ORIGINAL ARTICLE

Nr 2025;15 (4):408-415

Effect of Yogic Sukshma Vyayama on Shoulder Range of Motion among College Students

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DOI:
10.32098/mltj.04.2025.06

LEVEL OF EVIDENCE: 2B

SUMMARY

Background. Shoulder mobility and flexibility are essential for maintaining overall upper body function and preventing musculoskeletal issues. College students often face shoulder-related problems due to prolonged sitting and study-related stress, making it crucial to explore effective interventions to enhance their shoulder health and well-being.

Aims. This quasi-randomized study aimed to investigate the effects of yogic sukshma vyayama on shoulder mobility and flexibility among college-going students.

Materials and methods. 86 participants (aged 18-25 years) were assigned to either yoga group (n = 43) or the control group (n = 43). The yoga group participated in a 45-minute, yogic sukshma vyayama intervention six days a week for eight weeks involving gentle and precise movements targeting the shoulder joint, while the control group did not receive any type of intervention. Shoulder range of motion assessed using a goniometer at baseline and post-intervention.

Results. Within-group analysis revealed significant improvements in shoulder flexion, right shoulder flexion, and right shoulder extension in experimental group ($p < 0.05$). However, no statistically significant improvements observed in left shoulder extension, left shoulder abduction, and right shoulder abduction ($p > 0.05$). Between-group comparisons demonstrated significantly greater improvements in right shoulder flexion and right shoulder extension in the yogic sukshma vyayama group compared to the control group ($p < 0.05$).

Conclusions. The study suggests that yogic sukshma vyayama can enhance shoulder mobility and flexibility in college students, providing a potential alternative to traditional therapies, but further research is needed to confirm its sustainability and mechanisms.

KEY WORDS

Yogic sukshma vyayama; shoulder mobility; range of motion; musculoskeletal health; yoga therapy.

INTRODUCTION

Shoulder-related morbidities include a range of conditions, such as shoulder impingement and frozen shoulder. This has also been seen that a frozen shoulder is one of the major complaints among middle-aged and elderly populations (1). These conditions are a significant healthcare concern worldwide. The prevalence of these issues is substantial, affecting a considerable proportion of the population. Studies have reported that approximately 7.7 to 62 per 1,000 people per year experienced shoulder pain during their lifetime (2), with a higher prevalence among athletes, manual laborers, and the elderly (3). Shoulder pain can significantly affect an individual's quality of life, leading to limitations in daily activities and decreased productivity. The economic burden associated with shoulder-related healthcare costs and missed workdays is substantial. Therefore, addressing the prevention, diagnosis, and treatment of these conditions is crucial for improving overall population health and reducing healthcare expenditures.

Many therapy approaches to increase shoulder flexibility and mobility had been investigated in response to the increasing burden of shoulder-related morbidities. Mobility and strength-based programs (4), physical therapy (5), manual therapy techniques (6), therapeutic exercises (7),

and traditional exercises (8) are examples of evidence-based therapies. Although therapeutic exercises and physical therapy had proven beneficial in increasing shoulder flexibility and mobility, though, it may take some time and continuous practice to see noticeable results. The outcomes are influenced by the patient's adherence and motivation. Manual therapy techniques, while helpful, may not always provide sustained benefits and may necessitate skilled practitioners (9). Some patients may find physical therapy and therapeutic exercises to be time-consuming and difficult to incorporate into their daily routine. The availability of skilled practitioners for manual therapy techniques can also be limited, leading to potential delays in receiving treatment.

Amidst these therapeutic options, yogic sukshma vyayama, a traditional form of yoga exercise, has emerged as a promising alternative for enhancing shoulder mobility and flexibility (10). It involves gentle, rhythmic, and precise movements to mobilize joints, strengthen muscles, and promote overall physical well-being (11). Yogic sukshma vyayama draws upon the principles of yoga, such as mindfulness, breathe control, and body awareness. These principles are integrated into the practice to enhance the mind-body connection and promote overall physical and mental well-being (12). By incorporating these foundational aspects of yoga, yogic sukshma vyayama goes beyond just physical exercise and offers a holistic approach to improving shoulder mobility and flexibility. Its potential benefits include improved joint mobility, increased muscle strength, and enhanced body awareness (13). These factors make it a compelling intervention to explore for individuals with shoulder-related morbidities.

