

Yoga Module Development and Validation for Sickle Cell Disease

Abstract

Introduction: Sickle cell disease (SCD) is a genetic blood disorder that affects the shape and function of red blood cells (RBCs), which can lead to several health problems affecting the quality of life. SCD can be treated with certain expensive treatments such as RBC transfusion, hydroxyurea, stem cell transplantation, gene therapy, or bone marrow transplant. However, some of the most common symptoms such as pain, anxiety, and stress can also be alleviated with alternative therapies like yoga. In light of this, there is a need for the development of a specific yoga module (YM) for SCD that can complement the current therapies. **Objective:** To develop and validate a YM for SCD. **Methodology:** Concise literature reports on yoga practices used for varied symptoms/comorbidities associated with SCD were compiled and presented to focus groups. Based on the presented report and personal experience, the focus group created a preliminary version of the module. The preliminary module was further refined based on content validity ratio (CVR) following module validation by 33 yoga experts. **Results:** One hour ten minutes module developed by the focus group had in total 27 practices including, loosening exercises, *asanas*, *pranayama*, relaxation techniques, and meditation. After validation by the experts, 21 practices with a CVR ≥ 0.33 were retained. The predominant reason for excluding 12 practices was intensity, which may have some adverse effect on sickle cell comorbidities. **Conclusion:** The module developed is the first validated module for SCD.

Keywords: Anemia, module development, sickle cell disease, validation, yoga

Introduction

Sickle cell disease (SCD) is a disease that affects multiple organs. Although classified as a rare disease, worldwide, there are 300 thousand children born with SCD every year. India has the second highest SCD burden in the world^[1] with a prevalence in some tribal groups reaching up to 40%.^[2] SCD is caused by mutations in the beta-globin gene, resulting in polymerization of hemoglobin, eventually leading to sickling of red blood cell (RBC), which has wide ranging implications on the body: chronic hemolysis, vaso-occlusion, chronic pain, progressive end-organ damage, and reduced life expectancy being some of them.^[3,4] Despite its hereditary causes, several factors contribute to the severity and frequency of signs and symptoms of the disease, including infection, exercise, socioeconomics, air quality, and climate.^[5] The problem is exaggerated further due to limited disease management options available and the cost of treatment, with bone marrow transplant

being the only available cure for SCD patients.^[6] At present, apart from this, other treatment options available are drugs that manage the symptoms and pathology of SCD, like voxelotor to prevent the sickling of RBCs, crizanlizumab-TMCA to reduce vaso-occlusion, and hydroxyurea to reduce or prevent multiple complications.^[7] However, these drugs have been associated with common side effects including neutropenia, bone marrow suppression, elevation of hepatic enzymes, anorexia, nausea, vomiting, and infertility.^[8]

Basis of the disease according to yogic concepts

Yoga Vashishta elucidates the concept of “*Adhi Vyadhi*,” a category further divided into “*Sara*” and “*Samanya*.” Within the “*Sara Adhija Vyadhi*” classification, the text addresses disorders that have a genetic basis, underscoring the role of genetics in the transmission of certain physical and mental conditions across generations. SCD can also be considered one such *Sara Adhija-Vyadhi*. According to *Yoga*

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Vashishta, individuals can navigate and transcend these challenges through the practice of yoga, meditation, and the adoption of a harmonious lifestyle.^[9]

Complementary and alternative medicine therapy for sickle cell disease

Complementary and alternative medicine (CAM) therapies not only include classical traditional systems such as Ayurveda and Chinese medicine but also holistic systems that are centered around bringing the mind and body together, like Yoga, *Tai-chi*, prayers, and biofeedback.^[10] The most commonly used CAM treatments for SCD patients are prayer, relaxation, and spiritual healing.^[11]

A systematic review of 24 studies investigated the effectiveness, prevalence, and factors associated with CAM use in the pediatric SCD population. They found that the prevalence of CAM use in pediatric patients with SCD ranged from 36% to 84.5%. While inpatient CAM such as Yoga and acupuncture decreased pain scale scores, outpatient CAM therapies such as cognitive behavioral therapy, guided imagery, and massage therapy improved pain tolerance, but in all these, the evidence was limited and often not meeting the scientific rigor.^[12]

