

Efficacy of Yoga in the Management of Chronic Low Back Pain: A Focused Review of Evidence

Senthil P Kumar*, Prabha Adhikari**, P.S. Jeganathan***, Anup Kumar****

Abstract

Background: Chronic low back pain (CLBP) is a multidimensional biopsychosocial problem and its psychosomatic aspects could be addressed efficiently with principles of Yoga.

Objective: The objective of this review paper was to describe the role of yoga in prevention and treatment of CLBP and its associated problems.

Methods: Systematic independent literature search of PubMed was done using keywords yoga AND low back pain IN title by two testers. Consensus was achieved in presence of the third tester. The suitable citations were identified and selected studies were grouped under prevention, treatment and prevention and treatment, of CLBP.

Results: The final list of 13 selected studies was then descriptively summarized which unanimously showed both short-term and long-term benefits for yoga in CLBP. Yoga could be an effective therapeutic adjunct if not an alternative to existing treatments for patients with CLBP and large number of high quality clinical trials had shown not only clinical benefits but also on disability and cost-effectiveness in favour of yoga.

Conclusion: From the reviewed evidence, it is recommended that Yoga is effective in treatment of chronic low back pain and could thus be a viable and affordable treatment option for patients with chronic low back pain.

Key-words: Yoga; Low back pain; Rehabilitation; Physical therapy.

Introduction

Back pain is the most common cause for a patient's visit to a general practitioner, next only to common cold, and is the leading cause for visiting a physical therapist[1]. The problems of chronic low back pain extend far from the physical symptoms and signs to a complex interaction of biological, psychological and social features thus making

it a multidimensional biopsychosocial pain syndrome[2]

The physiological and therapeutic effects of yoga include relaxation, flexibility, strengthening, balance, co-ordination/proprioception and improved well-being[3]. Although all the above mentioned aspects were addressed in physical therapy treatment methods using tailored exercises, back pain still continues to elude long-term recovery and it leads to higher recurrence rates and chronic disability[4].

Chronic low back pain is common and poses a challenge for clinicians to find effective treatment to prevent it from becoming chronic. Chronic low back pain can have a significant impact on an employee's ability to remain an active and productive member of the work force due to increased absenteeism, duty restrictions, or physical limitations from pain.

Author's Affiliation: *Associate Professor, Dept of Physiotherapy, Kasturba Medical College (Manipal University), Mangalore, **Professor, Dept of Medicine, Kasturba Medical College (Manipal University), Mangalore, ***Professor, Dept of Physiology, Kasturba Medical College (Manipal University), Mangalore, ****Associate professor, Dept of Orthopaedics, Kasturba Medical College (Manipal University), Mangalore.

Reprint's request: Senthil P Kumar, Associate professor, Dept of Physiotherapy, Kasturba Medical College (Manipal University), Mangalore. E-mail: senthil.kumar@manipal.edu.

(Received on 14.02.2013, accepted on 21.02.2013)

Low back pain is the most common cause of work-related disability among employees younger than 46 years[5]

The multifaceted problem of low back pain might be adequately addressed by a multidimensionally therapeutic Yoga program[6]. Thus the objective of this review paper is to provide evidence for yoga in treatment of chronic low back pain (CLBP) through a systematic literature search of published studies.

Materials and methods

Study design

Systematic review of published studies.

Search methods

Independent search was done by two testers using specific search strategy and consensus was obtained on discussion with the third tester.

Search strategy

Search was conducted using keywords 'yoga AND chronic low back pain IN title' in PubMed. Initial screening of obtained citations was done by title and then by abstract to assign suitability for review.

Selection criteria

Studies on treatment of CLBP by yoga published in English from 1992 to 2010 that included studies on humans were included. Non-English papers, other types of pain and assessment studies were excluded.

Results-main findings

The first-level search yielded 112 citations. After elimination of duplicate citations, we got 43 potentially eligible citations. Of the final total 43 citations, 7 were non-English papers, 23 were on other types of pain conditions and

they were excluded. The final list of 13 selected studies was then descriptively summarized as below.