Despite the growing interest in yogic sukshma vyayama for its potential therapeutic effects, limited researches investigate its specific impact on shoulder-related morbidities. Prior studies had largely focused on its general benefits for overall health and well-being. Therefore, our study was conducted to assess the efficacy of yogic sukshma vyayama as an intervention for improving shoulder mobility and flexibility.

MATERIALS AND METHODS

The present study was conducted as a part of the Master's dissertation under the Department of Yoga Science, University of Patanjali. The research proposal underwent review and approval by an internal committee constituted by the Advisory Board of the Department of Research and Development. The committee, as named Departmental Research Committee (DRC) evaluated, refined, and endorsed the final version of the master's synopsis as proposed dissertation work for the year. The Institutional Ethics Committee (IEC) had minimal or no direct involvement in this process. The dissertation was formally approved by the DRC in July, 2022. Guidelines and Declaration of Helsinki were followed at maxima. An informed consent was signed from every participant before the start of the intervention protocol. The protocol was submitted to DRC for their approval before the start of the intervention protocol.

Participants and sample size calculation

Eighty-six participants (mean age = 20.6 ± 1.80; 69.77% F, 30.23% M) were recruited from an Indian University. The sample size was calculated using G power 3.1 software (14). The required sample size is 88 based on the effect size of 0.611 calculated from previous study (15). An alpha level of 0.05 and a power of 0.80 were set for the calculations. The final sample size included in this study was 86: 43 participants in each group (43 participants in yoga group (YG) and 43 participants in control group (CG)).

Selection criteria

The study enrolled participants of two genders (male and female) aged between 18 and 25 years. Inclusion criteria encompassed normative and healthy individuals willing to provide informed consent, exhibiting a body mass index (BMI) within the range of 18 to 25. Exclusion criteria comprised participants beyond the age of 25 and those presenting with notable musculoskeletal or neurological conditions that might introduce confounding variables to the study outcomes.

Study design

This study was a quasi-randomized control-group design study, investigating the effect of yogic sukshma vyayama on shoulder mobility and flexibility. Eligible participants were randomized based on their enrollment number through alternate allocation (ratio 1:1) into two groups: the YG group (n = 43) and the CG (n = 43) (**figure 1**). YG group participated in yogic sukshma vyayama intervention proposed by Brahmachari (11) for 8 weeks (45 minutes per day, 6 days a week), while the CG group had not participated in any kind of program and followed the daily routine of the university. The assessors and statisticians were unaware of the intervention assignment status of the subjects.

Assessments

All the assessments performed as per standard guidelines. The assessments of shoulder range of motion performed at baseline and after 8 weeks for both YG group and CG group.

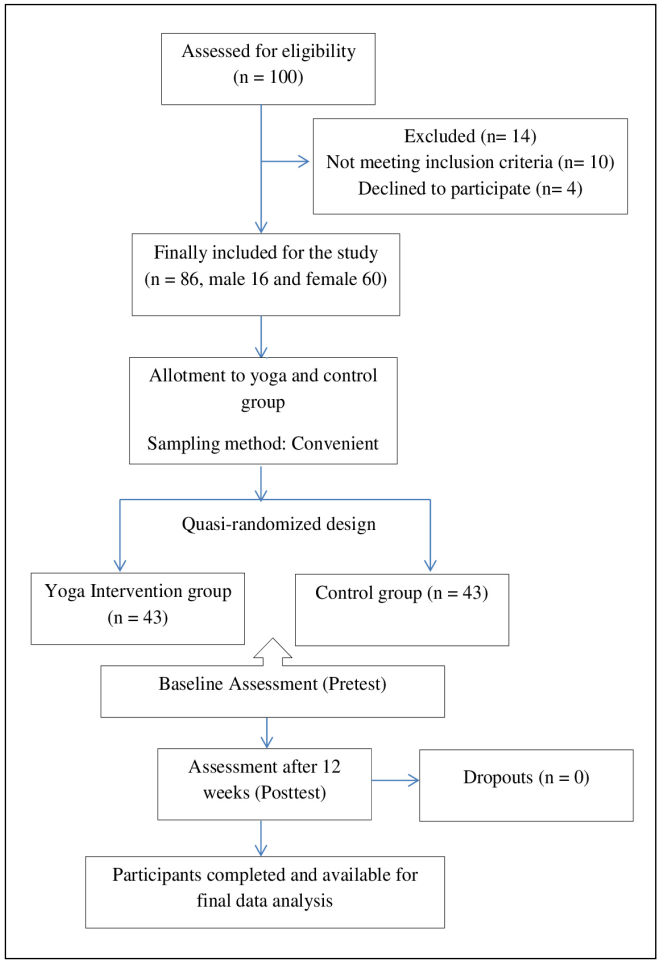


Figure 1. Flow diagram of quasi-randomized trial (n = 86).

