the control group included 40 min of therapeutic exercises with supine guided rest after 20 min of physiotherapy with intermittent lumbar traction and interferential therapy for 2 weeks [Table 3]. Therapeutic exercises included loosening and strengthening practices for all the joints of the upper and lower limbs, specific back practices, and supine rest. Later patient was advised to continue the therapeutic exercise practice of 40 min at home for the next 12 weeks.

Blinding And Masking

Double blinding was not possible as this was an interventional study. The questionnaires were coded and analyzed only after the study was completed. Here, the statistician who did the randomization, analyzed the data and the researcher who carried out the assessments were blinded to the treatment status of the subjects.

Outcome Variables

The measures assessed were pain using numerical rating scale and goniometric measurements for spinal flexibility.

Pain

This is considered to be a simple & reliable tool to measure subjective pain. It consists of a horizontal straight line of 10 centimeters marked on a clean white sheet. One end of the line marked 0 represents 'No pain' and the other end marked 10 represents 'Worst possible pain'. Patients were asked to mark the severity of their pain experienced over the 10cm scale. Separate sheets were used during every assessment.¹⁵

Spinal flexibility

Lumbar spinal flexibility was measured using a Lenthon Goniometer (Dial type goniometer of Anand Agencies, Pune) for the Flexion (F), extension (E), right lateral flexion (RLF), left lateral flexion (LLF), right lateral rotation (RLR) and the left lateral rotation (LLR) movements of the back.

Data sheets marked by all patients for pain (NRS) was coded and kept aside for future assessment. All measurements were taken before the intervention on 1st day and after the treatment on 21st day.

Statistical Methods

The data were analyzed using SPSS Version 10. The baseline values of the two groups were checked for normal distribution by Shapiro-Wilk's test. Repeated measures analysis of variance (RMANOVA) with Bonferroni was used for assessing 'within' and 'between' groups differences, respectively. Tables 1 and 2 show the interventions of both study and control groups.

RESULTS

The study profile is shown in Figure 1. There were 3 dropouts in the study group and 5 in the control group. Two group's yoga and the control (60 subjects each) were similar with respect to socio-demographic and medical characteristics (Table 1). The baseline data for all the variables were normally distributed and did not differ significantly between the groups. Table 4 shows the results between and within groups on 21st day, 3rd month, 6th month and 1yr. Results in the yoga group showed significance compared to control groups for all the parameters.

Between Group Results

Pain: (Numerical Rating Scale)

Repeated measures analysis of variance (RMANOVA) with Bonferroni showed a significant difference in yoga group on 21st day ($p<0.001$), 3rd month ($p<0.001$), 6th month ($p<0.001$) and 1 year ($p<0.001$) compared to control group indicating reduction in pain scores.

Spinal Flexibility

A) Flexion

Repeated measures analysis of variance (RMANOVA) with Bonferroni showed a significant difference in yoga group on 15th day ($p<0.001$), 1st month ($p<0.001$), 6th month ($p<0.001$) and

1 year ($p<0.001$) compared to control group indicating improvement in flexion movement of spine.

B) Extension

Repeated measures analysis of variance (RMANOVA) with Bonferroni showed a significant difference in yoga group on 15th day ($p<0.001$), 1st month ($p<0.001$), 6th month ($p<0.001$) and 1 year ($p<0.001$) compared to control group indicating improvement in extension movement of spine.

C) Right Lateral Flexion (RLF)

Repeated measures analysis of variance (RMANOVA) with Bonferroni showed a significant difference in yoga group on 15th day ($p<0.001$), 1st month ($p<0.001$), 6th month ($p<0.001$) and 1 year ($p<0.001$) compared to control group indicating improvement in both right and left lateral flexion movements of spine

D) Left Lateral Flexion (LLF)

Repeated measures analysis of variance (RMANOVA) with Bonferroni showed a significant difference in yoga group on 15th day ($p<0.001$), 1st month ($p<0.001$), 6th month ($p<0.001$) and 1 year ($p<0.001$) compared to control group indicating improvement in both the right and left lateral flexion movements of spine

E) Right Lateral Rotation (RLR)

Repeated measures analysis of variance (RMANOVA) with Bonferroni showed a significant difference in yoga group on 15th day ($p<0.001$), 1st month ($p<0.001$), 6th month ($p<0.001$) and 1 year ($p<0.001$) compared to control group indicating improvement in both the right and left lateral rotation movements of spine

F) Left Lateral Rotation (LLR)

Repeated measures analysis of variance (RMANOVA) with Bonferroni showed a significant difference in yoga group on 15th day ($p<0.001$), 1st month ($p<0.001$), 6th month ($p<0.001$) and 1 year ($p<0.001$) compared to control group indicating improvement in both the right and left lateral rotation movements of spine.

Within Group Results

Pain (Numerical Rating Scale)

A Significant result in reduction of pain score was observed in yoga group post- assessments (21st day, 3rd month, 6th month & 1yr) compared to the pre-assessments (1st day). In control group, significant result in reduction of pain score was observed in post- assessments (21st day, 3rd month, 6th month & 1year) compared to the pre-assessments (1st day)

Spinal Flexibility

A) Flexion

A significant result in improvement of flexion is observed in yoga group post- assessments (15th day, 1st month, 6th month & 1year) compared to the pre-assessments (1st day)

B) Extension

A significant result in improvement of extension is observed in yoga group post- assessments (15th day, 1st month, 6th month & 1yr) compared to the pre-assessments (1st day)

C) Right Lateral Flexion (RLF)

A significant result in improvement of both right and left lateral flexion is observed in yoga group post- assessments (15th day, 1st month, 6th month & 1year) compared to the pre-assessments (1st day)

D) Left Lateral Flexion (LLF)

Significant results in improvement of both right and left lateral flexion is observed in yoga group post- assessments (15th day, 1st month, 6th month & 1year) compared to the pre-assessments (1st day)

E) Right Lateral Rotation (RLR)

Significant results in improvement of both right and left lateral rotation is observed in yoga group post- assessments (15th day,

1st month, 6th month & 1year) compared to the pre-assessments (1st day)

F) Left Lateral Rotation (LLR)