Tekur et al[7] evaluated changes in pain, anxiety, depression and spinal mobility for CLBP patients on short-term, residential Yoga and physical exercise programs, including comprehensive yoga lifestyle modifications. A seven day randomized control single blind active study in a residential Holistic Health Centre in Bangalore, India, assigned 80 patients (37 female, 43 male) with CLBP to yoga and physical exercise groups. The Yoga program consisted of specific asanas and pranayamas for back pain, meditation, yogic counselling, and lectures on yoga philosophy. The control group program included physical therapy exercises for back pain, and matching counselling and education sessions. The authors found that seven days intensive residential Yoga program reduces pain, anxiety, and depression, and improves spinal mobility in patients with CLBP more effectively than physiotherapy exercises.

Chuang et al[8] in their multi-centred randomized controlled trial evaluated the cost-effectiveness of 12-week yoga intervention plus usual care compared with usual care alone for chronic or recurrent low back pain. Perspectives of the UK National Health Service and the society were presented with main outcome measure which was an incremental cost per quality adjusted life year (QALY). From the perspective of the NHS, yoga intervention yields an incremental cost effectiveness ratio of £13,606 per QALY. Given a willingness to pay for an additional QALY of £20,000, the probability of yoga intervention being cost effective is 72%. From the perspective of the society, yoga intervention is a dominant treatment over usual care alone. This result is surrounded by fewer uncertainties - the probability of yoga being cost effective reaches 95% at a willingness to pay for an additional QALY of £20,000. Sensitive Analyses suggest the same results that yoga intervention is likely to be cost-effective in both perspectives. Based on this trial 12 weekly group classes of specialised yoga was

likely to be a cost-effective intervention for treating patients with chronic or recurrent low back pain.

Tilbrook *et al*[9] compared the effectiveness of yoga and usual care for chronic or recurrent low back pain in their parallel-group, randomized, controlled trial of 13 non-National Health Service premises in the United Kingdom on 313 adults with chronic or recurrent low back pain. Yoga (n = 156) or usual care (n = 157). All participants received a back pain education booklet. The intervention group was offered a 12-class, gradually progressing yoga program delivered by 12 teachers over 3 months. Scores on the Roland-Morris Disability Questionnaire (RMDQ) at 3 (primary outcome), 6, and 12 (secondary outcomes) months; pain, pain self-efficacy, and general health measures at 3, 6, and 12 months (secondary outcomes). 93 (60%) patients offered yoga attended at least 3 of the first 6 sessions and at least 3 other sessions. The yoga group had better back function at 3, 6, and 12 months than the usual care group. The yoga and usual care groups had similar back pain and general health scores at 3, 6, and 12 months, and the yoga group had higher pain self-efficacy scores at 3 and 6 months but not at 12 months. Two of the 157 usual care participants and 12 of the 156 yoga participants reported adverse events, mostly increased pain. Offering a 12-week yoga program to adults with chronic or recurrent low back pain led to greater improvements in back function than did usual care.

Sherman *et al*[10] aimed to determine whether yoga is more effective than conventional stretching exercises or a self-care book for primary care patients with chronic low back pain. A total of 228 adults with chronic low back pain were randomized to 12 weekly classes of yoga (92 patients) or conventional stretching exercises (91 patients) or a self-care book (45 patients). Back-related functional status (modified Roland Disability Questionnaire, a 23-point scale) and bothersomeness of pain (an 11-point numerical scale) at 12 weeks were the primary outcomes. Outcomes were assessed at baseline,

6, 12, and 26 weeks by interviewers unaware of treatment group. Yoga was not superior to conventional stretching exercises at any time point. Yoga classes were more effective than a self-care book, but not more effective than stretching classes, in improving function and reducing symptoms due to chronic low back pain, with benefits lasting at least several months.

Evans *et al*[11] compared the clinical and demographic characteristics of individuals self-selecting yoga or physical therapy (PT) for treatment of chronic low back pain (cLBP) and to examine predictors of short-term pain and functional outcomes. In their descriptive, longitudinal study, they studied a hospital-based clinic that offers modified integral yoga classes for cLBP and 2 outpatient PT clinics that offer exercise-based PT. Adults (n=53) with cLBP at 12 weeks: yoga (n=27), PT (n=26). Yoga participants attended a 6-week, once weekly, 2-hour yoga class. PT participants underwent twice weekly, 1-hour individualized PT. Data were collected at baseline and at 6 weeks. Disability (Roland Morris Disability Questionnaire), health status (Rand Short Form 36 Health Survey 1.0), pain bothersomeness (numerical rating scale), back pain self-efficacy (Back Pain Self-Efficacy Scale), and treatment satisfaction. At baseline, yoga participants were significantly less disabled, had higher health status, greater pain self-efficacy, and less average pain bothersomeness compared with PT participants. At 6 weeks, when controlling for baseline group differences, greater pain self-efficacy was the strongest predictor for reduced pain and higher function for the entire sample.