Goniometer

The universal goniometer composed of interlocking plastic discs with a 360-degree range, spanned 30.5 cm. The stationary disc, linked to the fixed arm, was marked with graduated degrees, while a reference line extended across the mobile arm's diameter. Held together by a central friction bolt (fulcrum), the scale recorded angular shifts as the mobile arm moved relative to the fixed arm. This rotation mirrored the motion being assessed (16).

For sagittal plane shoulder flexion assessment, individuals lay supine with flexed knees to maintain lumbar alignment. Shoulder was at 0 degrees of abduction, adduction, and rotation: forearm set at 0 degrees of supination/pronation. Thorax stabilization prevented spine/rib movement. Alignment involved placing the fulcrum on the greater tubercle's lateral aspect, keeping the stationary arm parallel to the thorax's mid-axillary line, and aligning the moving arm with humerus's lateral midline.

Prone position evaluated shoulder extension, with alignment mirroring flexion. For frontal plane shoulder abduction, subjects were supine. Fulcrum aligns near acromial process anterior aspect, stationary arm paralleled sternum's anterior midline, and moving arm followed humerus's anterior midline.

Intervention

The YG engaged in a systematically structured yoga protocol specifically designed to target shoulder mobility. This intervention encompassed a series of gentle and precise movements targeting the shoulder joint, gradually increasing in intensity and complexity over the intervention peri-

Table I. Yogic Sukshma Vyayama Protocol.

Variables		
Duration	2 Months (8 weeks)	
Timing	Morning / Evening	
Session hour	45 minutes	
Session days	Monday-Saturday	
	Name of Practice	**Duration (in minutes)**
Yogic Prayer	3 times Om Chanting and Gayatri mantra	5
Yogic Sukshma Vyayama (10-25 cycle each)	Uchcharana-Sthala tatha-Vishuddh-chakra-shuddhi, Buddhi tatha dhurti-shakti-vikasaka, Smarana-shakti-vikasaka, Skandha tatha bahu mula sakthi vikasaka, Bhuja bandha sakthi vikasaka, Bhuja-valli-sakthi-vikasaka, Purna-bhuja-sakthi-vikasaka (17, 11)	
Relaxation	Savasana	5
Total Duration		**45**

od. Participants were actively involved in closely supervised collective sessions overseen by a duly certified yoga instructor. These sessions conducted in the morning, spanning 45 minutes each, and occurred on a frequency of six days per week for a total duration of eight weeks. The CG does not participate in yoga intervention during the study period. The detailed yogic module presented in **table I**.

Outcome measures

The primary outcome measures included were shoulder range of motion, assessed using a standardized goniometer, for various movements, such as flexion, extension, and abduction.

Statistical analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) – version 20, IBM Corporation Business Analytics Software portfolio, Chicago, Illinois, USA (18). Descriptive statistic was used to summarize participant characteristics. Within-group and between-group comparisons were performed using paired t-tests and independent t-tests based on data distribution. The significance level was set at $p < 0.05$. Effect sizes, such as Cohen's d, were calculated to quantify the magnitude of the intervention effects.

Limitations and controlling confounders

To control for potential confounding variables, participants were matched based on age, gender, and baseline shoulder mobility and flexibility levels. The efforts were made to minimize dropouts and non-compliance with the intervention program through regular reminders and support.

RESULTS

Out of 100 screened, 86 participants matching our selection criteria were categorized into two groups through convenience sampling: YG (n = 43) (mean age = 20.60 ± 1.62) and CG (n = 43) (mean age = 20.60 ± 1.99) completed the study. There was no difference in demographic variables between the YG and CG groups. **Table II** provides the demographic details of the participants.

Table II. Baseline characteristics of yoga and control groups.