Yoga and sickle cell disease

Yoga practices have been found beneficial for lifestyle diseases and several psychological disorders.^[13] Furthermore, the beneficial role of yoga in alleviating the most common clinical symptoms experienced in SCD, such as pain, oxidative stress, and inflammation^[14] and also psychological distress such as anxiety, depression, and general stress is well documented.^[15] A survey by Osunkwo *et al.* also found that patients frequently experience discrimination and stigma related to their disease. SCD had a significant negative influence on emotions (60%) and academic attainment (51%), as well as a reduction in job hours (53%). In this premise, yoga can play a vital role as it is found to be beneficial in regulating emotions, encouraging coping behaviors, and enabling better stress management.^[16] The same survey also reported that SCD has a significant impact on patients' lives, with most patients reporting and experiencing fatigue, difficulty sleeping, and a reduced ability to work or attend school. Yoga practices, especially those that involve meditation and deep relaxation techniques (DRTs) like mind sound resonance technique (MSRT) and *Yoga Nidra*, have been shown to significantly improve sleep quality and fatigue levels.^[17,18] People with SCD have to deal with persistent discomfort on a daily basis, and many of them use opioids to cope. Opioid dependence is associated with adverse effects.^[19] Yoga may also contribute to reduced dependency on opioid medications by decreasing pain scores and improving tolerance. It is also well established that yoga mostly works by regulating the hypothalamus-pituitary-adrenal axis' responses to stress. Yoga-based relaxation training

normalizes the function of the autonomic nervous system by deviating both sympathetic and parasympathetic indices toward normalcy and also by reducing cortisol levels.^[13] All in all, by adapting to a yoga-based lifestyle intervention, we anticipate several benefits for the SCD patients that could drastically improve their quality of life in the most cost-effective way.

This study aims to develop and validate a yoga module (YM) for SCD based on both scientific and ancient literature, which makes the intervention more comprehensive and robust which not only addresses pain, as seen in many of the previous studies, but also has the potential to manage many of the debilitating symptoms of SCD in the long term. For developing the YM for SCD, we followed the methodology guidelines for YM development.^[20] In addition, we confirmed that there is no standard YM for SCD.

Methodology

The study methodology encompasses two stages: (1) designing and development of the YM for SCD patients and (2) content validation of the YM as per the standard guidelines.^[21]

Design and development of yoga module for sickle cell disease

To begin with, a thorough review of the yoga texts and the relevant scientific literature was carried out [Table 1]. Two major yoga texts were included for the review^[34,38] alongside several scientific publications.

In the scientific literature, we specifically looked for articles that talked about the effects of yoga on pain, inflammation, oxidative stress, cognitive ability, and oxygen saturation. We also had a focus group discussion with 14 yoga experts, of whom two were themselves SCD patients and long-term yoga practitioners. The discussions brought out the safety elements of yoga for SCD, to eliminate practices that could potentially cause adverse events, and also entailed the possibility of including various types of gentle practices that could soothe the symptoms of SCD. We offered 33 practices in total, and the focus group rejected 6 practices based on the rigor of the practices, which were then sent to the experts for validation [Table 2].

Based on both traditional and contemporary yoga literature, research articles, and focus group discussion, the intervention developed had the following broad components; (1) *Sukshma Vyayama* (loosening exercises), (2) *Asana* (postures), (3) *Pranayama* (regulated breathing), and (4) *Dhyana* (meditation), with practices spread across a total of 70 min.

Validation of the module

The 70-min YM module was validated by 33 yoga experts with an average of 8.75 years of experience in teaching, yoga therapy, and research. The following criteria were

