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Designing, validation, and the feasibility of a yoga module for patients with ankylosing spondylitis



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ABSTRACT

Background: Ankylosing spondylitis (AS) is a chronic inflammatory disease that causes significant disability and reduced quality of life. Scientific studies on yoga have revealed its various health benefits in chronic conditions, including autoimmune diseases. However, whether yoga is feasible for AS patients or not is not studied. Further, no validated yoga module is available for AS patients.

Objective(s): This study intended to develop a yoga module for AS patients and investigated its feasibility of use.

Materials and methods: The study was completed in three phases. In Phase I, six yoga experts prepared a list of 64 yoga practices based on the classical and contemporary yogic literature review. Of these practices, 41 were included in the designed yoga module. In Phase II, 41 experts with a minimum of five years of experience in yoga therapy were invited for yoga module validation. The usefulness of the practices was rated by experts on a 3-point scale (1: not at all useful, 2: moderately useful, and 3: very much useful). The Lawshe content validity ratio (CVR) method was used for the content validity of the yoga module. Practices with a CVR score of > 0.3 were retained in the final yoga module. In Phase III, a certified yoga instructor administered the validated yoga module to 19 AS patients (average age: 35.5 ± 10.7 years) thrice weekly for a month. Feasibility was assessed on the basis of the attrition rate, retention rate, attendance of the participants, and the subjective response on practical sessions using a structured checklist.

Results: Of the 41 practices in the module, 31 had a CVR score of > 0.3 and were included in the final yoga module. Of the 25 participants, 19 (76%) completed the study while six dropped out (24%). Nineteen patients reported greater improvement in pain and flexibility. They found yoga relaxing and easy to practice. Most participants (65%) were able to practice a minimum of 30 min/day.

Conclusion: The present study offers a validated yoga module consisting of 31 practices for AS patients. The results of the pilot suggested that the module is feasible, acceptable, and easy to practice for AS patients. We recommend that AS patients should practice this yoga module for a minimum of 30 min every day under the supervision of a yoga expert.

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1. Introduction

Ankylosing spondylitis (AS) is a chronic progressive, inflammatory, immune-mediated arthritis that primarily affects the axial

skeleton and sacroiliac joints [1]. The spinal and extra-spinal manifestation of AS contributes to substantial disability. It leads to stiffness, pain, and reduced flexibility of the spine, causing significant deterioration in functions. AS is associated with 11% lower employment and 15% higher disability at work. AS-related disability contributes to the financial crisis through job loss and increased healthcare cost. Approximately 31% of AS patients quit

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their job due to disability [2,3]. Limited functioning, pain, and reduced socialism in AS patients leads to substantially poor quality of life.

Thus, improving spinal flexibility and the quality of life of patients are the two important objectives of AS management. Complementary therapies such as yoga have shown to be effective in improving pain, quality of life, and disability in several chronic conditions such as back pain [4,5]. Yoga is a mind-body intervention that includes yogic physical postures, breathing techniques, relaxation, and meditation. Yoga has become a popular alternative and complementary intervention in various chronic health conditions. Yoga intervention has been found to be beneficial in different types of musculoskeletal pain conditions such as chronic lower back pain, fibromyalgia, cervical spondylitis, and osteoarthritis of the knee. It also improves the quality of life [6–11]. These studies have indicated the positive role of yoga intervention in patients with back pain. Yoga practice may help in AS condition also. However, there are no structured yoga modules available for AS patients. Further, literature suggests the need of yoga studies in AS patients. Hence, a structured and validated yoga module needs to be developed for AS. The present study developed a structured yoga module and validated it for AS patients. It also evaluated the feasibility, acceptability, and efficacy of the module to reduce pain and improve physical functioning.

2. Methods

The study was conducted in three phases (Fig. 1).