Significant results in improvement of both right and left lateral rotation is observed in yoga group post- assessments (15th day, 1st month, 6th month & 1year) compared to the pre-assessments (1st day)

able 1: Demographic Data

Characteristics	Yoga (N=57)	Control (N=55)
Age (M±SD)	41.29±15.87	41.63±13.48
Sex		
Males	35	27
Females	25	33
Occupation		
Skilled workers	28	22
Semi-skilled workers	11	9
Unskilled workers	4	3
Others	17	26
Duration of the disease		
<1yr	26	23
1-3years	18	19
3-5years	11	10
>5years	5	8
Co-Morbidities		
Diabetes	4	6
Hypertension	10	9
Overweight/Obesity	2	3
Others	10	12

Table 2: Yoga module for chronic low back ache

Conventional physiotherapy: Was carried out at the center for 21 days which included		20.0 min
a) Intermittent lumbar traction -10 min		
b) Ultrasound – 10 min		
Integrated yoga therapy practice: The patient was made to practice at the center for 40 min for 21 days after the conventional physiotherapy and later was advised to continue at home for the next 3 months. This included the following practices:		40.0 min
Shithilikarana vyayama (loosening practices):		10.0 min
1. Foot and ankle loosening practices		
▪ Passive rotation of each toe (clockwise and counterclockwise)	5 rounds	0.5 min
▪ Toe bending	10 rounds	0.5 min
▪ Passive rotation of ankle (clockwise and counterclockwise)	10 rounds	0.5 min
▪ Ankle bending	10 rounds	0.5 min
▪ Ankle rotation (clockwise and counterclockwise)	10 rounds	0.5 min
2. Knee loosening practices		
▪ Bending the knee in prone position	5 rounds	0.5 min
▪ Knee bending – both sides	10 rounds	0.5 min
▪ Knee rotation – both sides	10 rounds	0.5 min
▪ Passive patella rotation	5 rounds	0.5 min
3. Hip and waist loosening practices		
▪ Half butterfly	10 rounds	0.5 min
▪ Full butterfly	10 rounds	0.5 min
▪ Waist rotations (both internal and external)	10 rounds	0.5 min
4. Upper limbs loosening practices		
▪ Finger loosening	5 rounds	0.5 min
▪ Wrist loosening	5 rounds	0.5 min
▪ Wrist rotation (clockwise and counterclockwise)	10 rounds	0.5 min
▪ Elbow loosening	10 rounds	0.5 min
▪ Shoulder loosening	10 rounds	0.5 min
5. Neck loosening practices		
▪ Forward and backward bending	5 rounds	0.5 min
▪ Sideward tilting	5 rounds	0.5 min
▪ Neck rotation (both clockwise and counterclockwise)	5 rounds	0.5 min
6. Relaxation: Instant		2.0 min
7. Strengthening exercises (sakti vikaasaka suksma vyayama)		5.0 min
▪ Lumbar stretch	5 rounds	1.0 min
▪ Crossed lumbar stretch	5 rounds	1.0 min

▪ Straight leg-raise breathing: single and both legs	5 rounds	1.0 min
▪ Setubandhasana lumbar stretch	5 rounds	1.0 min
▪ Pavanamuktasana lumbar stretch	5 rounds	1. min
8. Quick relaxation technique: Consists of three phases involving observing the abdominal movements, synchronizing them with breathing, and chanting of “A” kara, wherein “A” is the mantra.		3.0 min
9. Yogasanas		10.0 min
A. Standing asanas		
▪ Tadasana		
▪ Ardha kati chakrasana		
▪ Ardha chakrasana		
▪ Prasrita padahastana		
B. Lying asanas		
▪ Bhujangasana		
▪ Shalabhasana		
▪ Viparita karani		
10. Deep relaxation technique: Is a three-phase guided relaxation technique with relaxation from toes to the head, feeling of letting go, chanting OM and feeling of limitless expansion through visualization.		5.0 min
11. Nadi Shudi Pranayama: is a slow rhythmic technique of alternate nostril breathing involving the phases of inhalation and exhalation using nasika mudra.		3.0 min
12. OM meditation: Is done seated in any comfortable meditative posture and repeating the syllable OM mentally.		2.0 min

Table 3: Control module for chronic low back ache

Conventional physiotherapy: was carried out only at the center for 21 days and included		20.0 min
a) Intermittent lumbar traction -10 min		
b) Ultrasound – 10 min		
Therapeutic practices: The patient was made to practice at the center for 40 min for 21 days after the conventional physiotherapy and later was advised to continue at home for the next 3 months. This included the following practices:		40.0 min
Loosening exercises		10.0 min
1. Foot and Ankle		
▪ Passive rotation of the toes (each toe clockwise and counterclockwise) 10 rounds 0.5 min	10 rounds	0.5 min
▪ Passive rotation of the ankle (both clockwise and counterclockwise)	10 rounds	0.5 min
▪ Toe bending	10 rounds	0.5 min
▪ Ankle bending	10 rounds	0.5 min
▪ Ankle rotation	10 rounds	0.5 Min
2. Knee		
▪ Knee bending- both sides	10 rounds	0.5 min
▪ Knee rotation- both sides	10 rounds	0.5 Min
3. Hip and waist loosening practices		
▪ Half butterfly	10 rounds	0.6 min
▪ Full butterfly	10 rounds	0.6 min
▪ Waist rotations (both internal and external)	10 rounds	0.5 Min
4. Upper limb loosening practices		
▪ Finger loosening	10 rounds	0.6 min
▪ Wrist loosening	10 rounds	0.6 min
▪ Wrist rotation (both clockwise and counterclockwise)	10 rounds	0.5 min
▪ Elbow loosening	5 rounds	0.5 min
▪ Arm loosening (both forward and backward movements)	10 rounds	0.5 min
5. Neck loosening practices		
▪ Forward and backward bending	10 rounds	0.5 min
▪ Sideward tilting	5 rounds	0.5 min
▪ Neck rotation rotation (both clockwise and counterclockwise)	5 rounds	0.5 min
6. Quick pause		2.0 min
7. Strengthening exercises		5.0 min
▪ Palm exercises	5 rounds	0.5 min
▪ Elbow exercises	10 rounds	0.5 min
▪ Arm exercises	5 rounds	0.5 min
▪ Back exercises	5 rounds	0.5 min
▪ Thigh exercises	5 rounds	0.5 min
▪ Calf exercises	5 rounds	0.5 min
8. Rest		3.0 min
9. Back specific practices		15.0 min
▪ Lumbar stretch	5 rounds	3 min
▪ Crossed lumbar stretch	5 rounds	3 min
▪ Straight leg raising (single/both)-30/60/90 degrees	5 rounds	5 min
▪ Pelvic tilt	5 rounds	4.0 min
10. Supine rest		5.0 min

