Research Article

Beyond Physical Fitness: Effect Of Hatha Yoga On Cardiac Autonomic Function And Heart Rate Variability Among Male College Students: A Randomized Controlled Trial

Prasanna K [1], * Subbulakshmi Velusamy[2]

[1] Ph.D. Scholar, Meenakshi College of Yoga Science and Therapy (MCYST), Meenakshi Academy of Higher Education and Research (MAHER), (Deemed to be University), West K.K.Nagar, Chennai-600 078, Tamil Nadu, India. (email: prasannaaakash@gmail.com) ORCID: 0009-0004-2445-9526
[2] Principal, Meenakshi College of Yoga Science and Therapy (MCYST), Meenakshi Academy of Higher Education and Research (MAHER), (Deemed to be University), West K.K.Nagar, Chennai-600 078, Tamil Nadu, India. (email: principal.yoga@maher.ac.in) ORCID: 0009-0009-0504-9739.

Abstract

Background: College students experience academic demands, sedentary behaviour, irregular lifestyle patterns and psychosocial stressors that may influence cardiovascular autonomic regulation. Heart rate variability (HRV) provides a non-invasive measure of cardiac autonomic function. Hatha Yoga, through its combination of asanas, pranayama, relaxation and meditation, may improve cardiovascular regulation. However, evidence regarding chronic effects of Hatha Yoga on HRV remains inconsistent. **Objective:** To evaluate the effect of a four-month structured Hatha Yoga intervention on cardiac autonomic function, heart rate variability, resting heart rate and blood pressure among healthy male college students aged 19–23 years. **Methods:** A randomized controlled parallel-group study was designed with 180 male college students aged 19–23 years. Participants were allocated into a Hatha Yoga group (n=90) and a control group (n=90). The Hatha Yoga group participated in a structured 60-minute programme five days per week for four months, while the control group continued their usual routine. Primary outcomes included HRV parameters: RMSSD, SDNN, high-frequency (HF) power, low-frequency (LF) power and LF/HF ratio. Secondary outcomes included resting heart rate, systolic blood pressure and diastolic blood pressure. Pre- and post-intervention data were compared within and between groups. R**esults:** In the simulated dataset, the Hatha Yoga group demonstrated reductions in resting heart rate, systolic blood pressure and diastolic blood pressure and increases in RMSSD, SDNN and HF power. Resting heart rate decreased from 80.05 ± 7.37 to 70.72 ± 5.69 beats/min, while RMSSD increased from 28.53 ± 7.52 to 36.89 ± 8.42 ms. Compared with controls, between-group differences in change were significant for resting heart rate, systolic blood pressure, diastolic blood pressure, RMSSD, SDNN, HF power and LF/HF ratio. The between-group difference for LF power did not reach statistical significance. **Conclusion:** The simulated findings demonstrate a pattern consistent with improved cardiovascular autonomic regulation following four months of Hatha Yoga. The results support further investigation of structured Hatha Yoga as a potentially useful non-pharmacological approach for cardiovascular health promotion among young adults. However, the numerical findings presented in this manuscript are simulated and must be replaced by analyses of actual participant data before publication.

Keywords: Hatha Yoga; heart rate variability; cardiac autonomic function; RMSSD; SDNN; HF power; LF power; blood pressure; resting heart rate; college.

Introduction

The college years represent an important period for establishing health behaviours that may influence cardiovascular health across adulthood. Academic pressure, prolonged sitting, reduced physical activity, irregular sleep and lifestyle changes may contribute to physiological stress and altered cardiovascular regulation. Although cardiovascular disease generally manifests later in life, several physiological risk markers, including resting heart rate, blood pressure and autonomic function, can be evaluated during young adulthood.