2.1. Phase I: development of the yoga module

In Phase I of the study, both classical and contemporary yoga texts were viewed to develop a yoga module to alleviate pain and disability and improve the quality of life in AS patients. Three experts were invited for the literature review. Five classical texts, namely Hath Yoga Pradipika [12], Gheranda Samhita [13], Patanjali

Yoga Sutra [14], Hath Ratnavali [15], and Shiva Samhita [16], were reviewed by these experts. Research articles on pain management, spinal flexibility, and quality of life in patients with musculoskeletal problems such as chronic lower back pain, cervical spondylitis, slip disc, and fibromyalgia were also reviewed using search engines like PubMed, Google Scholar, Scopus, and ScieFinder using keywords “yoga” and “pain”, “back pain”, “cervical pain”, “spinal flexibility”, “ankylosing”, and “spondylitis”.

2.2. Phase II: validation of yoga module

The validation process was performed by inviting experts who fulfilled the following eligibility criteria: (a) a minimum of five years of field experience in clinical yoga and (b) actively involved in treating pain conditions and musculoskeletal conditions by yoga intervention. Academicians and non-clinical yoga practitioners were excluded.

Sixty-eight potential experts were approached. Of them, 52 responded and were evaluated according to the eligibility criteria. Forty-eight of these experts were found to be eligible. Of 48 experts, 46 agreed and shared their opinion on the yoga module. Of their submissions, 5 were found to be incomplete.

Fig. 2 presents the recruitment of experts in the study including the number of experts approached, eligible experts, and experts who performed the final validation.

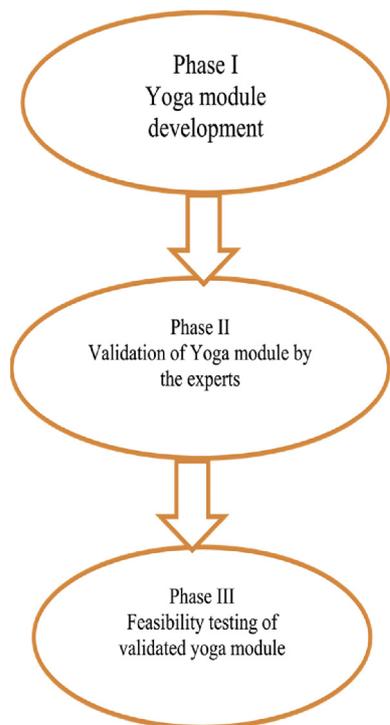


Fig. 1. Phases of the study.

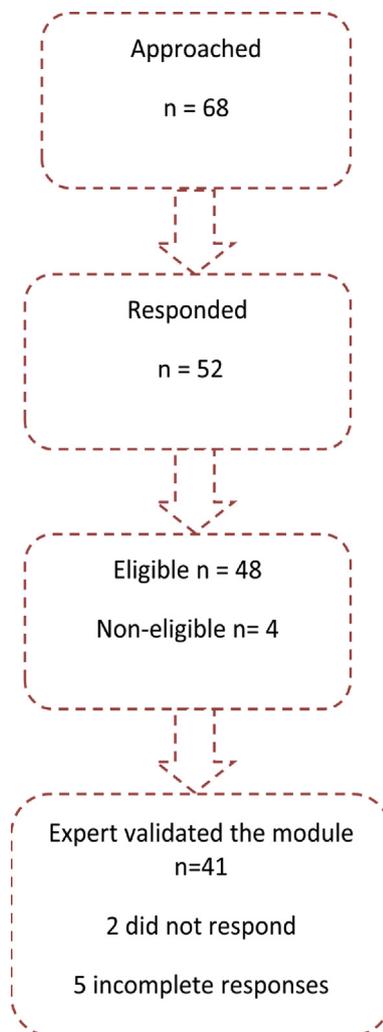


Fig. 2. Recruitment of experts for validation.