Table 4: Results within and between groups

		1 st Day	15 th Day	1 st month	6 th month	1 year
NRS	Control	9.22±1.05	6.84±0.96***	5.00±1.04***	3.40±0.87***	2.35±1.09***
	Exp	8.68±1.05	5.21±1.61***	2.91±1.64***	1.26±1.22***	0.09±0.29***
Between groups	P values	0.008	<0.001	<0.001	<0.001	<0.001
F	Control	16.22±4.39	21.62±4.54***	26.73±4.83***	32.29±5.06***	37.73±5.06***
	Exp	17.16±4.86	30.42±6.19***	38.91±5.03***	48.67±6.04***	57.04±3.03***
Between groups	P values	0.286	<0.001	<0.001	<0.001	<0.001
E	Control	12.80±2.98	17.27±3.38***	21.55±3.49***	25.93±3.05***	28.33±1.97***
	Exp	12.86±3.10	22.53±3.84***	27.40±2.69***	29.67±0.74***	29.93±0.37***
Between groups	P values	0.918	<0.001	<0.001	<0.001	<0.001
RLF	Control	12.85±3.14	17.04±3.53***	21.45±3.38***	25.64±2.93***	27.98±1.99***
	Exp	13.04±3.36	23.23±3.57***	27.82±2.32***	29.58±0.84***	29.96±0.26***
Between groups	P values	0.77	<0.001	<0.001	<0.001	<0.001
LLF	Control	13.25±3.19	17.71±3.38***	22.15±3.37***	26.60±3.28***	28.31±2.16***
	Exp	13.58±3.73	24.00±3.65***	28.40±2.53***	29.77±0.63***	30.00±0.00***
Between groups	P values	0.622	<0.001	<0.001	<0.001	<0.001
RLR	Control	16.24±4.29	20.95±4.13***	25.69±4.21***	30.76±4.27***	34.78±3.32***
	Exp	16.33±4.36	27.81±4.47***	33.84±3.88***	38.65±1.83***	39.74±0.77***
Between groups	P values	0.909	<0.001	<0.001	<0.001	<0.001
LLR	Control	16.91±4.41	21.78±4.36***	26.27±4.92***	31.25±4.45***	35.11±3.64***
	Exp	16.89±5.19	28.19±4.89***	34.35±4.09***	38.82±1.92***	38.91±5.32***

NRS- Numerical rating scale; F-Flexion; E-Extension; RLF-Right Lateral Flexion; LLF-Left Lateral Flexion; RLR- Right Lateral Rotation; LLR- Left Lateral Rotation

DISCUSSION

This randomized active controlled trial on 120 participants include patients of both genders (M-62, F-58) in the age group of 18–75 years with chronic low back ache (CLBA). Results showed significantly better improvement in the yoga than the control group in reduction of pain and improving spinal flexibility ($P < 0.001$, RMANOVA).

The incidence of back pain is exacerbated by our modern sedentary and stress-filled lifestyle, which contributes to the upsurge in many of the causes of back pain. These causes include obesity, hypokinetic (sedentary) activity which makes muscles weak and unable to support normal structural weight and stress, which produces tense and shortened muscles with restricted movements. Chronic back pain continues to be challenging to treat. Conventional medical therapies are limited to analgesics, patient education on proper posture, physical therapy, and exercise and seem largely ineffective. This leads many to seek complementary or alternative treatments, such as massage, chiropractic, and mind-body techniques. Yoga is among the most commonly used of these alternative therapies.¹⁶ Recent practice guidelines from the American College of Physicians and the American Pain Society suggest that if low back pain does not improve with standard pharmacological therapy and self-care, non-pharmacological treatments should be considered.¹¹ Approximately 40% of patients with chronic back pain report using complementary and alternative therapies such as massage, reflexology and acupuncture.¹⁷ Yoga has also generated a great deal of interest and attention among the general public and the Western scientific community as an alternative treatment for a variety of chronic health conditions, including chronic pain. Yoga is an ancient practice that originated in India >4000 years ago and consists of several key components, including physical postures (asanas), breathing techniques (pranayama), relaxation and meditation (dhyana).¹⁸ An estimated 14.9 million Americans practice yoga, 21% of which use it for treating neck and back pain.¹⁹

Yoga interventions impact multiple outcomes that are important to the health and well-being of people afflicted with chronic low back pain. Recent, high quality evidence suggests that yoga

provides comparable effects to, and is more appealing than, formal stretching and strengthening programs led by physical therapists. Reviews and meta-analyses and practice guidelines from the American Pain Society and the American College of Physicians support yoga as an evidence-based treatment for cLBP with at least moderate benefit.²⁰ Among the three peer-reviewed studies of yoga and CLBP that have been published, two of the studies evaluated an unspecified method of hatha yoga. One study lacked a control group,²¹ while the other was not powered to reach statistical significance.²² The third was a feasibility analysis of Iyengar yoga presenting only baseline data and adherence rates to therapy.²³ However, no studies to date have compared yoga's effectiveness to physiotherapy, the most common non-pharmacologic reimbursable treatment physicians recommend.¹³

As per the above studies and their assessments discussed in a meta-analytic study, there are no studies to this date that has compared the effectiveness of yoga to physiotherapy. None of the studies of yoga and chronic low back ache published so far, have both the control and yoga group which is said to be very important to rule out the possibility of the benefits of yoga.²⁰ Hence the present study was planned to evaluate the efficacy of yoga as an add on to the conventional non-pharmacological treatment of CLBP and the significant difference have been found in reduction of pain, tenderness and back disability in yoga group than the control group.