Characteristics	Yoga group (n = 43)	Control group (n = 43)	P-value
Male	13	13	
Female	30	30	
Mean age in years (SD)	20.60 ± 1.62	20.60 ± 1.99	0.3
BMI (kg/m^2)	21.22 ± 3.72	20.50 ± 2.94	0.07

SD: Standard deviation; BMI: Body mass index.

Table III. Within and between group analysis of shoulder range of motion.

Variable	Yoga group (n = 43)			Control group (n = 43)		
	Pretest (M ± SD)	Posttest (M ± SD)	Cohen's d	Pretest (M ± SD)	Posttest (M ± SD)	Cohen's d
Left shoulder flexion	175.49 ± 12.43	180.21 ± 13.53***	0.36	175.65 ± 11.61	176.33 ± 11.65	0.06
Right shoulder flexion	175.47 ± 14.42	180.35 ± 13.21**#	0.35	173.19 ± 13.83	171.77 ± 18.55	-0.09
Left shoulder extension	79.00 ± 12.11	79.86 ± 11.87	0.07	78.44 ± 11.27	78.02 ± 12.29	-0.04
Right shoulder extension	75.42 ± 9.61	79.47 ± 10.85***#	0.40	74.74 ± 9.97	74.49 ± 9.68	-0.03
Left shoulder abduction	170.07 ± 9.33	171.95 ± 10.14	0.19	170.05 ± 9.84	168.65 ± 11.96	-0.13
Right shoulder abduction	170.47 ± 14.13	170.16 ± 18.22	-0.02	170.60 ± 10.6	170.37 ± 10.57	-0.02

#Calculated by independent t-test = $p < 0.05$; **$p < 0.01$; ***calculated by paired t-test = $p \leq 0.001$.