Heart rate variability (HRV) is a non-invasive physiological measure representing the variation between successive cardiac cycles. It is widely used to assess cardiac autonomic regulation. Time-domain measures such as the root mean square of successive differences (RMSSD) and standard deviation of normal-to-normal intervals (SDNN), together with frequency-domain measures such as high-frequency (HF) and low-frequency (LF) power, provide complementary information about cardiac rhythm regulation. HRV methodology and interpretation have been extensively described in the literature, with RMSSD being particularly useful for assessing short-term beat-to-beat variability and vagally mediated cardiac modulation. [1,2]

Yoga is a mind-body practice incorporating physical postures, breathing practices, relaxation and meditative techniques. Hatha Yoga may influence cardiovascular function through changes in respiration, physical conditioning and autonomic regulation. Previous literature has suggested that regular yoga practice may be associated with changes in HRV and autonomic modulation, although the quality and methodological consistency of the evidence have varied. [3,4]

A systematic review and meta-analysis of randomized clinical trials published in 2015 evaluated the effects of yoga on HRV. Fourteen randomized trials were included; however, only two were considered to have acceptable methodological quality. Although several individual trials reported favourable effects on different HRV domains,

the pooled evidence was considered insufficient to provide convincing evidence that yoga consistently modifies HRV because of substantial methodological heterogeneity. [5] This finding highlights the need for well-designed randomized controlled trials using standardized intervention and HRV assessment protocols.

In contrast, a subsequent systematic review and meta-analysis of 17 medium-to-high-quality randomized controlled trials examining mind-body exercises, including Yoga and Tai Chi, reported significant beneficial effects on normalized LF, normalized HF and the LF/HF ratio. The analysis reported small effects for normalized LF and HF and a moderate effect for the LF/HF ratio, suggesting that regular mind-body exercise may influence cardiac autonomic regulation. [6] The authors also suggested that the duration and weekly dose of yoga practice may influence the magnitude of the observed HRV response. [6]

Evidence specifically concerning Hatha Yoga remains mixed. Cheema et al. conducted a randomized controlled trial involving 37 university office workers who participated in a 10-week Hatha Yoga programme consisting of three 50-minute sessions per week. The study found no significant improvement in HF power or most other HRV parameters compared with the control group. Interestingly, LF/HF increased and pNN50 decreased in the yoga group, contrary to the original hypothesis. [7] These findings suggest that the effects of Hatha Yoga on chronic resting HRV may not be uniform and may depend on the characteristics of the participants, intervention duration, frequency and adherence. [7]

Research involving healthy students has also produced mixed cardiovascular findings. Papp et al. conducted a randomized controlled study involving 44 healthy students, of whom 38 were women and 6 were men, to investigate the effects of a six-week high-intensity Hatha Yoga programme. The intervention did not produce significant changes in cardiovascular fitness, heart rate, heart-rate recovery or blood pressure compared with controls. However, significant improvements were observed in ApoA1 and adiponectin concentrations. [8] The relatively short intervention period and low frequency of supervised sessions may have contributed to the absence of significant cardiovascular adaptations.

Other studies have reported more favourable effects on cardiac autonomic function. In a prospective randomized comparative study, yogic training was associated with significant increases in SDNN and RMSSD, together with increases in HF and reductions in LF/HF ratio. The authors reported greater improvements in several HRV measures in the yoga group compared with the swimming group. [9] These findings provide support for investigating both time-domain and frequency-domain HRV measures following regular yoga training.

Evidence from more recent experimental research further demonstrates that cardiovascular and autonomic responses to yoga may vary according to the type and timing of the intervention. A randomized crossover study examining a single 60-minute Vinyasa Yoga session found a favourable short-term reduction in systolic blood pressure but variable acute effects on heart rate and HRV, emphasizing the importance of distinguishing **acute** responses from chronic adaptations. [10]

Similarly, a study examining short-term yoga practice assessed HRV using standardized ECG recordings and included SDNN, RMSSD, LF, HF and LF/HF ratio as outcome measures, demonstrating the feasibility of using these parameters to evaluate autonomic responses to yoga. [11]

Taken together, the existing literature suggests that Yoga may influence cardiovascular and autonomic function, but findings concerning HRV remain inconsistent. Differences in yoga style, intervention duration, training frequency, participant characteristics, adherence and HRV recording methodology may contribute to the variability between studies. Importantly, there is limited evidence from adequately powered randomized controlled trials specifically examining the effects of a longer-duration Hatha Yoga programme in healthy male

Aim

To determine the effect of a four-month structured Hatha Yoga intervention on cardiac autonomic function and heart rate variability among male college students aged 19–23 years.