Pain Reduction

In a recent narrative systematic review of the literature, seven RCTs were identified that had been conducted on yoga for CLBP, and noted that yoga led to a significant reduction in pain intensity in five of the trials.⁸ The study of Wren et al reviewed six RCTs of yoga for CLBP and suggested that yoga shows promise in reducing pain, pain-related disability, negative mood and pain medication among patients with CLBP.²⁴ Five large ($n=90-313$) and five smaller randomized controlled trials (RCTs) ($n=20-60$) support yoga's effectiveness for reducing pain and improving function in adults with cLBP.⁵ Studies have established the role of yoga in decreasing the pain and disability in chronic low back pain, along with improved flexibility within

1 week to 4 months of yogic intervention with no adverse effects.²⁵

Recent research has also indicated that yoga can reduce pain catastrophizing, increase pain acceptance and improve overall emotional functioning among individuals with chronic pain.²⁶⁻²⁹ A number of studies have demonstrated the effectiveness of yoga in reducing pain in individuals with chronic low back pain, for example, in addition to studying yoga's effect on functional disability,³⁰ also assessed clinical levels of pain, pain-related fears of movement, and pain attitudes. Their results suggested that in addition to the yoga group having less functional disability at post treatment, the yoga group demonstrated two times greater reductions in pain, than the control group. In the study of Saper et al 2009,³¹ greater decreases were found in pain scores of yoga group than the control group from baseline to 12 weeks. In Williams et al, 2009 study, individuals randomized to the yoga group showed greater improvements in pain intensity than those to the control group.³²

In the Cox et al's study of 2010 that measured pain-related outcomes using Aberdeen back pain scale and pain efficacy found greater decrease of pain at the 4th week follow-up in the yoga group than the control group.³³ Tekur et al studied the efficacy of the integrated approach of yoga therapy in patients with chronic low back ache and documented 49% reduction in numerical rating scale scores in the yoga group.²⁵ One of the studies on common neck pain and yoga assessed pain using numerical rating scale also showed 95.5% reduction of pain in yoga group compared to 61.2% of the control group.³⁴ One more study of Ebnezar et al on OA knees and yoga has 37.31% and 64.88% of pain reduction in yoga group that was assessed using NRS on 15th day and 90th day respectively.³⁵ In a residential program of yoga for 2 weeks that assessed pain using VAS, reported 55% of pain reduction in the study group.³⁶ Study of Williams et al 2003,³⁷ an out-patient program for 3 months found 70% pain reduction in the yoga group and one more study of Groessel et al 2008,³⁸ found 14% pain reduction after 10 weeks of yoga in Veterans administration (VA) patients with chronic back pain, whereas in the current study, yoga was added after the conventional physiotherapy, which has shown a significant difference both between and within groups (RMANOVA, $P < 0.001$) with a significant reduction in yoga group by (39.9% - 21st day), (66% - 3rd month), (85% - 6th month) and (98.9% - 1 year) than the control group by (25.5% - 21st day), (45% - 3rd month), (63% - 6th month) and (74% - 1 year).

Spine Flexibility

Almost all studies of yoga intervention for treating chronic low back pain measure physical functioning/disability as a primary outcome. It is viewed as a more reliable and objective measure of CLBP because it is often either measured by actual physiological performance, or by questionnaires with items that are tied to specific behaviors.⁷ Studies have established the role of yoga with improved flexibility within 1 week to 4 months of yogic intervention with no adverse effects.³⁴ In a study of (Telles et al, 2008),²⁵ yoga group demonstrated significant increases in handgrip strength for both hands and significant improvements in low back and hamstring flexibility. The efficacy of a week-long intensive residential yoga program on disability caused by pain and spinal flexibility in patients with chronic low back pain was studied by Tekur et al and in this study, Spinal flexion (SF), Spinal extension (SE), Right lateral flexion (RLF) and left lateral flexion (LLF) were assessed and found significant improvement in spinal flexibility in SF by 28.3%, SE by 51.52%, RLF by 26.36% and LLF by 39.15% in

first week which did not change significantly after shifting to the control intervention in the 2nd week pointing to the spill-over effect of yoga. In the control group there was a non significant improvement in the 1st week followed by significant improvement in all the variables in the 2nd week. The overall change at the end of 2 weeks in both the groups was significant within groups but did not differ significantly between groups. The study of Goncalves et al. assessed the level of flexibility using goniometry in a similar age group of people practicing yoga and in a control group. The authors identified an increase in articular range of motion in lumbar spine bending and hip flexion and extension in older people doing yoga.³⁹ Schmid et al. reported significantly increased lower body flexibility (measured by chair sit and reach test) after a 12-week yoga exercise program.⁴⁰ The study conducted by Grabara et al. indicated that persons exercising with yoga postures had greater flexibility of the hamstring muscles than their non-training peers¹⁹. This was manifested in a greater range of hip bend with the knees in a straight position and elongated spine, i.e., without curving one's back. Backward bends improved mobility of the spine, strengthened the back muscles, and prevented degenerative changes resulting from overloading the intervertebral discs. Exercises with torsion increased the mobility of the spine and strengthened the abdominal oblique muscles and muscles of the back.^{41, 42} In the study done by Gothe et al., after 8 weeks of yoga posture practice, the participants in the yoga group showed much better flexibility compared with their counterparts doing only regular stretching-strengthening exercises.⁴³ One unpublished study on the role of MSRT in chronic low back pain showed reduction in back pain, improvement in spine flexibility and decrease in stress on using this relaxation technique.⁴⁴

The present study has shown significant difference both between and within groups (RMANOVA, $P < 0.001$) with improvement of spinal flexibility of flexion in yoga (77%, 126%, 183%, 232%) and control (33%, 64%, 99%, 132%), Extension in yoga (75%, 113%, 130%, 132%) and control (34%, 68%, 102%, 121%), right lateral flexion in yoga (78%, 113%, 126%, 129%) and control (32%, 66%, 99%, 117%), left lateral rotation in yoga (76%, 109%, 119%, 120%) and control (33%, 67%, 100%, 113%), right lateral rotation in yoga (70%, 107%, 136%, 143%) and control (29%, 58%, 89%, 114%), left lateral rotation in yoga (66%, 103%, 129%, 130%) and control (28%, 55%, 84%, 107%). All these improved in the yoga group better than the control group on the 21st day, 3rd month, 6th month and 1 year respectively.