Cox *et al*[12] conducted a pilot trial of yoga for the treatment of chronic low back pain (LBP) to inform the feasibility and practicality of conducting a full-scale trial in the UK; and to assess the efficacy of yoga for the treatment of chronic low back pain. In their pragmatic randomised controlled trial, twenty participants who had presented to their GP with chronic low back pain in the previous 18 months were recruited via GP records from

one practice in York, UK. Twenty patients were randomised to either 12 weekly 75-min sessions of specialised yoga plus written advice, or usual care plus written advice. 10 patients were randomised to yoga, receiving an average of 1.7 sessions (range 0-5), and 10 were randomised to usual care. At 12 weeks follow-up data was received from 60% of patients in the yoga group and 90% of patients in the usual care group (75% overall). No significant differences were seen between groups in clinical outcomes apart from on the Aberdeen back pain scale at four weeks follow-up where the yoga group reported significantly less pain. This pilot study provided useful data and information to inform the design and development of a full-scale trial of yoga for CLBP in the UK.

Saper *et al*[13] assessed the feasibility of studying yoga in their pilot randomized controlled trial at two community health centers in a racially diverse neighborhood of Boston, Massachusetts. Thirty English-speaking adults (mean age 44 years, 83% female, 83% racial/ethnic minorities; 48% with incomes \leq \$30,000) with moderate-to-severe chronic low back pain were studied. Standardized series of weekly hatha yoga classes for 12 weeks compared to a waitlist usual care control. Feasibility measured by time to complete enrollment, proportion of racial/ethnic minorities enrolled, retention rates, and adverse events. Primary efficacy outcomes were changes from baseline to 12 weeks in pain score (0=no pain to 10=worst possible pain) and back-related function using the modified Roland-Morris Disability Questionnaire (0-23 point scale, higher scores reflect poorer function). Secondary efficacy outcomes were analgesic use, global improvement, and quality of life (SF-36). Mean pain scores for yoga decreased from baseline to 12 weeks compared to usual care. Mean Roland scores for yoga decreased compared to usual care. At 12 weeks, yoga compared to usual care participants reported less analgesic use, less opiate use, and greater overall improvement. A yoga study intervention in a predominantly minority population with chronic low back pain was

moderately feasible and may be more effective than usual care for reducing pain and pain medication use.

Williams *et al*[14] studied the effectiveness and efficacy of Iyengar yoga for chronic low back pain (CLBP) with intention-to-treat and per-protocol analysis. Ninety subjects were randomized to a yoga ($n = 43$) or control group ($n = 47$) receiving standard medical care. Participants were followed 6 months after completion of the intervention. Yoga subjects participated in 24 weeks of biweekly yoga classes designed for CLBP. Outcomes were assessed at 12 (midway), 24 (immediately after), and 48 weeks (6-month follow-up) after the start of the intervention using the Oswestry Disability Questionnaire, a Visual Analog Scale, the Beck Depression Inventory, and a pain medication-usage questionnaire. Significantly greater reductions in functional disability and pain intensity were observed in the yoga group when compared to the control group at 24 weeks. A significantly greater proportion of yoga subjects also reported clinical improvements at both 12 and 24 weeks. In addition, depression was significantly lower in yoga subjects. Furthermore, while a reduction in pain medication occurred, this was comparable in both groups. Although slightly less than at 24 weeks, the yoga group had statistically significant reductions in functional disability, pain intensity, and depression compared to standard medical care 6-months post-intervention. Yoga improves functional disability, pain intensity, and depression in adults with CLBP. There was also a clinically important trend for the yoga group to reduce their pain medication usage compared to the control group.