The yoga module was shared with the experts with a brief explanation of the study's background and objectives along with the list of practices to be rated. The yoga experts were requested to rate each practice in the yoga module on a scale of 0–2 (0: not useful, 1: useful but essential, 2: essential). If they wished to, the experts could also provide their subjective opinion on each practice.

The Lawshe content validity ratio (CVR) method was used for determining the content validity of the yoga module [17]. CVR was used to validate each practice. $CVR = (ne - N/2)/N/2$ — where ne is the number of experts indicating a practice 'useful' and N is the total number of experts for considering a particular yoga practice in the final yoga module.

2.3. Phase III: feasibility testing of the validated yoga module

A pilot study was conducted on 19 AS patients to assess the acceptance and feasibility of the validated yoga module. Feasibility was assessed on the basis of the attrition rate, retention rate, and subjective difficulty during the practice. They were also requested to opine on an overall 1-month yoga intervention.

2.3.1. Inclusion and exclusion criteria

Participants the feasibility study were consented AS patients (previously diagnosed by rheumatologists based on New York AS diagnosis criteria) within the age range 30–50 years. Participants were excluded if they had severe disability, undergone spinal/abdominal surgery in the last 1 year, previous expose to yoga practice, receiving physiotherapy, heart failure, vertigo.

2.3.2. Participants

Participants were invited from Anthardwani centre, Gujarat, India. An advertisement was placed on the notice board, and a text message was sent to all the AS patients who were members of the Anthardwani centre. Total fifty-seven AS patients were screened for eligibility criteria. Of these, thirty-two patients found eligible. Seven participants declined to participate in the study and twenty-five completed baseline assessments and enroll the study (See Fig. 3). The average age of patients was 35.5 ± 10.7 years. Weekly, three supervised yoga sessions were conducted for 1 month. Yoga therapist administered the yoga protocol. Finally, nineteen patients completed the intervention and post assessment. Six patients dropped out during the intervention phase due various personal regions. None of the drop-outs were attributed to adverse effects of the intervention.

Institutional ethical approval was obtained from Swami Vivekananda Yoga Anusandhan Samsthan (SVYASA University). SVYASA University and Antardhwani AS Society had collaboration and MOU for research activities. This study was the part of SVYASA research and ANtardhwani was source of sample for this study. This study was registered with the Clinical Trial Registry of India: CTRI/2020/08/027,215. Patients and experts in this study signed the informed consent.

2.3.3. Intervention

Yoga sessions were conducted at the Anthardwani centre. Two sessions (morning 8–9 am and evening 4–5 pm) were conducted to increase the participation rate. Participants were asked to attend the session in loose clothes after a fasting period of a minimum of 2 h.

3. Results

3.1. Designing and validation of the yoga module

Based on classical and contemporary literature, 56 practices were listed. Of these, 41 practices were included in the designed yoga module (Table 2).

The yoga module consisted of loosening and breathing practices, yoga postures, pranayama, relaxation methods, and meditation.

Forty-one experts aged between 35–50 years (average age 36.7 ± 7.2 years) participated in the study. Of the 41 experts, 33 were men, and 8 were women. Their average experience in yoga after formal training was 10.07 ± 5.72 years.

The experts were from different yoga institutes, namely, SVYASA University of Yoga, Kaivalyadhama Institute of Yoga, The Moraji Desai National Institute of Yoga, Devaraja Institute of Medical Sciences, National Institute of Mental Health and Neurosciences, Bihar School of Yoga, Naraya Hospital, All India Institute of Medical Sciences (Delhi), and Central University of Rajasthan.

Practices having a CVR score of < 0.3 were excluded from the final list. As a recommendation, most of the experts have suggested including yogic counseling. Table 2 lists yoga practices with their CVR scores, and Table 3 presents the final draft of yoga practices.

3.2. Acceptability and feasibility of yoga-based practices

Of the total 57 patients screened for the study, 32 fulfilled the eligibility criteria, and were invited to participate in the study. Of them, 25 agreed to participate, reporting an acceptance rate of 78.12%. Nineteen participants completed the study. Six participants dropped out of the study due to personal reasons. The attrition rate was 24%.