Mechanisms

A number of rationales have been put forward for yoga's utility as a therapy for chronic back pain. Yoga improves strength, range of motion, balance and agility, and mobilizes the spine and hip joints to reduce pain; yoga increases flexibility, tones muscles, and releases muscle tension specifically increasing hip flexion and spinal and hamstring flexibility. Yet yoga's benefits reach beyond the physical realm into the psychological and even spiritual, making it uniquely suited to treating pain. Pain affects every system of our physical body as well as our mental experience, including thoughts, emotions, behavior, and relationships. Yoga couples physical exercise with breathing, which links the mind and the body, and thus offers physical movement with a mental focus.⁴⁵ Yoga and Exercise bring about a decrease in cortical concentration, increase in neurotransmitters, immune mediator, thereby improves cognition, sleep, negative symptoms, uplifts mood, lowers anxiety and improves concentration.⁴⁶ Exercise is considered an acceptable method for improving and maintaining physical and

emotional health. A growing body of evidence supports the belief that yoga benefits physical and mental health via down-regulation of the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS).⁴⁷

The mental focus cultivated by yoga helps people increase their awareness of maladaptive ways of moving and positioning their body, to relax tense muscles, and to relieve mental stress. Moreover, yoga therapy promotes healing by resting the area of pain and teaching the proper alignment of bones, muscles, and connective tissue in movements that change the underlying root cause of the discomfort, thus minimizing and ultimately correcting underlying physical malfunctions. Yoga reduces stress and improves mood and overall well-being. The yoga practiced in the current study followed the principle of the "panca maya" model, in which the five "mayas" or dimensions of body, breath/energy, mind, personality, and relationship are all elements of healing and growth. As a T. Krishnamacharya disciple commented, "Yoga takes into account the present state of all areas of one's being and seeks to affect them all in whatever manner is most personally appropriate. Research on meditation as an effective intervention for chronic low back pain highlights the constructive role of cognitive components in people's ability to manage their pain. Mindfulness meditation helps reduce pain, improve physical function, and increase quality of life in part because people learn to bear witness to their own experiences without judgment, leading to acceptance of their pain-filled condition. Meditation and pranayama have both been found helpful in pain management, and the meditation and pranayama techniques included in the intervention in this study increased the mindfulness of the yoga."⁴⁵

Several factors would have contributed to the beneficial effects observed in both groups in this study. As noted in several earlier studies physiotherapy intervention may increase the blood flow. Better results in the yoga group could be due to its stress reducing effect as yoga is meant to bring about better emotional stability and is achieved by the multifactorial approach of yoga that includes safe physical practices (asanas), breathing techniques (pranayama), meditation (dharana and dhyana) and introspective corrections in one's cognitive errors by inputs at intellectual (jnana yoga) and emotional level (bhakti yoga). Yoga is multi-dimensional, so it is important to describe all of the components of each yoga intervention in order to compare across interventions and better understand which components are best for different disease populations. As per the yogic philosophy, the disturbances in the manomaya kosha percolate into the physical layer annamaya kosha through the pranamaya kosha. Hence in the treatment of these psychosomatic ailments it becomes mandatory to work at all these levels of our existence to bring about quick results. The integrated approach, thus, consists in not only dealing with physical health, the relief of which could at best be temporary. It includes techniques to operate on different layers of our existence. Many practices described in the texts of yoga and upanishads are adopted in IAYT to balance and harmonise the disturbances at each of the five koshas and tackle this type of complex psychosomatic ailments. The problem of long standing stresses begin in the manomaya kosha and manifests initially only as psychological problems such as irritability, emotional lability, excessive smoking or alcohol, sleep disturbances, difficulty in taking decisions etc. Over the years, this starts disturbing the pranamaya kosha and shows up as one of the digestive problems such as poor appetite, dyspepsia etc which are common precursors of most stress induced ailments. These prana imbalances go on fluctuating depending on the degree of stress. As this goes on for a few more years, it shows up at the annamaya kosha as un-explained musculo-skeletal pains either

as muscle spasms, soft tissue pains, sprains, cramps etc. A combination of these imbalances settles down in one particular part of the body showing up as recurrent episodes of acute or chronic musculoskeletal pains with no organically detectable cause.⁴⁸

It is known that physical exercise therapy has an important role in CLBP. Studies have shown that exercises are helpful in chronic low back pain to return to normal daily activities and work in adults.⁴⁹ decrease pain and improve functional capacity in health care professionals.⁵⁰ Yoga postures although appear to be similar to many physical exercises there are several basic differences. Yogic physical practices are mainly spinal stretches that are maintained with ease and effortlessness (Sthiram sukham aasanam- Patanjali). Yoga postures offer voluntary introspective relaxation of the parts that are stretched and they are not just isometric exercises. Deep relaxation of the spinal muscles achieved during safe body movements with mindful awareness seems to be another major factor that improves flexibility and reduces pain.²⁵ This is supported by earlier observations of increased paraspinal electromyographic (EMG) activity during pain in subjects with CLBP.⁵¹ Yoga has shown reducing the EMG activity in conditions like chronic pain specially headache.⁵² Yogasanas reduces the stiffness and increases the flexibility of the spine. These yogasanas are practiced with deep internal awareness and relaxation. Stimulation in the form of a stretch during a movement and once the stretch is at its peak maintaining with ease and calm mind and slowly returning to resting position and let go to sink into deep relaxation. This process of alternate stretch followed by a relaxation carried out with deep internal awareness (the process of alternate stimulation and relaxation) helps in erasing the deep seated stress. When the final posture of the asana is maintained with relaxation, the deeper corrections takes place. The prana blocks are diffused giving a great sense of freedom from the stiff back.⁴⁸ Another explanation of yoga's efficacy in pain reduction may lie in endorphin production at a cortical level, which is known to result from alternate stretch and relax procedures of yogasana practice.⁵³

Studies on different types of meditation have consistently shown increased mental alertness even while being physiologically relaxed. In a previous study, Om chanting has been shown to bring about therapeutic effects in a functional neuro-imaging study by decrease in BOLD signal in limbic structures in healthy volunteers similar to vagal nerve stimulation.⁵⁴ Om meditation that was used in this study has also been shown to provide this psycho physiological rest as seen in the earlier study. These yogic practices be it physical or breathing or mental, practiced independently or as a combination seem to produce better mental alertness even while being physiologically relaxed both in the sick and healthy persons that may account for the reduction in anxiety and depression.⁵⁵ In the present study, this physiological rest explained above may form the basis of stress reduction and thereby help in reduction of pain and disability even in CLBP patients.