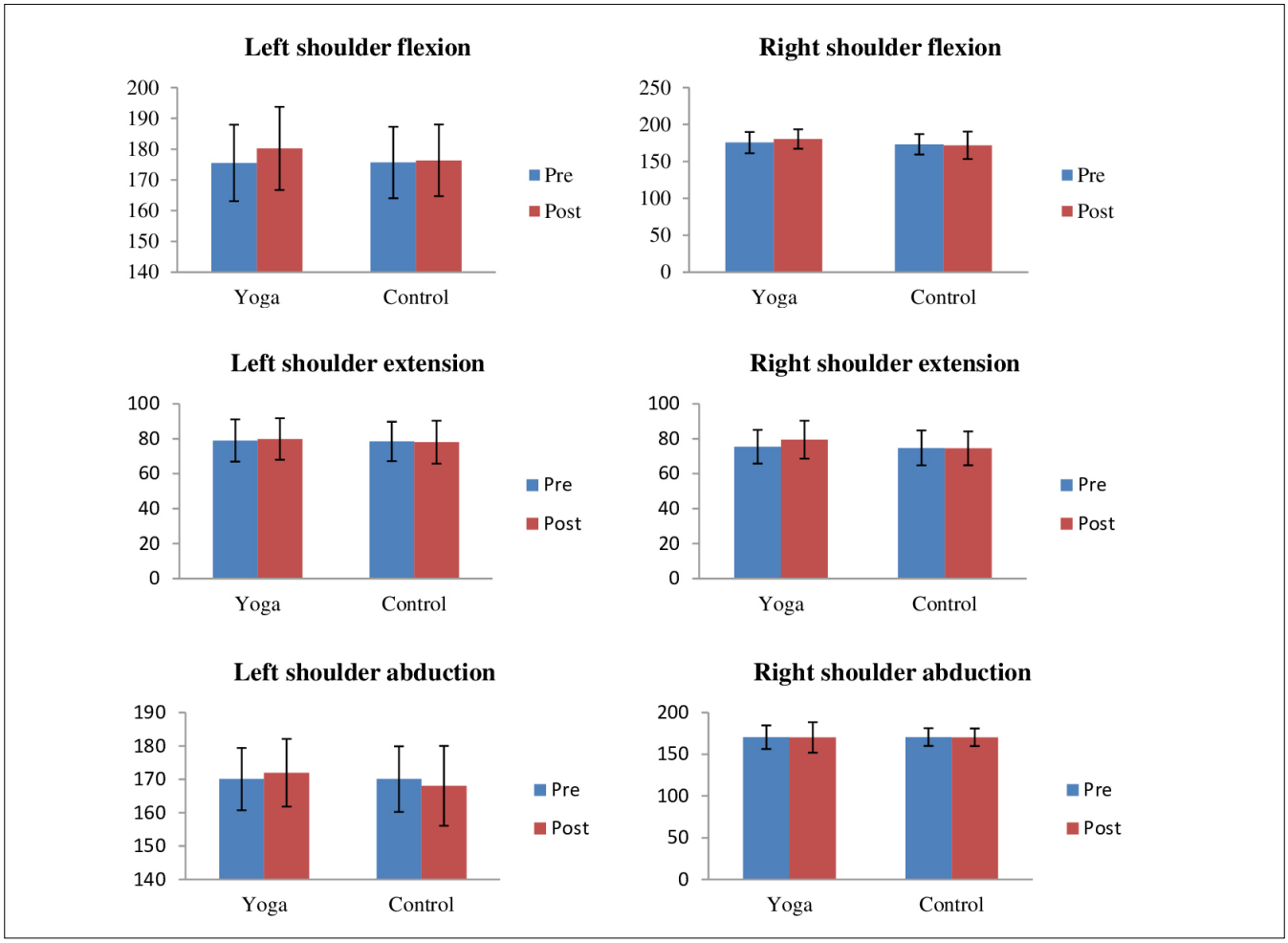


Figure 2. Histogram showing pre-test and post-test mean of yoga group and control group for shoulder range of motion.

The within-group analysis demonstrated significant improvements in various shoulder movements in the YG. There were significant improvements in left shoulder flexion ($p = 0.001$, 95%CI -2.554 to 1.206), right shoulder flexion ($p = 0.004$, 95%CI -4.094 to 6.931), and right shoulder extension ($p = 0.001$, 95%CI -2.258 to 2.77). However, no statistically significant improvements were observed in left shoulder extension, left shoulder abduction, and right shoulder abduction ($p > 0.05$) (**table III**).

Between-group comparisons showed no significant differences in pre-test scores for any of the variables, indicating that the YG and the CG were comparable at baseline. Following the intervention, there was a significant difference between the groups in right shoulder flexion ($p = 0.015$, 95%CI -15.486 to -1.677) and right shoulder extension ($p = 0.027$, 95%CI -9.386 to -0.567), suggesting that the YG experienced greater improvements in these movements compared to the control group. However, no statistically significant differences were found between the two groups for the remaining variables ($p > 0.05$) (**table III**, **figure 2**).

Cohen's d effect sizes were computed to assess the magnitude of the differences within and between groups. For the yoga group, Cohen's d effect sizes ranged from 0.07 to 0.40, indicating small to moderate effect sizes. In the Control group, Cohen's d effect sizes ranged from -0.13 to 0.06, indicating negligible to small effect sizes.

DISCUSSION

The present study investigated the effect of yogic sukshma vyayama on shoulder range of motion in YG participants

compared to the CG. The within-group analysis revealed significant improvements in left shoulder flexion, right shoulder flexion, and right shoulder extension in the YG after the intervention. However, no statistically significant improvements were observed in left shoulder extension, left shoulder abduction, and right shoulder abduction. Between-group comparisons indicated that the yoga group exhibited significantly greater improvements in right shoulder flexion and right shoulder extension compared to the control group. Cohen's d effect sizes suggested moderate effect sizes for the improvements in the yoga group, while the control group showed negligible to small effect sizes.

The observed improvements in shoulder range of motion in the YG can be attributed to the specific nature of yogic sukshma vyayama exercises, which involved slow and precise movements that targeted different body parts, including the shoulders. These exercises typically focus on joint mobilization, flexibility, and strength building, which could have contributed to the enhanced shoulder range of motion in the YG.

One possible physiological explanation for the observed improvements in shoulder range of motion is the activation and stretching of the muscles and connective tissues around the shoulder joint during yogic sukshma vyayama (19). This form of exercise incorporates dynamic movements, leading to increased blood flow and oxygen supply to the shoulder region, which may facilitate tissue repair and muscle adaptation (11). Regular practice of these exercises could have induced muscular hypertrophy, improved muscular coordination, and reduced muscle stiffness, thus enhancing overall shoulder mobility (20). The findings of this study, which showed improvements in shoulder range of motion after practicing yoga, supports previous research that had also found positive effects of yoga on shoulder flexibility. Previous studies have consistently shown that yoga practices, including sukshma vyayama, can greatly improve flexibility and range of motion in the shoulder. These studies have highlighted the benefits of yoga for enhancing joint function and mobility through targeted stretching and strengthening exercises.