Table 1: Ancient and scientific literature review

Yoga practices	Relevant benefits	References
Loosening and warming up stretches	Loosening practices in general have shown to improve blood flow throughout the	[22]
Hand in and out, breathing/hand stretch breathing	body and help in warming up	[23]
Rabbit breathing/dog breathing	Helps to improve mobility by loosening the joints and thereby prevent risk of injuries	[24]
Sasankasana breathing	Improves oxygen uptake, reduce muscular pain and enhance performance by reducing fatigue	
Tiger breathing	Certain psychological benefits like reduced stress and anxiety are also found	
Spot jogging (forward bend/backward bend and side-kicks)		
Twisting		
Pavanamuktasana Kriya		
SN	SN in general balances the metabolism and stimulates the reproductive, circulatory, respiratory, digestive systems, and endocrine system	[25]
	SN synchronized breathing and body movement increases mental clarity by bringing fresh, oxygenated blood to the brain	[26]
	SN increases the mobility of the joints	[27]
	SN enhances muscle strength, endurance, cardio-respiratory efficiency, and lung capacity	[28]
	SN has shown to increase alertness, attention, and short-term memory when combined with other yogic practices	[29]
	SN has shown to improve psychopathology and quality of life	[30]
Asana	Significant improvement in psychological well-being including changes in depression, anxiety, positive and negative affect, and perceived stress	[31]
Ardha Chakrasana	Asana alters the flow of blood and nervous impulses in the pelvic region and strengthens the pelvic muscles	[32]
Ardhakati Chakrasana		[33]
Padahasthasana	Physical practices shown to be acceptable, feasible, and helpful intervention for hospitalized SCD children with vaso-occlusive crisis	[34]
Vajrasana	Decreases oxidative stress and improve antioxidant status	[35]
Gomukhasana	Lowers stress and pain by down regulating the HPA axis and stimulating the vagus nerve	[36]
Bhujangasana		[37]
Salabhasana		
Sarvangasana		
Pavanamukthasana		
Kriya and Pranayama	Stabilization of mind occurs when breath is steady	[38]
Sectional breathing (abdominal, thoracic, clavicular, full yogic breathing)	Breathing practices reduces anxiety and negative affect through modulating brain activity and connections in emotion processing, attention, and awareness regions	[39]
Kapalabhati and Bhastrika	Profoundly affects the parasympathetic nervous system	[40]
Nadisuddhi (alternate nostril breathing)	Single nostril breathing helps to calm the sympathetic nervous system	[41]
Brahmari Pranayama	Reduces oxidative stress	[42]
Meditation/relaxation techniques	Decreases airway resistance, increases respiratory muscle endurance, and oxygen diffusion	[43]
IRT	Meditation and relaxation help in the management of stress, and depression	[44]
QRT	Patients who received QRT reported less pain than the control group	[45]
DRT	Yoga Nidra and relaxing music have been found to reduce discomfort during colonoscopy	[46]
Yoga Nidra/MSRT	Relaxation techniques reduces anxiety symptoms in patients with SCD	[47]

SN: Surya Namaskar, IRT: Instant relaxation technique, QRT: Quick relaxation technique, DRT: Deep relaxation technique, MSRT: Mind sound resonance technique, SCD: Sickle cell disease, HPA: Hypothalamus-pituitary-adrenal

used to consider a person for expert validation: Ph.D. in yoga, or a Master's degree in yoga with a minimum of 5 years of experience; or a Bachelor of Naturopathy and Yogic Sciences (BNYS) degree with a minimum of 5 years

of yoga therapy experience. Eighty-eight potential experts were approached. Out of them, thirty-seven responded, and thirty-three met the eligibility criteria. The details are mentioned in Table 3.

Table 2: Details of experts in focus group discussion for module design

The total number of experts in focus group	Qualification	Therapy and teaching experience	Average years of experience in yoga research/therapy
14	11 with Ph.D. Yoga (among the eleven, one held an MBBS degree, another a BNYS degree, and a third had a BAMS degree) 3 with MSc. Yoga	Minimum of 5–10 years	13.28

BNYS: Bachelor of naturopathy and yogic sciences

Table 3: Social demographic details of validation experts

Gender distribution	Male (n=18; 51.5%)	Female (n=16; 48.5%)	Total/mean=33
Years of experience in yoga (mean)	10.5	10.5	10.59
Years of experience in yoga therapy (mean)	8.8	9.05	8.86
Year of experience in yoga research (mean)	6.7	6.8	6.78
Education qualification (n)			
Ph.D.	9	7	16
Postgraduation (Yoga)	8	8	18
Under graduation (BNYS)	0	1	1

BNYS: Bachelor of naturopathy and yogic sciences

The YM was shared with yoga experts for their qualitative inputs using a questionnaire that was intended to collect information on the following aspects of the YM; (1) essentiality/nonessentiality of each practice, (2) duration and number of rounds of each practice, and (3) relevance of the practices with respect to SCD. The form also had a brief description of the study background, objectives, disease pathology, and other important information for the experts to read before registering their responses. The experts could also give their personal comments or remarks on each practice if they wished to do so in a separate section. The content validity of each of the practice of the YM was determined using the Lawshe content validity ratio (CVR) method using the formula $CVR = (Ne - N/2) / (N/2)$, where Ne is the number of panelists indicating “essential” and N is the total number of panelists. The numeric value of the CVR was determined by the Lawshe table.^[21]

After compiling the CVRs from all the experts for all practices individually, a given practice was included if the average CVR score for a given practice was >0.33 [Table 4].