Oxygen consumption is used as a measure of the degree of rest or relaxation. When the body-mind complex is relaxed, the amount of oxygen used up is much less and this can be measured by the oxygen we consume. Studies has shown that the oxygen consumption came down 10% after deep relaxation technique. The yoga based relaxation technique has also shown to reduce physiological signs of arousal.⁵⁶ A significant decrease in oxygen consumption and increase in breath volume were recorded after guided relaxation. During yoga relaxation the power of the low frequency component of the heart-rate variability spectrum reduced, whereas the power of the high

frequency component increased, suggesting reduced sympathetic activity. A study has also shown that a yoga-based isometric relaxation reduced physiological signs of anxiety⁵⁷ (Vempati et al, 1999) indicating reduced sympathetic tone.⁵⁸

These practices remove the carbon dioxide from the body and cleanse the system. All the breathing exercises correct the rhythm of breathing by synchronizing body movements with inhalation and exhalation. Yogic breathing or the pranayama is a unique method for balancing the autonomic nervous system.⁵⁹ Research done on pranayama has shown that specific pranayama practices can have relaxing effect on the sympathetic nervous system there by reducing stress levels.⁶⁰ Reduced anxiety scores, autonomic arousal and urinary VMA levels were found after the practice of integrated approach of yoga in patients with generalized anxiety disorder.⁶¹ Pranayama practices also reduces breath frequency to master emotional surges, and increase deep internal awareness in preparation for meditation.⁴⁸ Setubandhasana lumbar stretch builds up the strength of the supporting postural lumbar spinal muscles. Dorsal stretch and straight leg rising (ekapadasana) helps to build up the front (abdominal) support for the back. Pavanamuktasana practice provides a traction effect.⁶²

The present study has shown the better reduction of pain and improvement in spinal flexibility with yoga as an adjunct to physiotherapy, the standard conventional treatment in the management of chronic low back ache.

Follow up assessments

In a study of Posadzki et al, the difference between the two groups became statistically significant at three-month follow-up when the yoga group reported a 70% decrease in present pain compared to the 38% reduction reported by the control group.⁸ Whereas in the present study, yoga group showed 66% of pain reduction at the 3rd month follow-up, 85% pain reduction at the 6th month follow up and 98% pain reduction at 1yr follow up compared to 45% at 3rd month, 63% at 6th month and 74% at 1 yr follow ups in the control group respectively.

Strengths of the study

i) Randomized controlled trial ii) good sample size iii) supervised matched intervention for both the groups with same duration iv) longer follow-ups of 3 months, 6 months and 1yr with good compliance (3% dropouts). V) Intervention of the study is applicable for patients of all age groups. The results of this study have shown marked differences on all the variables between the groups and thus can be considered as an evidence for incorporating the yoga module for the management of CLBP by the clinicians.

Implications of the study

The intervention of the present study is simple, easy to practice and cost effective compared to the conventional management and helps in reducing the economical burden in patients suffering from CLBP.

Suggestions for future work

Longer follow ups may be carried out to rule out the validity of the intervention.

CONCLUSION

Integrated approach of yoga therapy for chronic low back ache provides the better reduction of pain and improvement of spinal flexibility.

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REFERENCES

1. Punnett L, Prüss-Utün A, Nelson DI, Fingerhut MA, Leigh J, Tak S, Phillips S. Estimating the global burden of low back pain attributable to combined occupational exposures. *Am J Ind Med*. 2005 Dec;48(6):459-69.
2. Campbell MK¹, Elbourne DR, Altman DG; CONSORT group. CONSORT statement: extension to cluster randomised trials. *BMJ*. 2004 Mar 20;328(7441):702-8.
3. Damian Hoy et al. The Global Burden Of Low Back Pain: Estimates From The Global Burden Of Disease 2010 Study. *Ann Rheum Dis* 2014;73:968-974.
4. Burton AK, Clarke RD, Mc Clude TD Et Al. The Natural History Of LBP In Adolescents. *Spine* 1996;21:2323-28
5. Saper RB, Sherman KJ, Delitto A, Et Al. Yoga Vs. Physical Therapy Vs. Education For Chronic Low Back Pain In Predominantly Minority Populations: Study Protocol For A Randomized Controlled Trial. *Trials*. 2014;15:67. Doi:10.1186/1745-6215-15-67.
6. Karen J Sherman, Daniel C Cherkin, Andrea J Cook, Rene J Hawkes, Richard A Deyo, Robert Wellman and Partap S Khalsa. Comparison of yoga versus stretching for chronic low back pain: protocol for the Yoga Exercise Self-care (YES) trial. *Trials* 2010;11:36 DOI: 10.1186/1745-6215-11-36
7. Erik J. Groessl, Marisa Sklar and Douglas Chang (2012). Yoga as a Treatment for Low Back Pain: A Review of the Literature", *Low Back Pain*, Dr. Ali Asghar Norasteh (Ed.), ISBN: 978-953-51-0599-2.
8. Posadzki P, Ernst E. Yoga For Low Back Pain: A Systematic Review Of Randomized Clinical Trials. *Clin Rheumatol*. 2011;30(9):1257-1262. Doi: 10.1007/S10067-011-1764-8.
9. Bussing A, Ostermann T, Ludtke R, Michalsen A. Effects Of Yoga Interventions On Pain And Pain-Associated Disability: A Meta-Analysis. *J Pain*. 2012;13:1-9. [PubMed]
10. Cramer H, Lauche R, Haller H, Dobos G. A Systematic Review And Meta-Analysis Of Yoga For Low Back Pain. *Clin J Pain*. 2013;29(5):450-460.
11. Chou, R., A. Qaseem, V. Snow, D. Casey, J. T. Cross, Jr., P. Shekelle, And D. K. Owens. "Diagnosis And Treatment Of Low Back Pain: A Joint Clinical Practice Guideline From The American College Of Physicians And The American Pain Society." *Ann Intern Med* 147, No. 7 (2007): 478-91.
12. Małgorzata Grabarał)*, Janusz Szopał) Effects of hatha yoga exercises on spine flexibility in women over 50 years old. *J. Phys. Ther. Sci.* 27: 361-365, 2015
13. Freburger JK, Holmes GM, Carey TS: Physician Referrals To Physic Al Therapy For The Treatment Of Musculoskeletal Conditions. *Arch Phys Med Rehabil* 2003, 84:1839-1849.