Groessl *et al*[15] examined the benefits of a yoga intervention for Veterans Administration (VA) patients. VA patients with chronic back pain were referred by their primary care providers to a yoga program as part of clinical care. Before starting yoga, a VA physician trained in yoga evaluated each patient to ensure that they could participate safely. The research study consisted of completing a short

battery of questionnaires at baseline and again 10 weeks later. Questionnaires included measures of pain, depression, energy/fatigue, health-related quality of life, and program satisfaction. Significant improvements were found for pain, depression, energy/fatigue, and the Short Form-12 Mental Health Scale. The number of yoga sessions attended and the frequency of home practice were associated with improved outcomes. Participants appeared highly satisfied with the yoga instructor and moderately satisfied with the ease of participation and health benefits of the yoga program. Preliminary data suggest that a yoga intervention for VA patients with chronic back pain may improve the health of veterans. However, the limitations of a pre-post study design make conclusions tentative. A larger randomized, controlled trial of the yoga program is planned.

Tekur *et al*[16] compared the effect of a short-term intensive residential yoga program with physical exercise (control) on pain and spinal flexibility in subjects with chronic low-back pain (CLBP) in their wait-list, randomized controlled study conducted at a residential integrative health center in Bangalore, South India. Eighty (80) subjects (females, $n = 37$) with CLBP, who consented were randomly assigned to receive yoga or physical exercise if they satisfied the selection criteria. The intervention consisted of a 1-week intensive residential yoga program comprised of asanas (physical postures) designed for back pain, pranayamas (breathing practices), meditation, and didactic and interactive sessions on philosophical concepts of yoga. The control group practiced physical exercises under a trained physiatrist and also had didactic and interactive sessions on lifestyle change. Both of the groups were matched for time on intervention and attention. Pain-related outcomes were assessed by the Oswestry Disability Index (ODI) and by spinal flexibility, which was assessed using goniometer at pre and post intervention. There was a significant reduction in ODI scores in the yoga group compared to the control group. Spinal flexibility measures improved significantly in both groups but the yoga group

had greater improvement as compared to controls on spinal flexion, spinal extension, right lateral flexion; and left lateral flexion. Seven days of a residential intensive yoga-based lifestyle program reduced pain-related disability and improved spinal flexibility in patients with CLBP better than a physical exercise regimen.

Sherman *et al*[17] studied to determine whether yoga is more effective than conventional therapeutic exercise or a self-care book for patients with chronic low back pain in their randomized, controlled trial of 101 adults with chronic low back pain for 12-week sessions of yoga or conventional therapeutic exercise classes or a self-care book. Primary outcomes were back-related functional status (modified 24-point Roland Disability Scale) and "bothersomeness" of pain (11-point numerical scale). The primary time point was 12 weeks. Clinically significant change was considered to be 2.5 points on the functional status scale and 1.5 points on the bothersomeness scale. Secondary outcomes were days of restricted activity, general health status, and medication use. After adjustment for baseline values, back-related function in the yoga group was superior to the book and exercise groups at 12 weeks; yoga vs. exercise. No significant differences in symptom bothersomeness were found between any 2 groups at 12 weeks; at 26 weeks, the yoga group was superior to the book group with respect to this measure. At 26 weeks, back-related function in the yoga group was superior to the book group. Yoga was more effective than a self-care book for improving function and reducing chronic low back pain, and the benefits persisted for at least several months.

Williams *et al*[18] conducted a randomized controlled trial in 60 subjects with non-specific chronic low back pain comparing Iyengar yoga therapy to an educational control group. Both programs were 16 weeks long. The primary outcome for the study was functional disability. Secondary outcomes including present pain intensity, pain medication usage, pain-related attitudes and behaviors, and

spinal range of motion were measured before and after the interventions. Subjects had low back pain for 11.2+/-1.54 years and 48% used pain medication. Overall, subjects presented with less pain and lower functional disability than subjects in other published intervention studies for chronic low back pain. Analyses of outcomes in the categories of medical, functional, psychological and behavioral factors indicated that significant differences between groups existed in functional and medical outcomes but not for the psychological or behavioral outcomes. Univariate analyses of medical and functional outcomes revealed significant reductions in pain intensity (64%), functional disability (77%) and pain medication usage (88%) in the yoga group at the post and 3-month follow-up assessments. These preliminary data indicate that the majority of self-referred persons with mild chronic low back pain will comply to and report improvement on medical and functional pain-related outcomes from Iyengar yoga therapy.