Objectives

1. To determine the effect of Hatha Yoga on resting heart rate.
2. To determine the effect of Hatha Yoga on systolic blood pressure.
3. To determine the effect of Hatha Yoga on diastolic blood pressure.
4. To evaluate the effect of Hatha Yoga on RMSSD.
5. To evaluate the effect of Hatha Yoga on SDNN.
6. To determine the effect of Hatha Yoga on LF power.
7. To determine the effect of Hatha Yoga on HF power.
8. To evaluate the effect of Hatha Yoga on LF/HF ratio.
9. To compare pre- to post-intervention changes between the Hatha Yoga and control groups.

Hypothesis

Four months of structured Hatha Yoga will result in significant improvements in cardiac autonomic function, reflected by favourable changes in HRV, resting heart rate and blood pressure compared with the control group.

Materials and Methods

Study design

A randomized controlled parallel-group experimental design was used for the proposed analysis.
The study consisted of two groups:

- Hatha Yoga group: n = 90
- Control group: n = 90

Total sample: 180 participants.
The intervention duration was four months.

Participants

The proposed participants were healthy male college students aged 19–23 years. The study procedure was approved by the MAHER (Meenakshi Academy of Higher Education and Research) Institutional Ethics Committee (Approval no: MAHER/IEC/PhD/48/Nov24). Each participant gave written, informed consent before to enrolment. The trial was conducted in accordance with the Declaration of Helsinki (2013 edition) and the 2010 CONSORT criteria (Schulz et al., 2010).

Inclusion criteria

Participants were eligible if they:

- were male college students;
- were between 19 and 23 years of age;
- were apparently healthy;
- were able to participate in moderate physical activity;
- had not been participating in regular structured yoga training;
- were willing to participate for the entire intervention period.

Exclusion criteria

Participants were excluded if they had:

- known cardiovascular disease;
- uncontrolled hypertension;
- major respiratory disease;
- major neurological disease;
- conditions contraindicating yoga practice;
- regular structured yoga practice;
- medication substantially affecting cardiovascular or autonomic function.

Randomization

Eligible participants were randomly allocated into the Hatha Yoga or control group following baseline assessment.
Randomization should preferably be performed using a computer-generated sequence, with allocation concealed until baseline testing has been completed.

Hatha Yoga intervention

The Hatha Yoga group participated in a structured 60-minute programme.
The proposed session included:

Component	Duration
Centering and relaxation	5 min
Loosening practices	10 min
Hatha Yoga asanas	25 min
Pranayama	10 min
Meditation/relaxation	5 min

Component	Duration
Shavasana	5 min
Total	60 min

Sessions were conducted five days per week for four months.
The intervention should be delivered by a qualified yoga instructor using a standardized protocol.

Control group
Participants allocated to the control group continued their usual daily activities and did not participate in the structured Hatha Yoga intervention during the study period.

Outcome measures

Resting heart rate
Resting heart rate was recorded after an adequate period of seated or supine rest and expressed in beats/min.
Blood pressure
Systolic and diastolic blood pressure were measured using a calibrated automated or validated sphygmomanometer following standardized resting conditions.
Heart rate variability
HRV was assessed using standardized short-term ECG/RR-interval recording.
The primary HRV parameters were:

- RMSSD (ms)
- SDNN (ms)
- LF power (ms^2)
- HF power (ms^2)
- LF/HF ratio

HRV recording conditions
All HRV measurements should be obtained under standardized conditions. Participants should avoid vigorous exercise and acute stimulant consumption before testing. Measurements should preferably be performed at the same time of day and after a standardized rest period.
The same equipment, sampling procedures and HRV analysis software should be used at baseline and post-intervention.

Statistical analysis
Continuous variables were summarized using mean and standard deviation.
Within-group pre-post changes were examined using paired-samples t-tests.
Between-group differences in change scores were assessed using independent-samples t-tests.
For each outcome, the change score was calculated as:

Change = Post-intervention − Pre-intervention
The difference between the two groups was then evaluated.
Effect size was expressed as Cohen's d, and 95% confidence intervals were calculated for the between-group difference in change.
Statistical significance was set at $p < 0.05$.
For the final real study, a mixed-effects model or repeated-measures ANOVA examining the Group × Time interaction is preferable to relying only on separate t-tests.

Results

Participant characteristics
The dataset consisted of 180 simulated participants, with 90 participants in each group.
The mean age was approximately 21 years in both groups, with participants ranging from 19 to 23 years.
Baseline cardiovascular and HRV measures were broadly comparable between groups.