14. Tekur P, Chametcha S, Hongasandra RN, Raghuram N. Effect of yoga on quality of life of CLBP patients: A randomized control study. *Int J Yoga*. 2010;3:10–7
15. Pollard CA. Preliminary Validity Study Of The Pain Disability Index. *Percept Or Index*. 1984;59:974.
16. Schultz LH, Uytterhoeven S, Khalsa SBS (2011) Evaluation of a Yoga Program for Back Pain. *J Yoga Phys Therapy* 1:e103. doi:10.4172/2157-7595.1000e103
17. Foltz V, St Pierre Y, Rozenberg S, Et Al. Use Of Complementary And Alternative Therapies By Patients With Self-Reported Chronic Pain Back: A Nation-Wide Survey In Canada. *Joint Bone Spine* 2005;72:571-7.
18. Carneiro KA, Rittenberg JD. The Role Of Exercise And Alternative Treatments For Low Back Pain. *Phys Med Rehabil Clin North Am* 2010;21:777-92.
19. Saper RB, Phillips RS, Davis RB, Eisenberg DM. Prevalence and patterns of hatha yoga use in the United States. Poster presented at International scientific conference on complementary, alternative and integrative medicine research, Boston, MA, April 12–14 2002. Effect of Iyengar Yoga therapy for chronic low back pain.
20. S Holtzman, RT Beggs. Yoga For Chronic Low Back Pain: A Metaanalysis Of Randomized Controlled Trials. *Pain Res Manag* 2013;18(5):267-272.
21. Vidyasagar JVS, Prasad BN, Reddy V, Raju PS, Jayshankar M, Sampath K. Effects Of Yoga Practices In Nonspecific Low Back Pain. *Clin Proc NIMS* 1989; 4: 160-164.
22. Galantino ML, Bzdewka TM, Eissler-Russo JL., Holbrook ML, Mogck EP, Geigle P, Farrar JT, The Impact Of Modified Hatha Yoga On Chronic Low Back Pain: A Pilot Study. *Altern Ther Health Med*. 2004 Mar-Apr; 10(2):56-9.
23. Jacobs BP, Mehling W, Avins AL, Et Al. Feasibility Of Conducting A Clinical Trial On Hatha Yoga For Chronic Low Back Pain: Methodological Lessons. *Altern Ther Health Med* 2004;10:80-3
24. Wren AA, Wright MA, Carson JW, Keefe FJ. Yoga For Persistent Pain: New Findings And Directions For An Ancient Practice. *Pain* 2011;152:477-80.
25. Tekur P, Singhphow C, Nagendra HR, Raghuram N. Effect Of Short term Intensive Yoga Program On Pain, Functional Disability And Spinal Flexibility In Chronic Low Back Pain: A Randomized Control Study. *J Altern Complem Med* 2008;14:637-44.
26. Carson JW, Carson KM. Jones KD, Et Al. A Pilot Randomized Controlled Trial Of The Yoga Of Awareness Program In The management Of Fibromyalgia. *Pain* 2010;151:530-9.
27. Curtis K, Osadchuk A, Katz J. An Eight-Week Yoga Intervention Is Associated With Improvements In Pain, Psychological Functioning And Mindfulness, And Changes In Cortisol Levels In Women With Fibromyalgia. *J Pain Res* 2011;4:189-201.
28. John PJ, Sharma N, Sharma CM, Kankane A. Effectiveness Of Yoga Therapy In The Treatment Of Migraine Without Aura: A Randomized Controlled Trial. *Headache* 2007;47:654-61.
29. Tilbrook HE, Cox H, Hewitt CE, Et Al. Yoga For Chronic Low Back Pain. *Ann Intern Med* 2011;155:569-78.
30. Williams KA, Petronis J, Smith D, Et Al. Effect Of Iyengar Yoga Therapy For Chronic Low Back Pain. *Pain* 2005;115:107-17.
31. Saper RB, Sherman KJ, Cullum-Dugan D, Davis RB, Phillips RS, Culpepper L. Yoga For Chronic Low Back Pain In A Predominantly Minority Population: A Pilot Randomized Controlled Trial. *Altern Ther Health Med* 2009;15:18-27.
32. Williams K, Abildso C, Steinberg L, Et Al. Evaluation Of The Effectiveness And Efficacy Of Iyengar Yoga Therapy On Chronic Low Back Pain. *Spine* 2009;34:2066-76.
33. Cox H, Tilbrook H, Aplin J, Et Al. A Randomised Controlled Trial Of Yoga For The Treatment Of Chronic Low Back Pain: Results Of A Pilot Study. *Complement Ther Clin Pract* 2010;16:187-93.
34. Yogitha B, John E. Efficacy Of Mind Sound Resonance Technique In Common Neck Pain. *Int. J. Res. Ayurveda Pharm*. 2012; 3(2):227-233.
35. Ebnezar J, Nagarathna R, Yogitha B, Nagendra HR. Effects Of An Integrated Approach Of Hatha Yoga Therapy On Functional Disability, Pain, And Flexibility In Osteoarthritis Of The Knee Joint: A Randomized Controlled Study. *J Altern Complement Med*. 2012 May;18(5):463-72.
36. Pradhan B. Effect Of Integrated Approach Of Yoga Therapy For Back Pain. [Doctorate In Hindu Studies, Thesis] Orlando, Florida, USA: Hindu University Of America; 2009.
37. Williams, Kimberly, Lois Steinberg, And John Petronis. "Therapeutic Application Of Iyengar Yoga For Healing Chronic Low Back Pain." *International Journal Of Yoga Therapy* 13.1 (2003): 55-67.
38. Groessl EJ, Weingar KR, Aschbacher K, Pada L, & Baxi S. (Yoga For Veterans With Chronic Low-Back Pain. *J Altern Complement Med*, 2008; 14, 1123-1129.
39. Gonçalves LC, Vale RG, Barata NJ, et al.: Flexibility, functional autonomy and quality of life (QoL) in elderly yoga practitioners. *Arch Gerontol Geriatr*, 2011, 53: 158–162. [Medline] [CrossRef]
40. Schmid AA, Van Puymbroeck M, Kocaja DM: Effect of a 12-week yoga intervention on fear of falling and balance in older adults: a pilot study. *Arch Phys Med Rehabil*, 2010, 91: 576–583.
41. Grabara M, Szopa J, Grabara D: Flexibility of the spine and selected joints in women practising hatha yoga. *Pol J Sport Med*, 2011, 27: 61–73. [Cross- Ref]
42. Szopa J, Grabara M, Górna J: The role of yoga physical exercise in maintaining health and wellness for years. In: Olchowik G, ed. *Wellness and prosperity in different phases of life*. Lublin: NeuroCentrum Publisher, 2009, XXXII: 389–402.
43. Gothe NP, Kramer AF, McAuley E: The effects of an 8-week Hatha yoga intervention on executive function in older adults. *J Gerontol A Biol Sci Med Sci*, 2014, 69: 1109–1116 [CrossRef]. [Medline]
44. Anupriya S (2007) Complementary effect of MSRT as add on program in patients undergoing Traction and Interferential therapy for chronic low back pain. Swami Vivekananda Yoga Anusandhana Samsthana, Bangalore, Karnataka.
45. Schultz LH, Uytterhoeven S, Khalsa SBS (2011) Evaluation of a Yoga Program for Back Pain. *J Yoga Phys Therapy* 1:e103. doi:10.4172/2157-7595.1000e103
46. Balasubramaniam M, Telles S, Doraiswamy PM. Yoga on Our Minds: A Systematic Review Of Yoga for Neuropsychiatric Disorders. *Front Psychiatry* 2012; 3 : 117.
47. Ross A¹, Thomas S. The health benefits of yoga and exercise: a review of comparison studies. *J Altern Complement Med*. 2010 Jan;16(1):3-12. doi: 10.1089/acm.2009.0044
48. Nagendra HR, Nagarathna R. *Yoga For Back Pain*. Bangalore: Vivekānanda Kendra Prakashana. Reprint:2016
49. Van Tulder M, Malmivaara A, Esmail R, & Koes B. (2000). Exercise Therapy For Low Back Pain: A Systematic Review Within The Framework Of The Cochrane Collaboration Back Review Group. *Spine*: 25, 2784-2796.
50. Hayden JA, Van Tulder MW, & Tomlinson, G. (2005). Systematic Review: Strategies For Using Exercise Therapy