Along with this, two adults with SCD were asked to practice the validated YM for a month.

The preliminary YM of 70 min, developed based on a literature review and focus group discussion, had 33 practices including *Sukshma Vyayama*, *Asana*, *Pranayama*, *Dhyana*, and relaxation practices which were shared with a group of experts for validation. Out of the 88 experts approached, 33 accepted to provide their input. The CVR scores for individual practice and their acceptance status into the final module are given in Table 4. Out of the 27 practices that were initially proposed, 6 were eliminated due to CVR scores below 0.3. Following validation, six practices were removed, resulting in a module with a total duration of 60 min. Although the remaining practices have received

mixed opinions in terms of their essentiality and relevance, there was an overall positive agreement that the proposed module has the potential to be an adjunct therapy for SCD.

It is worthy to note that 2 practices, *Nadi-shuddhi* and *Bhramari*, both of which are pranayama practices, have a CVR score of 1, indicating absolute agreement from all experts. Furthermore, practices like DRT, sectional breathing, and *Yoga nidra/MSRT* have a higher CVR score, with an average of 0.88 suggesting that experts have given emphasis to the relaxation practices for SCD patients. Moreover, techniques such as *Surya Namaskar*, *Kapalabhati*, and *Bhastrika* have received moderate acceptance due to the strenuous nature of the practice. Some have suggested modifications to those practices to suit the SCD patients, like reducing the number of counts/minute and slowing the pace of the practice, while others advised to be cautious and monitor the subjects for safety.

There were few practices in the proposed module that received very low CVR scores; *Pavanamuktasana* (0.27), alternate and double leg raises (0.21) *Gomukhasana*, and *Sarvangasana* (0.15), were all eliminated from the final module. In the comments section for individual practices, it was suggested that *Pavanamuktasana* may not be required since *Pavanmuktasana kriya* was already part of loosening practices. *Sarvangasana* has proven benefits like improved circulation and mental relaxation, but is contraindicated for retinopathy. Since retinopathy is a known comorbidity in SCD subjects, the practice was excluded. Although experts opined that alternate and double leg raises could be beneficial for improving core strength and balance, they marked it not essential for SCD management as it may cause exertion to the participants. Moreover, there were few practices that had negative CVR scores due to very low essentiality quotients from the expert panel. They were rabbit breathing/dog breathing (−0.09) and spot-jogging (−0.33). From the

Table 4: Yoga module for sickle cell disease with their content validity ratio scores

Technique number	Name of the practices	Number of experts marked essential	Necessary but not essential	Not necessary	CVR	Accepted/rejected
1	<i>Sukshama Vyayama</i> <i>Sukshma Vyayama</i> (loosening) Breathing practices	28	5	0	0.7	Accepted
2	Hand in and out, breathing/hand stretch breathing	30	3	0	0.82	Accepted
3	Rabbit breathing and dog breathing	15	18	0	-0.09	Rejected
4	<i>Sashankasana</i> breathing	27	6	0	0.64	Accepted
5	Tiger breathing (1 min and six rounds)	26	7	0	0.58	Accepted
	Loosening practices					
6	Alternate and both leg raising	20	13	0	0.21	Rejected
7	IRT	25	6	2	0.52	Accepted
8	Forward jogging, backward jogging, sideways, jogging and <i>Mukhadauti</i>	11	17	5	-0.33	Rejected
9	Side bending/twisting	25	6	1	0.52	Accepted
10	<i>Pavanamukthasana Kriya</i>	25	8	0	0.52	Accepted
11	Twelve steps <i>Surya Namaskara</i>	27	6	0	0.64	Accepted
12	QRT	28	5	0	0.7	Accepted
	Standing <i>Asana</i>					
13	<i>Ardha Chakrasana</i>	29	4	0	0.76	Accepted
14	<i>Ardhakati Chakrasana</i>	28	5	0	0.7	Accepted
15	<i>Padahastasana</i>	22	11	0	0.33	Accepted
	Sitting <i>Asana</i>					
16	<i>Vajrasana</i>	27	6	0	0.64	Accepted
17	<i>Gomukhasana</i>	19	14	0	0.15	Rejected
	Prone <i>Asana</i>					
18	<i>Bhujangasana</i>	29	4	0	0.76	Accepted
19	<i>Salabhasana</i>	22	9	2	0.33	Accepted
	Supine <i>Asana</i>					
20	<i>Sarvangasana</i>	19	14	0	0.15	Rejected
21	<i>Pavanamukthasana</i>	21	12	0	0.27	Rejected
22	DRT	31	2	0	0.88	Accepted
	<i>Kriya and Pranayama</i>					
23	<i>Kapalabhati and Bhastrika</i>	27	6	0	0.64	Accepted
24	<i>Nadisuddhi</i> (alternate nostril breathing)	33	0	0	1	Accepted
25	<i>Brahmari Pranayama</i>	33	0	0	1	Accepted
26	“Sectional breathing (abdominal, thoracic, clavicular, full <i>yogic</i> breathing)”	31	2	0	0.88	Accepted
	Meditation					
27	Yoga <i>Nidra</i> /MSRT	31	2	0	0.88	Accepted