Resting heart rate
In the Hatha Yoga group, resting heart rate decreased from 80.05 ± 7.37 beats/min at baseline to 70.72 ± 5.69 beats/min following the four-month intervention.
The control group changed from 80.66 ± 7.21 to 79.68 ± 6.39 beats/min.
The within-group change was statistically significant in the Hatha Yoga group ($p < 0.001$), whereas the control group showed no significant change ($p = 0.352$).
The between-group difference in change was −8.35 beats/min (95% CI −11.16 to −5.53; $p < 0.001$; Cohen's $d = −0.87$).

Systolic blood pressure
Systolic blood pressure decreased in the Hatha Yoga group from 122.11 ± 8.18 to 116.41 ± 6.73 mmHg.
The control group decreased from 121.92 ± 8.69 to 120.47 ± 7.65 mmHg.
The between-group difference in change was −4.24 mmHg (95% CI −7.61 to −0.88; $p = 0.014$; Cohen's $d = −0.37$).

Diastolic blood pressure
Diastolic blood pressure decreased from 78.07 ± 5.29 to 74.42 ± 4.70 mmHg in the Hatha Yoga group.
The control group showed minimal change from 78.04 ± 5.57 to 77.98 ± 6.40 mmHg.
The between-group difference in change was −3.59 mmHg (95% CI −5.74 to −1.44; $p = 0.001$; Cohen's $d = −0.49$).

RMSSD
RMSSD increased from 28.53 ± 7.52 to 36.89 ± 8.42 ms in the Hatha Yoga group.
The control group changed from 28.07 ± 6.84 to 28.86 ± 6.84 ms.
The between-group difference in change was +7.57 ms (95% CI 4.47 to 10.67; $p < 0.001$; Cohen's $d = 0.72$).
SDNN
SDNN increased from 39.96 ± 8.34 to 47.05 ± 8.75 ms in the Hatha Yoga group.
The control group demonstrated minimal change from 40.21 ± 7.92 to 40.08 ± 7.53 ms.
The between-group difference in change was +7.21 ms (95% CI 3.80 to 10.63; $p < 0.001$; Cohen's $d = 0.62$).
LF power
LF power decreased from 568.50 ± 121.48 to 510.89 ± 133.64 ms^2 in the Hatha Yoga group.
The control group changed from 532.39 ± 149.24 to 529.29 ± 141.15 ms^2.
The between-group difference in change was −54.50 ms^2 (95% CI −110.85 to 1.84; $p = 0.058$; Cohen's $d = −0.29$).
Thus, the between-group difference did not reach conventional statistical significance.
HF power
HF power increased from 365.56 ± 112.78 to 522.96 ± 125.71 ms^2 in the Hatha Yoga group.
The control group changed from 386.01 ± 127.24 to 396.29 ± 116.13 ms^2.
The between-group difference in change was +147.13 ms^2 (95% CI 97.73 to 196.52; $p < 0.001$; Cohen's $d = 0.88$).
LF/HF ratio
The LF/HF ratio decreased from 1.76 ± 0.86 to 1.04 ± 0.40 in the Hatha Yoga group.
The control group changed from 1.58 ± 0.76 to 1.48 ± 0.69.
The between-group difference in change was −0.63 (95% CI −0.92 to −0.33; $p < 0.001$; Cohen's $d = −0.63$).

Statistical Results Table

Table 1. Pre- and post-intervention cardiovascular and HRV parameters

Variable	Hatha Yoga Pre	Hatha Yoga Post	Control Pre	Control Post
Resting HR (beats/min)	80.05 ± 7.37	70.72 ± 5.69	80.66 ± 7.21	79.68 ± 6.39
SBP (mmHg)	122.11 ± 8.18	116.41 ± 6.73	121.92 ± 8.69	120.47 ± 7.65
DBP (mmHg)	78.07 ± 5.29	74.42 ± 4.70	78.04 ± 5.57	77.98 ± 6.40
RMSSD (ms)	28.53 ± 7.52	36.89 ± 8.42	28.07 ± 6.84	28.86 ± 6.84
SDNN (ms)	39.96 ± 8.34	47.05 ± 8.75	40.21 ± 7.92	40.08 ± 7.53
LF power (ms^2)	568.50 ± 121.48	510.89 ± 133.64	532.39 ± 149.24	529.29 ± 141.15
HF power (ms^2)	365.56 ± 112.78	522.96 ± 125.71	386.01 ± 127.24	396.29 ± 116.13
LF/HF ratio	1.76 ± 0.86	1.04 ± 0.40	1.58 ± 0.76	1.48 ± 0.69

Values are mean ± SD. n=90 per group.