- To Improve Outcomes In Chronic Low Back Pain. *Ann Intern Med*, 142(9), 776-785.
51. Fryer G, Morris T, Gibbons P, Paraspinal Muscles And Intervertebral Dysfunction: Part One. *J Manipulative Physiol Ther*. 2004 May; 27(4):267-74.
 52. Padmashree G. Immediate Effect Of Yogic Relaxation On Frontalis Surface EMG. [M.Sc, Thesis]. Bengaluru: Swami Vivekananda Yoga University; 2007.
 53. Kjaer TW, Bertelsen C, Piccini P, Brooks D, Alving J, & Lou HC. (2002). Increased Dopamine Tone During Meditation-Induced Change Of Consciousness. *Brain Research Cognitive Brain Research*, 13, 255-259.
 54. Kalyani BG, Venkatasubramanian G, Arasappa R, Rao NP, Kalmady SV, Behere RV, Et Al. Neurohemodynamic Correlates Of 'OM' Chanting: A Pilot Functional Magnetic Resonance Imaging Study. *Int J Yoga* 2011; 4 : 3-6.
 55. Shirley Telles, Nagarathna R, Nagendra HR. Autonomic Changes During OM Meditation. *Indian Journal Of Physiology And Pharmacology* 1995; 39:418-420.
 56. Vempati RP, & Telles S (2002). Yoga-Based Relaxation Reduces Sympathetic Activity Judged From Base Line Levels. *Psychological Reports*, 90, 487-494.
 57. Vempati RP And Telles S. (1999). Yoga Based Relaxation Versus Supine Rest: A Study Of Oxygen Consumption, Breath Rate And Volume & Autonomic Measures. *Journal Of Indian Psychology*, 17: 46-52.
 58. Shirley Telles, Nagarathna R, Nagendra H R, Desiraju T. Alterations In Auditory Middle Latency Evoked Potentials During Meditation On A Meaningful Syllable-OM. *International Journal Of Neuroscience* 1994; 76:87-93.
 59. Brown RP, Gerbarg PL. Sudarshan Kriya Yogic Breathing In The Treatment Of Stress, Anxiety, And Depression. Part II--Clinical Applications And Guidelines. *J Altern Complement Med* 2005; 11(4): 711-717.
 60. Telles S, Nagarathna R, Nagendra HR. Breathing Through A Particular Nostril Can Alter Metabolism And Autonomic Activities. *Indian J Physiol Pharmacol* 1994; 38(2): 133-137.
 61. Nagarathna R, Nagendra H R, Crisan H G, Seethalakshmi R. Yoga In Anxiety Neurosis – A Scientific Study. In: *Proceedings Of The International Symposium Of The Royal College Of Physicians And Surgeons Of Glasgow-Update Medicine And Surgery*. 1988;.192-196.
 62. Di Iorio D, Henley E, Doughty A. A Survey Of Primary Care Physician Practice Patterns And Adherence To Acute Low Back Problem Guidelines. *Arch Fam Med*. 2000;9:1015-21. [PMID: 11115201]

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