Based on the duration of practice, the participants were categorized into three groups: < 30 min (13 patients; 65%), 30–45 min (4 patients; 25%), and > 45 min to 1 h (2 patients; 10%). In accordance with the patients' perceived response related to treatment satisfaction, 100% patients (20/20) rated ≥ 2 for indicating satisfactory response towards the intervention.

Table 1
Demographics of experts.

Average age (years)	36.7 ± 7.2
Gender distribution	N = 41; Men = 33; Women = 8
Average experience in the field (years)	10.07 ± 5.72
Education levels	PhD = 11 Post graduation = 25 Graduation = 5

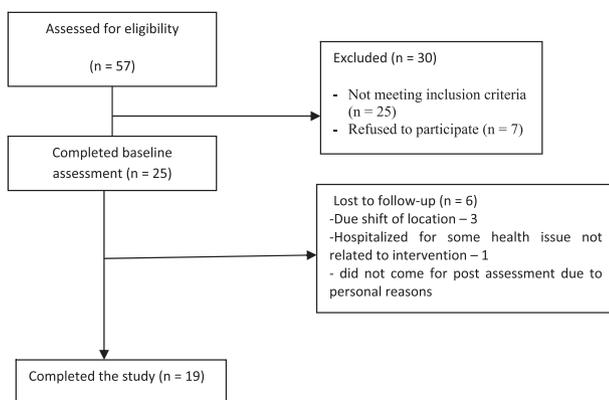


Fig. 3. Recruitment.

Table 2
Yoga module designed on the basis of classical and contemporary literature review with their CVR scores.

S.N.	Practices	Score given by the experts			Number of experts given score ≥ 3 (%)	CVR	Remarks
		Score 1	Score 2	Score 3			
Loosening Practices							
1	Neck movement (Front-back-side bending, twisting, androtation)	0	3	37	37(97.5)	0.85	Retained
2	Shoulder rotation	0	5	35	35(87.5)	0.75	Retained
3	Twisting	1	6	33	33(82.5)	0.65	Retained
4	Side bending	0	5	35	35(87.5)	0.75	Retained
5	Butterfly	3	13	24	24(60)	0.2	Deleted
6	Alternate straight leg raising	0	14	26	26(65)	0.3	Retained
7	Vertical stretch of the knee	2	9	29	29(72.5)	0.45	Retained
8	Vertical stretch of the knee of both legs	3	9	28	28(70)	0.4	Retained
9	<i>Pavanmuktasana</i> lumbar stretch (Single andboth legs)	1	6	33	33(82.5)	0.65	Retained
10	Dorsal stretch	4	7	29	29(72.5)	0.45	Retained
11	Alternate foot knee lumbar stretch	0	5	35	35(87.5)	0.75	Retained
12	Side leg raising	0	13	27	27(67.5)	0.35	Retained
13	Side lumbar stretch	1	10	29	29(72.5)	0.45	Retained
14	Instant relaxation techniques	0	10	30	30(75)	0.5	Retained
Breathing practices							
1	Hands in and out breathing	0	11	29	29(72.5)	0.45	Retained
2	Hands stretch breathing	0	11	29	29(72.5)	0.45	Retained
3	Ankle stretch breathing	1	14	25	25(62.5)	0.25	Deleted
4	Tiger breathing	0	3	37	37(92.5)	0.85	Retained
5	<i>Shashankasana</i> breathing on chair	1	11	28	28(70)	0.4	Retained
6	Lumbar stretch breathing	1	4	35	35(87.5)	0.75	Retained
7	Chair <i>Suryanamaskara</i>	1	13	26	26(65)	0.3	Retained
Asanas							
1	<i>Tadasana</i>	2	10	28	28(70)	0.4	Retained
2	<i>Ardha Kati Chakrasna</i>	0	6	34	34(85)	0.7	Retained
3	<i>Ardha Chakrasna</i>	1	8	31	31(77.5)	0.55	Retained
4	<i>Prasarita Padahastasana</i>	7	14	19	19(47.5)	-0.05	Deleted
5	<i>Dandasana</i>	2	16	22	22(55)	0.1	Deleted
6	<i>Marjariyasana</i> (Cat pose)	1	10	29	29(72.5)	0.45	Retained
7	<i>Makarasana</i>	2	7	31	31(77.5)	0.55	Retained
8	<i>Adho Mukha Svanasana</i>	4	19	17	17(42.5)	-0.15	Deleted
9	<i>Bhujangasana</i>	0	2	38	38(95)	0.9	Retained
10	<i>Navasana</i>	7	11	22	22(55)	0.1	Deleted
11	<i>Salabhasana</i>	0	13	27	27(67.5)	0.35	Retained
Pranayama							
1	<i>Kapalbhati</i>	9	10	21	21(52.5)	0.05	Deleted
2	Sectional breathing	1	5	34	34(85)	0.7	Retained
3	<i>Nadisuddhi</i>	0	8	32	32(80)	0.6	Retained
4	<i>Bhramari</i>	0	3	37	37(92.5)	0.85	Retained
5	<i>Nadanusandhana</i>	1	9	30	30(75)	0.5	Retained
6	Deep relaxation technique	0	2	38	38(95)	0.9	Retained
Kriyas							
1	<i>Jala and Sutra Neti</i>	7	16	17	17(42.5)	-0.15	Deleted
2	<i>Vaman Dhouti</i>	15	15	10	10(25)	-0.5	Deleted
3	<i>Laghu Sankha Prakshalana</i>	7	14	19	19(47.5)	-0.05	Deleted