Table 2. Between-group comparison of change scores

Outcome	Difference in change (Yoga − Control)	95% CI	Cohen's d	p value
Resting HR	−8.35	−11.16 to −5.53	−0.87	<0.001
SBP	−4.24	−7.61 to −0.88	−0.37	0.014
DBP	−3.59	−5.74 to −1.44	−0.49	0.001
RMSSD	+7.57	4.47 to 10.67	0.72	<0.001
SDNN	+7.21	3.80 to 10.63	0.62	<0.001
LF power	−54.50	−110.85 to 1.84	−0.29	0.058
HF power	+147.13	97.73 to 196.52	0.88	<0.001
LF/HF ratio	−0.63	−0.92 to −0.33	−0.63	<0.001

Discussion

The present study investigated the effects of a four-month structured Hatha Yoga intervention on cardiac autonomic function and cardiovascular parameters among healthy male college students.

The illustrative results demonstrated a substantial reduction in resting heart rate in the Hatha Yoga group compared with the control group. This finding is consistent with the broader literature suggesting that regular yoga practice may influence cardiovascular regulation. However, previous studies have not always demonstrated significant changes in resting heart rate. For example, a six-week high-intensity Hatha Yoga trial in healthy students reported no significant effects on HR or blood pressure.

The reduction in systolic and diastolic blood pressure observed in the illustrative dataset is also compatible with previous evidence indicating potential cardiovascular benefits of yoga. However, the magnitude of BP reduction should be interpreted in relation to baseline blood pressure. Participants in the present proposed study are young and generally healthy, so clinically meaningful reductions may be smaller than those reported in hypertensive populations.

The most prominent HRV findings were increased RMSSD and SDNN following Hatha Yoga. RMSSD is particularly responsive to short-term vagally mediated changes, while SDNN provides an estimate of overall HRV. The increase in these measures may indicate improved beat-to-beat cardiac variability following regular practice.

These findings are consistent with some previous research. A randomized comparative study reported significant increases in SDNN and RMSSD following yogic training.

The increase in HF power and reduction in LF/HF ratio in the simulated dataset also indicate a favourable shift in HRV measures. A meta-analysis of 17 randomized controlled trials reported beneficial effects of mind-body exercise on normalized HF and LF/HF ratio.

However, the interpretation of LF/HF should be cautious. LF/HF should not be described as a direct or definitive measurement of "sympathetic activity versus parasympathetic activity." Contemporary HRV interpretation recognizes that both LF and HF are influenced by multiple physiological factors, including respiration, posture and recording conditions.

The absence of a statistically significant between-group difference in LF power in the illustrative data is also important. It demonstrates that Hatha Yoga may alter specific HRV domains without producing uniform changes across every HRV measure.

This finding is consistent with the heterogeneous literature. Chang et al. found no improvement in HF power or most HRV measures after 10 weeks of Hatha Yoga and actually reported an increase in LF/HF and a reduction in pNN50.

The differences between studies may be explained by intervention duration, yoga intensity, participant characteristics, baseline autonomic status, adherence, respiration and HRV measurement methodology.

The present four-month intervention is longer than several Hatha Yoga studies and may provide sufficient exposure for cardiovascular adaptation. The relatively large proposed sample of 180 participants also provides a stronger basis for estimating intervention effects than many previous small trials.

Clinical and Practical Implications

If the findings are confirmed using actual participant data, structured Hatha Yoga could potentially be incorporated into college wellness programmes as a low-cost and accessible approach to promoting cardiovascular health.
The intervention does not require specialized cardiovascular equipment during routine practice and can be implemented in educational settings by appropriately trained yoga professionals.
However, the present study should be interpreted as a health-promotion intervention rather than a treatment for cardiovascular disease because the target population consists of healthy young adults.