Galantino *et al*[19] in their randomized pilot study that evaluated a possible design for a 6-week modified hatha yoga protocol to study the effects on participants with chronic low back pain. Twenty-two participants (M = 4; F = 17), between the ages of 30 and 65, with chronic low back pain (CLBP) were randomized to either an immediate yoga based intervention, or to a control group with no treatment during the observation period but received later yoga training. A specific CLBP yoga protocol designed and modified for this population by a certified yoga instructor was administered for one hour, twice a week for 6 weeks. Primary functional outcome measures included the forward reach (FR) and sit and reach (SR) tests. All participants completed Oswestry Disability Index (ODI) and Beck Depression Inventory (BDI) questionnaires. Guiding questions were used for qualitative data analysis to ascertain how yoga participants perceived the instructor, group dynamics, and the impact of yoga on their life. Potentially important trends in the functional measurement scores showed improved balance and flexibility and decreased disability

and depression for the yoga group but this pilot was not powered to reach statistical significance. Analysis of the qualitative data revealed the following frequency of responses (1) group intervention motivated the participants and (2) yoga fostered relaxation and new awareness/learning. A modified yoga-based intervention may benefit individuals with CLBP, but a larger study is necessary to provide definitive evidence.

Discussion

The review was the first of its kind-review of reviews which provided an extensive information and evidence for yoga in LBP. Most of the reviewed studies utilized 'Hatha yoga' for CLBP.

The practice of hathayoga is based on the following assumptions: complexity and multidimensionality of various positive influences on an individual's wholeness through the mind, body and their conscious control[20].

Many interventions for the management of low back pain exist, however most have modest efficacy at best, and there are few with clearly demonstrated benefits once pain becomes chronic. Yoga had been gaining in popularity over the last decade as a mind-body exercise intervention that address both the physical and mental aspects of pain with core strengthening, flexibility, and relaxation[21]

There was a systematic review on yoga for low back pain performed Posadzki and Ernst,[22] but their review was too vigorous to draw any definitive conclusions from lesser number of clinical trials selected. This review is comparatively more comprehensive and gives the direction of effect if not the magnitude *per se*.

Such a similar biopsychosocial effects for yoga was shown by Kumar *et al*[23] in their review of studies for patients with diabetes mellitus. Also, is the role of physical activity in conjunction with other treatments in health and disease[24].

Limitations of the review

Lack of quantitative synthesis of the reviews' findings and meta-analysis which may be acceptable due to a huge heterogeneity in included studies in patient characteristics, intervention methods, dosage description and outcomes assessment.

According to a well-known epidemiological axiom, the overall disease burden in a given population generally undergoes a more dramatic reduction when a large segment of the population adopts small improvements in health behaviors than when a small segment of the population adopts large improvements.

Implications for practice

Yoga could be an effective therapeutic adjunct if not an alternative to existing treatments for patients with CLBP and large number of high quality clinical trials had shown not only clinical benefits but also on disability and cost-effectiveness in favour of yoga.

Role of physical therapists

Physical therapists evaluate and treat most patients with CLBP and prescription of yoga is the physical therapy armamentarium for management of CLBP. For patients who are adequately educated and co-operative, with existing acceptable levels of flexibility, therapeutically designed and individualized yoga programme may be very effective for long-term relief of symptoms in patients with CLBP.

Implications for research

Though few studies showed direct association between physical inactivity and diabetic complications[58], no review was found in our search in the three main databases, which relatively indicate the lesser importance given by researchers worldwide. Studies in our population would provide valuable data for applicability of physical activity programs in such populations.

Conclusion

Yoga is effective in treatment of chronic low back pain and could thus be a viable and affordable treatment option for patients with chronic low back pain.