CVR: Content validity ratio, IRT: Instant relaxation technique, QRT: Quick relaxation technique, DRT: Deep relaxation technique, MSRT: Mind sound resonance technique

expert comments, it was noted that rabbit/dog breathing involves shallow, rapid breathing and may not be suitable for SCD patients. Panelists pointed out that spot-jogging is a nonyogic practice and it may induce fatigue in the participants by increasing their cardiac burden, and it may entail risk for SCD subjects. Thus, jogging was also excluded from the final module.

Discussion

The present study describes the development and validation of a YM for SCD making it the first validated module

for SCD. The module was put together after carrying out a thorough scientific and ancient literature review to specifically address the most frequently experienced, but difficult to manage symptoms of SCD like pain, end organ damage, psychological stress, anxiety, and depression. The uniqueness of the study is that the framework developed was validated by multidisciplinary experts where one expert had an MBBS degree, one doctor with a BNYS degree, and one doctor with a BAMS degree and others from the field of Yoga therapy, yoga research, and SCD patients who are yoga practitioners. Moreover, the practices in the module

were individually validated for their physiological benefits to suit the requirements and limitations of the SCD patients. The adaptability of the module to a wide age group, to both children and adults, is an added advantage since SCD is diagnosed at a very young age. Early intervention may also delay the onset and frequency of pain crises and reduce the severity of the disease and comorbidities.^[48,49]

Previous studies have shown that CAM therapies are well accepted by SCD patients.^[49] Prayer was the most commonly used CAM therapy to manage painful episodes. Although relaxation techniques and exercises come across as most beneficial, they are not as commonly used as prayer.^[50] The advantages of CAM therapies are that they take into account the lifestyle, dietary habits, psychological well-being, and not just focus on treating the symptoms. The current study also has developed such a module that takes into consideration all these aspects. This type of 'lifestyle intervention' approach enables the patients to become more involved, empowered, and educated about their own health, making it more impactful in their daily lives.

However, there are certain challenges in this approach, like lack of insurance policies covering these therapies, a lack of funding for conducting research and developing infrastructure (e.g., integrative treatment centers for SCD), and a lack of awareness regarding the availability of such therapies, especially in rural and remote areas where the prevalence is highest (in India). Health-care professionals also need to get familiarized and educated about such lifestyle interventions for them to proactively recommend it to their patients. Moreover, there is a need for evidence-based research to bring such therapies to the forefront and make them more acceptable as a treatment modality owing to their cost-effectiveness and long-term benefits. The current study is taking its first step toward generating scientific evidence by way of the methodical development of an intervention and validation of the same, which in the future will be used for SCD patients as an adjunct therapy alongside the standard of care, to understand its efficacy and biological mechanism.

Conclusion

A scientific literature and traditional text-based YM for SCD patients was developed, which may benefit SCD patients by potentially reducing pain, inflammation, oxidative stress, improving oxygen saturation, and improving cognitive ability. Thirty-three experts who agreed with the majority of practices validated the YM.

Ethical clearance

Ethical clearance is taken from institutional Ethics Committee (IEC, S-VYASA), Bangalore Karnataka India. (IEC NUMBER RES/IEC-SVYASA/156/2019).

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Conflicts of interest

There are no conflicts of interest.

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