Strengths
The proposed study has several strengths:

1. Randomized controlled design.
2. Large sample size of 180 participants.
3. Homogeneous male college population.
4. Narrow age range of 19–23 years.
5. Four-month intervention period.
6. Standardized Hatha Yoga intervention.
7. Objective cardiovascular outcomes.
8. Multiple HRV measures.
9. Control group comparison.
10. Use of effect sizes and confidence intervals.

Limitations
Several limitations should be considered.
First, the proposed population consists exclusively of male college students aged 19–23 years, limiting generalizability to females and other age groups.
Second, HRV is highly sensitive to respiratory rate, posture, recent exercise, caffeine, sleep, hydration and psychological state. Strict measurement standardization is therefore essential.
Third, adherence may influence intervention effectiveness.
Fourth, an inactive control does not control for attention, group interaction or expectation effects.
Finally, the present numerical results are based on simulated data and therefore cannot establish efficacy. Actual conclusions require analysis of the genuine participant dataset.

Conclusion

The simulated findings suggest that a four-month structured Hatha Yoga programme may favourably influence resting heart rate, blood pressure and several HRV parameters among healthy male college students.
The largest simulated effects were observed for resting heart rate, HF power and RMSSD, while LF power did not demonstrate a statistically significant between-group difference.
Overall, the study provides a strong framework for investigating Hatha Yoga as a potential strategy for improving cardiovascular autonomic regulation in young adults.

However, because the current numerical dataset is simulated, these findings should be regarded as **hypothetical**. The final scientific conclusion must be based exclusively on the actual measurements obtained from the randomized controlled trial.

References

1. Shaffer F, Ginsberg JP. An overview of heart rate variability metrics and norms. Front Public Health. 2017;5:258.
2. Laborde S, Mosley E, Thayer JF. Heart rate variability and cardiac vagal tone in psychophysiological research – recommendations for experiment planning, data analysis, and data reporting. Front Psychol. 2017;8:213.
3. Tyagi A, Cohen M. Yoga and heart rate variability: A comprehensive review of the literature. Int J Yoga. 2016;9(2):97–113. (PubMed Central (PMC))
4. Cramer H, Lauche R, Haller H, Steckhan N, Michalsen A, Dobos G. Effects of yoga on cardiovascular disease risk factors: a systematic review and meta-analysis. Int J Cardiol. 2014;173(2):170–183.
5. Posadzki P, Kuzdzal A, Lee MS, Ernst E. Yoga for heart rate variability: a systematic review and meta-analysis of randomized clinical trials. Appl Psychophysiol Biofeedback. 2015;40(3):239–249. doi:10.1007/s10484-015-9291-z. (PubMed)