Table 1: Yoga module designed on the basis of classical and contemporary literature review along with their CVR scores. Practices having a CVR scores of >0.3 were excluded from the final list and other practices were retained.

3.3. Effectiveness of the yoga module

The feasibility of the yoga module was assessed on the basis of the subjective response of the patients in the domain of pain and spinal flexibility following yoga practice. The responses for these items were coded on a scale of 0, 1, and 2, with 0 being a negative remark, and 2 being a highly positive remark. We dichotomized the study participants into two mutually exclusive categories. The participants who scored the third quartile (Q3) were attributed as lower efficacy and those who scored $\geq Q3$ were perceived as higher efficacy. The range of five responses in the efficacy domain was 0–7. The mean \pm standard deviation score of the responses was 6.85 ± 0.36 , and the interquartile range was 7 (7, 7). Based on these values, the responses were dichotomized as below and above Q3. The percentage of responses suggesting a high efficacy of the yoga module ($\geq Q3$) was 85% (17/20). When analysed separately, the percentage of participants claiming pain reduction in the pain and improvement in the spinal flexibility with a yoga practice was 100%

and 96%, respectively. Yoga practices in the module may have a high efficacy in reducing pain and increasing spinal flexibility, which is of high clinical significance.

A checklist for evaluation of subjective experience about usefulness of individual practices was given to all the participants. Participants rated their subjective experience on a 0–3 scale (not useful and 3-extremely useful). The majority of the patients experienced relaxation and improvement in the flexibility following the yoga intervention. No participant has reported any adverse events during the intervention. This is suggestive of safety and feasibility of the yoga module.

4. Discussion

This study provides a validated yoga module for patients with AS. This module was found to be acceptable, easy to practice, and feasible to use for patients with AS. Most patients were able to practice minimum 30 min each day in the pilot study. We

Table 3
Validated yoga module for AS.