A study showed improvement in muscle strength, balance, gait, active range of motion (AROM) and activities of daily living (ADL) in sedentary older adults with chronic conditions after 9 weeks of intervention of chair yoga (CY), and tai chi (TC). The author discusses the potentiality to prevent age-related mobility, balance, and related fall risk (21). It had been opined that practicing yoga stretching poses before eccentric exercise protocol may have an effect in reducing Delayed onset muscle soreness (DOMS) and pain (22).

A randomized controlled study evaluated the effects of yoga on shoulder and spinal actions for women with breast cancer-related lymphedema of the arm and reported significant improvements in the strength of shoulder abduction and improvement in the range of motion in the yoga group compared to the control group (23). Another study investigated the effects of yoga training on bilateral strength, shoulder and hip range of motion and found similar results, with improvements in shoulder flexion, hip flexion, hip extension, and abduction range of motion after the intervention (24). The research investigated the impact of an eight-week yoga intervention on the range of motion (ROM) of the shoulder joint in women aged 47 to 65 years who had undergone mastectomy due to breast cancer. The study assessed 24 participants to determine the effectiveness of yoga practice in improving their shoulder ROM, aiming to provide insights into potential rehabilitation methods for this demographic (25). In contrast, our current research extends its scope to encompass both male and female healthy participants and investigates a larger sample size of 86 participants aged between 18 and 25 years who underwent an eight-week yoga intervention. This study revealed a statistically noteworthy enhancement in the ROM measures, specifically in flexion, extension, abduction, external rotation, and internal rotation within the experimental group at $p < 0.05$ (25). In congruence with these outcomes, our study exhibited considerable advancements in the ROM of the left shoulder flexion as well as in both right shoulder flexion and extension within the yoga intervention group.

Another study investigated the effects of hatha yoga on the range of motion and strength in women with breast cancer. The research included 93 participants, with an average age of 57.53 ± 1.92 years in the yoga group and 58.10 ± 1.17 years in the control group. The participants were randomly assigned to either the yoga group or the control group. They received hatha yoga sessions over a span of 3 months, while the remaining 45 formed the control group, receiving standard care that included advice on using compression sleeves, safeguarding the skin, and caring for the affected arm. Upon the completion of the 3-month hatha yoga program, the study observed substantial improvements in the active range of motion of the shoulder in the affected arm. Notably, these improvements were significantly more pronounced compared to the control group: there was an increase of 76.76° in flexion at $p < 0.001$, 18.92° in extension at $p < 0.001$, 80.21° in abduction at $p < 0.001$, 33.29° in internal rotation at $p < 0.001$, and 27.36° in external rotation at $p < 0.01$. Moreover, the yoga group exhibited enhanced strength in wrist flexion and an increased power index of the affected limb by 6% at $p < 0.001$ and 8.25% at $p < 0.001$, respectively. In contrast, the

control group only experienced a slight increase of 1.1% at $p > 0.05$ in wrist flexion strength and a marginal rise of 1.44% at $p > 0.05$ in the power index (26).

In comparison to our study, where we implemented an eight-week intervention for 45 minutes six days a week involving 86 participants, we observed significant improvements in left shoulder flexion as well as right shoulder flexion and extension among individuals in the YG. While the duration of the intervention differed, both studies underscore the beneficial effects of yoga on shoulder movement and strength in distinct populations.

The present study demonstrated that yogic sukshma vyayama resulted in significant improvements in shoulder range of motion, specifically in left shoulder flexion, right shoulder flexion, and right shoulder extension. These findings suggests that yoga-based interventions can be an effective approach to enhancing shoulder mobility and flexibility. The probable cause for these improvements lies in the specific exercises targeting the shoulder joint and the subsequent physiological adaptations in the muscles and connective tissues. This study's results align with previous research, supporting the beneficial effects of yoga on shoulder function. However, further investigations with larger samples and longer intervention durations needed to consolidate these findings and explore the long-term effects of yogic sukshma vyayama on shoulder range of motion and overall shoulder health.