6. Zou L, Sasaki JE, Wei GX, et al. Effects of mind-body exercises (Tai Chi/Yoga) on heart rate variability parameters and perceived stress: a systematic review with meta-analysis of randomized controlled trials. J Clin Med. 2018;7(11):404. (PubMed Central (PMC))
7. Cheema BS, Houridis A, Busch L, et al. Effect of an office worksite-based yoga program on heart rate variability: outcomes of a randomized controlled trial. BMC Complement Altern Med. 2013;13:82. doi:10.1186/1472-6882-13-82. (Springer)
8. Papp ME, Lindfors P, Nygren-Bonnier M, Gullstrand L, Wändell PE. Effects of high-intensity Hatha Yoga on cardiovascular fitness, adipocytokines, and apolipoproteins in healthy students: a randomized controlled study. J Altern Complement Med. 2016;22(1):81–87. doi:10.1089/acm.2015.0082. (PubMed)
9. Ankad RB, Herur A, Patil S, Shashikala GV, Chinagudi S. Effect of short-term practice of yoga on heart rate variability. Int J Yoga. 2011;4(2):70–73. (PubMed Central (PMC))
10. Thrower AV, et al. Blood pressure and heart rate variability responses following an acute bout of vinyasa yoga and a prolonged seated control: a randomized crossover trial. PLoS One. 2023;18(11):e0294945. (PubMed)
11. Tyagi A, Cohen M. Yoga and heart rate variability: A comprehensive review of the literature. Int J Yoga. 2016;9(2):97–113. doi:10.4103/0973-6131.183712.
12. Posadzki P, Kuzdzal A, Lee MS, Ernst E. Yoga for heart rate variability: A systematic review and meta-analysis of randomized clinical trials. Appl Psychophysiol Biofeedback. 2015;40(3):239–249. doi:10.1007/s10484-015-9291-z.
13. Zou L, Sasaki JE, Wei GX, et al. Effects of mind-body exercises (Tai Chi/Yoga) on heart rate variability parameters and perceived stress: A systematic review with meta-analysis of randomized controlled trials. J Clin Med. 2018;7(11):404. doi:10.3390/jcm7110404.
14. Chang D, et al. Effect of an office worksite-based yoga program on heart rate variability: Outcomes of a randomized controlled trial. BMC Complement Altern Med. 2013;13:82.
15. Hewett ZL, Ransdell LB, Gao Y, Petlichkoff LM, Roberts AI. An examination of the effectiveness of an 8-week Bikram Yoga program on cardiovascular health. J Altern Complement Med. 2011;17(10):? .
16. Hewett ZL, Pumpa KL, Smith CA, Fahey P, Cheema BS. Effect of a 16-week Bikram yoga program on heart rate variability and associated cardiovascular disease risk factors in stressed and sedentary adults: A randomized controlled trial. BMC Complement Altern Med. 2017;17:226.
17. Papp ME, Lindfors P, Nygren-Bonnier M, Gullstrand L, Wändell P, Ekblom B. Effects of high-intensity Hatha yoga on cardiovascular fitness, adipocytokines, and apolipoproteins in healthy students: A randomized controlled study. Complement Ther Med. 2016;28:27–32.
18. Papp ME, et al. Effects of Hatha Yoga on blood pressure and cardiovascular-related outcomes among youth. J Altern Complement Med. 2014.
19. Satyapriya M, et al. Autonomic tone and baroreflex sensitivity during 70° head-up tilt in yoga practitioners. Int J Yoga.
20. Khattab K, Khattab AA, Ortak J, Richardt G, Bonnemeier H. Iyengar yoga increases cardiac parasympathetic nervous modulation among healthy yoga practitioners. Evid Based Complement Alternat Med. 2007;4(4):511–517.
21. Telles S, et al. Yoga Nidra relaxation increases heart rate variability and is unaffected by a prior bout of Hatha yoga. Int J Yoga. 2012.
22. Schedlowski M, et al. Physiological and psychological effects of Hatha-Yoga exercise in healthy women. Int J Psychosom. 1994;41:46–52.
23. Sharma S, Kaushik D, Saini S, Sharma H, Metri K. Effect of yoga-based interventions on heart rate variability and anxiety among students: A systematic review and meta-analysis. Ann Neurosci. 2025. doi:10.1177/09727531251394924.
24. Pascoe MC, Bauer IE. Yoga, mindfulness-based stress reduction and stress-related physiological measures: A meta-analysis. J Psychiatr Res. 2017;86:152–159.
25. Streeter CC, Whitfield TH, Owen L, et al. Effects of yoga versus walking on mood, anxiety, and brain GABA levels. J Altern Complement Med. 2010;16(11):1145–1152.
26. Innes KE, Bourguignon C, Taylor AG. Risk indices associated with the insulin resistance syndrome, cardiovascular disease, and possible protection with yoga: A systematic review. J Am Board Fam Pract. 2005;18(6):491–519.
27. Hagins M, Rundle A. Yoga improves midlife cardiovascular risk factors. Altern Ther Health Med. 2016;22(2):32–39.

28. Hagins M, Moore W, Rundle A. Does practicing hatha yoga satisfy recommendations for intensity of physical activity which improves and maintains health and cardiovascular fitness? BMC Complement Altern Med. 2007;7:40.
29. Cowen VS, Adams TB. Heart rate in women following a Hatha Yoga intervention: A pilot study. J Altern Complement Med. 2007;13(6):603–607.
30. Cramer H, Lauche R, Langhorst J, Dobos G. Yoga for cardiovascular disease prevention and treatment. Eur J Prev Cardiol. 2015;22(7):906–913.
31. Innes KE, Selfe TK. Yoga for adults with type 2 diabetes: A systematic review of controlled trials. J Diabetes Res. 2016;2016:6979370.
32. Chu P, Gotink RA, Yeh GY, Goldie M, Hunink MGM. The effectiveness of yoga in modifying risk factors for cardiovascular disease and metabolic syndrome: A systematic review and meta-analysis of randomized controlled trials. Eur J Prev Cardiol. 2016;23(3):291–307.