Type of practices	Name of the practices
Loosening practices	Neck movement (Front-back- side bending, twisting and rotation), shoulder rotation, twisting, side bending, butterfly, alternate straight leg raising vertical stretch of the knee, vertical stretch of the knee (both legs), <i>pavanmuktasana</i> , lumbar stretch (single and both legs), dorsal stretch, alternate foot knee lumbar stretch, side leg raising, side lumbar stretch.
Instant relaxation techniques	
Breathing practices	Hands in and out breathing, hands stretch breathing, ankle stretch breathing, tiger breathing, <i>Shashankasana</i> breathing on chair, lumbar stretch breathing.
Chair Suryanamaskara	
Asanas	<i>Tadasana</i> , <i>Ardha Kati Chakrasna</i> , <i>Ardha Chakrasna</i> , <i>Prasarita Padahastasana</i> <i>Dandasana</i> , <i>Marjariyasana</i> (Cat pose), <i>Makarasana</i> , <i>Adho Mukha Svanasana</i> , <i>Bhujangasana</i> , <i>Navasana</i> , <i>Salabhasana</i>
Pranayama	Yogic breathing practices, <i>Kapalbhati</i> , Sectional breathing, <i>Nadisuddhi</i> , <i>Bhramari</i> , <i>Nadanusandhana</i>
Yogic cleansing techniques	<i>Jala and Sutra Neti</i> , <i>Vaman Dhouti</i> , <i>Laghu Sankha Prakshalana</i>

Table 3: The final validated yoga module for AS.

recommend practising the present yoga module under the guidance of an expert yoga instructor.

AS affects the axial skeleton, leading to significant disability [18]. Pain reduction and mobility enhancement are the primary objectives of AS management. Forty-one yoga experts validated the study. The study used the CVR method, which has been used in many previous studies, for content validity. Ten practices were omitted from the designed yoga module, which included some loosening practices and *asanas*. The validated module can be practiced for a minimum of 3 days a week for 3 months to obtain desirable results. A feasibility study confirms the usefulness and acceptability of the validated module. Most pilot study participants reported that the yoga module enhanced relaxation, reduced pain, and improved flexibility. No adverse effects were reported during the pilot study. Of the 25 participants who agreed to participate, 6 dropped out; 3 had difficulty in visiting the centre, 1 had medical emergencies (not due to yoga), and 2 had to relocate.

The practices listed in the yoga module are simple and easy to practice. These practices help to improve spinal flexibility. The practices such as relaxation techniques and breathing practices may help to improve pain sensitivity and pain tolerance. Yoga practice is associated with increased endorphin levels and reduced HPA axis activity. Yoga is known to improve spinal flexibility among patients with chronic low back pain [19–21].

The yoga module for AS was developed and validated using robust methods. The yoga practices included in the module were based on classical texts and contemporary literature review. The yoga experts were from different schools of yoga and were clinicians and researchers who were actively involved in the yoga therapy. The module consisted of all loosening practices, yoga postures, and yoga breathing techniques in addition to various relaxation practices. Validation was performed using the CVR method. A validated yoga module was confirmed for feasibility from a pilot study conducted on 19 participants.

This study has several limitations. We did not find a direct reference of the health benefits of yoga practices in classical texts. However, we conducted a recent literature search in which practices that were used to improve pain and spinal flexibility were considered. Our feasibility testing had a small sample size and lacked a control group and objective variables.

5. Conclusions

The present study offers a validated yoga module consisting of 41 practices for AS patients. The results of the pilot study suggested that the module is feasible, acceptable, and easy to practice for AS patients. We recommend the yoga module to AS patients.

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None.

Conflict of interest

None.

Author contributions

K.M., AS & P.T.: conception of the study, design, statistics. J.S., M.Z., S.M.: Yoga module development. K.M.: Manuscript writing and final approval.