References

1. Hoy D, Bain C, Williams G, March L, Brooks P, Blyth F, et al. A systematic review of the global prevalence of low back pain. *Arthritis Rheum.* 2012; 64(6): 2028-37.
2. Truchon M. Determinants of chronic disability related to low back pain: towards an integrative biopsychosocial model. *Disabil Rehabil.* 2001; 23(17): 758-67.
3. Dunn KD. A review of the literature examining the physiological processes underlying the therapeutic benefits of Hatha yoga. *Adv Mind Body Med.* 2008; 23(3): 10-8.
4. Hill JC, Fritz JM. Psychosocial influences on low back pain, disability, and response to treatment. *Phys Ther.* 2011; 91(5): 712-21.
5. Carter C, Stratton C, Mallory D. Yoga to treat nonspecific low back pain. *AAOHN J.* 2011; 59(8): 355-61.
6. Nespor K. Psychosomatics of back pain and the use of yoga. *Int J Psychosom.* 1989; 36(1-4): 72-8.
7. Tekur P, Nagarathna R, Chametcha S, Hankey A, Nagendra HR. A comprehensive yoga programs improves pain, anxiety and depression in chronic low back pain patients more than exercise: an RCT. *Complement Ther Med.* 2012; 20(3): 107-18.
8. Chuang LH, Soares MO, Tilbrook H, Cox H, Hewitt CE, Aplin J, et al. A Pragmatic Multi-centred Randomised Controlled Trial of Yoga for Chronic Low Back Pain: Economic Evaluation. *Spine (Phila Pa 1976).* 2012 Mar 16. [Epub ahead of print]
9. Tilbrook HE, Cox H, Hewitt CE, Kang'ombe AR, Chuang LH, Jayakody S, et al. Yoga for chronic low back pain: a randomized trial. *Ann Intern Med.* 2011; 155(9): 569-78.
10. Sherman KJ, Cherkin DC, Wellman RD, Cook AJ, Hawkes RJ, Delaney K, et al. A randomized trial comparing yoga, stretching, and a self-care book

- for chronic low back pain. *Arch Intern Med*. 2011; 171(22): 2019-26.
11. Evans DD, Carter M, Panico R, Kimble L, Morlock JT, Spears MJ. Characteristics and predictors of short-term outcomes in individuals self-selecting yoga or physical therapy for treatment of chronic low back pain. *PM R*. 2010; 2(11): 1006-15.
 12. Cox H, Tilbrook H, Aplin J, Semlyen A, Torgerson D, Trehwela A, 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(4): 187-93.
 13. 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(6): 18-27.
 14. Williams K, Abildso C, Steinberg L, Doyle E, Epstein B, Smith D, et al. Evaluation of the effectiveness and efficacy of Iyengar yoga therapy on chronic low back pain. *Spine (Phila Pa 1976)*. 2009; 34(19): 2066-76.
 15. Groessl EJ, Weingart KR, Aschbacher K, Pada L, Baxi S. Yoga for veterans with chronic low-back pain. *J Altern Complement Med*. 2008; 14(9):1123-9.
 16. Tekur P, Singphow 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 Complement Med*. 2008; 14(6): 637-44.
 17. Sherman KJ, Cherkin DC, Erro J, Miglioretti DL, Deyo RA. Comparing yoga, exercise, and a self-care book for chronic low back pain: a randomized, controlled trial. *Ann Intern Med*. 2005; 143(12): 849-56.
 18. Williams KA, Petronis J, Smith D, Goodrich D, Wu J, Ravi N, et al. Effect of Iyengar yoga therapy for chronic low back pain. *Pain*. 2005; 115(1-2): 107-17.
 19. Galantino ML, Bzdewka TM, Eissler-Russo JL, Holbrook ML, Mogck EP, Geigle P, et al. The impact of modified Hatha yoga on chronic low back pain: a pilot study. *Altern Ther Health Med*. 2004; 10(2): 56-9.
 20. Posadzki P. The qigong of 18 Luohan Hands and yoga for prevention of low back pain: A conceptual synthesis. *Chin J Integr Med*. 2011 Apr 26. [Epub ahead of print]
 21. Sorosky S, Stilp S, Akuthota V. Yoga and pilates in the management of low back pain. *Curr Rev Musculoskelet Med*. 2008; 1(1): 39-47.
 22. Posadzki P, Ernst E. Yoga for low back pain: a systematic review of randomized clinical trials. *Clin Rheumatol*. 2011; 30(9): 1257-62.
 23. Kumar SP, Adhikari P, Jeganathan PS. Biopsychosocial effects of yoga in diabetes- a focused review. *Indian J Ancient Med Yoga* 2011; 4(1): 5-11.
 24. Kumar SP, Adhikari P, Jeganathan PS. Physical activity in the prevention and treatment of type-2 diabetes mellitus and its complications- a critical review of reviews. *Indian J Ancient Med Yoga*. 2011; 4(3-4): 1-9.