CONCLUSIONS

The present study demonstrated that yogic sukshma vyayama resulted in significant improvements in shoulder range of motion, specifically in left shoulder flexion, right shoulder flexion, and right shoulder extension. These findings support the effectiveness of yoga-based interventions in enhancing shoulder mobility and flexibility, likely due to the precise exercises targeting the shoulder joint and resulting physiological adaptations. Extensive research is required to validate the findings and explore the enduring benefits of yogic sukshma vyayama on shoulder range of motion and overall shoulder health. The understanding of potential mechanisms behind these improvements could provide valuable insights for developing targeted interventions for individuals with shoulder impairments.

Limitations and future scope

The present study limits to various factors. Primarily, the sample size could have been larger than the present sample size (n = 86) for the best fit for generalizability of the findings. Hence, there are the limitations of the patients. Secondly, the intervention plan could have extended more than 8 weeks. This would give the researchers in assessing the sustainable improvements in shoulder range of motion. Future research should consider implementing longer intervention durations to assess the long-term effects of yogic sukshma vyayama on shoulder range of motion and overall shoulder health. The study may explore the benefits of yogic sukshma vyayama on shoulder health extends beyond the general population and apply to specific subgroups.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

VR: conceptualization, methodology, investigation, formal analysis, writing - original draft. AV: writing - original draft, formal analysis. SS: methodology, writing- reviewing & editing, supervision. NY: conceptualization, supervision, writing – review & editing.

ACKNOWLEDGEMENTS

The author sincerely thanks Simran and Hemant Saini of the postgraduate program of University of Patanjali for their assistance in collecting the data. We are also offering our gratitude to Dr. V. K. Katiyar, Dean of Research and Academics, University of Patanjali for his contributions during the preliminary phase of the project. We sincerely thank participants who took part in this research project and gave their support. Their willingness to share their data, dedication throughout the intervention, active participation, and insightful feedback have all been crucial to the success of this study.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