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References

- [1] Exarchou S, Lindström U, Askling J, Ericsson JK, Forsblad H, Neovius M, et al. The prevalence of clinically diagnosed ankylosing spondylitis and its clinical manifestations: a nationwide register study. *Arthritis Res Ther* 2015;17:118. <https://doi.org/10.1186/s13075-015-0627-0>.
- [2] Dean LE, Jones GT, MacDonald AG, Downham C, Sturrock RD, Macfarlane GJ. Global prevalence of ankylosing spondylitis. *Rheumatology* 2014;53(4):650–7. <https://doi.org/10.1093/rheumatology/ket387>.
- [3] Moon K-H, Kim Y-T. Medical treatment of ankylosing spondylitis. *Hip pelvis* 2014;26(3):129–35. <https://doi.org/10.5371/hp.2014.26.3.129>.
- [4] do Rosário JL, Orcesi LS, Kobayashi FN, Aun AN, Assumpção IT, Blasioli GJ, et al. The immediate effects of modified Yoga positions on musculoskeletal pain relief. *J Bodyw Mov Ther* 2013 Oct 1;17(4):469–74.
- [5] Kan L, Zhang J, Yang Y, Wang P. The effects of yoga on pain, mobility, and quality of life in patients with knee osteoarthritis: a systematic review. *Evid base Compl Alternative Med* 2016 Jan 1;2016(Special Issue):52–61. 2016.
- [6] Chobe S, Patra SK, Chobe M, Metri K. Effect of integrated Yoga and Ayurveda Rasayana on cognitive functions in elderly with mild cognitive impairment. *J Ayurveda Integr Med* 2020 Dec 19 [in press].
- [7] Woodyard C. Exploring the therapeutic effects of yoga and its ability to increase quality of life. *Int J Yoga* 2011;4(2):49. <https://doi.org/10.4103/0973-6131.85485>.
- [8] Khalsa SBS. Yoga as a therapeutic intervention: a bibliometric analysis of published research studies. *Indian J Physiol Pharmacol* 2004;48(3):269–85.
- [9] Satyanand V, Gopalakrishnaiah T, Panneerselvam E, Mahaboobvali S, Basha SA, Sarala V. Effects of yogasanas on cervical spondylosis. https://laimjournal.com/Wp_Content/Uploads/2015/07/laim_2015_0207_02Pdf;2015.
- [10] 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 Alternative Compl Med* 2012;18(5):463–72. <https://doi.org/10.1089/acm.2010.0320>.
- [11] 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. <https://doi.org/10.2147/JPR.S22761>.
- [12] 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):450–60. <https://doi.org/10.1097/AJP.0b013e31825e1492>.
- [13] Digambarji S. The hatha yoga Pradipika of svatmarama. 2020.
- [14] Nagasawa KH. Gheranda Samhita. *J Indian Buddh Stud* 1970.
- [15] Satchidananda SS. The yoga sutras of Patanjali. Integr Yoga Publication; 1990.
- [16] Venkata M. Hatharatnavali of srinivasabhakta. CcrasNic.in. Mallinson. J. Shiva Shamhita. 2007.
- [17] Lawshe Ch. A quantitative approach to content validity. *Person Psychol* 1975;28(4):563–75. <https://doi.org/10.1111/j.1744-6570.1975.tb01393.x>.
- [18] Kristensen LE, Petersson IF, Geborek P, Jöud A, Saxne T, Jacobsson LT, et al. Sick leave in patients with ankylosing spondylitis before and after anti-TNF therapy: a population-based cohort study. *Rheumatology* 2012;51(2):243–9. <https://doi.org/10.1093/rheumatology/ker169>.
- [19] Suri M, Sharma R, Saini N. Neuro-physiological correlation between yoga, pain and endorphins. *International Journal of Adapted Physical Education and Yoga* 2017.
- [20] 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 Alternative Compl Med* 2008 Jul 1;14(6):637–44.
- [21] Grant JA, Rainville P. Pain sensitivity and analgesic effects of mindful states in Zen meditators: a cross-sectional study. *Psychosom Med* 2009 Jan 1;71(1): 106–14.