REFERENCES

1. Momenzadeh A, Adigozali H, Ahadi J, Oskouei AE. Effects of Subscapularis Muscle Dry Needling on clinical symptom improvement in People with Frozen Shoulder: A Randomized Controlled Trial Protocol. Muscles Ligaments Tendons J. 2024;14(1):145. doi: 10.32098/mltj.01.2024.12.
2. Lucas J, van Doorn P, Hegedus E, Lewis J, van der Windt D. A systematic review of the global prevalence and incidence of shoulder pain. BMC Musculoskelet Disord. 2022;23(1):1073. doi: 10.1186/s12891-022-05973-8.
3. Hodgetts CJ, Leboeuf-Yde C, Beynon A, Walker BF. Shoulder pain prevalence by age and within occupational groups: a systematic review. Arch Physiother. 2021;11(1):24. doi: 10.1186/s40945-021-00119-w.
4. López-Laval I, Sitko S, Cantonero J, Corbi F, Cirer-Sastre R. The effectiveness of shoulder mobility and strength programs in competitive water-polo players. Life (Basel). 2022;12(5):758. doi: 10.3390/life12050758.
5. Chan HBY, Pua PY, How CH. Physical therapy in the management of frozen shoulder. Singapore Med J. 2017;58(12):685-9. doi: 10.11622/smedj.2017107.
6. Dueñas L, Balasch-Bernat M, Aguilar-Rodríguez M, Struyf F, Meeus M, Lluch E. A manual therapy and home stretching program in patients with primary frozen shoulder contracture syndrome: A case series. J Orthop Sports Phys Ther. 2019;49(3):192-201. doi: 10.2519/jospt.2019.8194.
7. Brudvig TJ, Kulkarni H, Shah S. The effect of therapeutic exercise and mobilization on patients with shoulder dysfunction: A systematic review with meta-analysis. J Orthop Sports Phys Ther. 2011;41(10):734-48. doi: 10.2519/jospt.2011.3440.
8. Schedler S, Brueckner D, Hagen M, Muehlbauer T. Effects of a traditional versus an alternative strengthening exercise program on shoulder pain, function and physical performance in individuals with subacromial shoulder pain: A randomized controlled trial. Sports. 2020;8(4):48. doi: 10.3390/sports8040048.
9. Florianovicz VC, Bueno BS, Dalpiaz A, et al. Effects of Manual and Instrumental Therapy on the Treatment of Myofascial Pain Syndrome in Descending Trapezius of Women: A Blind Randomized Clinical Study. Muscles Ligaments Tendons J. 2024;14(1):75-86. doi: 10.32098/mltj.01.2024.08.
10. Palukuru S, Patil SS, Nagarathna R, Singh A, Nibedita KS. Content validity of an integrated yoga module for practice during remission in relapsing–remitting multiple sclerosis patients. Ann Neurosci. 2021;28(1-2):29-38. doi: 10.1177/09727531211023754.
11. Brahmachari D. Yoga: Yogic Sūkṣma Vyāyāma. India: Indian Book Company, 1975.
12. Bringmann HC, Bringmann N, Jeitler M, Brunnhuber S, Michalsen A, Sedlmeier P. Meditation-Based Lifestyle Modification: Development of an integrative mind-body program for mental health and human flourishing. Complement Med Res. 2021;28(3):252-62. doi: 10.1159/000512333.
13. Govindaraj R, Karmani S, Varambally S, Gangadhar BN. Yoga and physical exercise - a review and comparison. Int Rev Psychiatry. 2016;28(3):242-53. doi: 10.3109/09540261.2016.1160878.
14. Kang H. Sample size determination and power analysis using the G*Power software. J Educ Eval Health Prof. 2021;18:17. doi: 10.3352/jeehp.2021.18.17.
15. Mazor M, Lee JQ, Peled A, et al. The effect of yoga on arm volume, strength, and range of motion in women at risk for breast cancer-related lymphedema. J Altern Complement Med. 2018;24(2):154-60. doi: 10.1089/acm.2017.014.
16. Norkin CC, White J. Measurement of Joint Motion: A Guide to Goniometry. FA Davis, McGrawHill, 1995;138-49.
17. Dhargave P, Nalini A, Nagarathna R, et al. Effect of yoga and physiotherapy on pulmonary functions in children with duchenne muscular dystrophy-a comparative study. Int J Yoga. 2021;14(2):133-40. doi: 10.4103/ijoy.IJOY_49_20.
18. Stehlik-Barry K, Babinec AJ. Data analysis with IBM SPSS statistics. Packt Publishing, 2017.
19. Wang MY, Greendale GA, Kazadi L, Salem GJ. Yoga improves upper-extremity function and scapular posturing in persons with hyperkyphosis. J Yoga Phys Ther. 2012;2(3):117. doi: 10.4172/2157-7595.1000117.
20. Mitchell J. Yoga Biomechanics: Stretching Redefined. Jessica Kingsley Publishers; 2019.
21. Sadacharan CM. Tai chi and yoga performance prior to eccentric exercise benefits older adults with chronic conditions. A pilot study. Muscles Ligaments Tendons J. 2022;12(1):43-54. doi: 10.32098/mltj.01.2022.06.
22. Sadacharan CM. Pre-exercise strategies: Effect of yoga poses on various intensities of eccentric exercise-induced pain and functional limitations. Muscles Ligaments Tendons J. 2021;11(1):92-100. doi: 10.32098/mltj.01.2021.11.
23. Loudon A, Barnett T, Piller N, Immink MA, Visentin D, Williams AD. The effects of yoga on shoulder and spinal actions for women with breast cancer-related lymphoedema of the arm: A randomised controlled pilot study. BMC Complement Altern Med. 2016;16(1):343. doi: 10.1186/s12906-016-1330-7.
24. Pauline M, Rintaugu EG. Effects of yoga training on bilateral strength and shoulder and hip range of motion. Int J Curr Res. 2011;3(11):467-70.
25. Mirhosseini H, Rahnama N, Shiryazdi M, Mirhosseini M. Effect of eight weeks of yoga on range of motion of shoulder joint in breast cancer women with mastectomy. J Paramed Sci Rehabil. 2016;5(1):45-50. doi: 10.22038/JPSR.2016.6387.
26. Odynets T, Briskin Y, Dolinsky B, et al. The effect of hatha yoga on range of motion and strength in patients with breast cancer. Physiother Q. 2021;29(1):56-60. doi: 10.5114/pq.2020.99755.