Research Article

BREATHING BEYOND THE BREATH: EFFECT OF DHEERGHA SWASAM INTEGRATED YOGIC PRACTICES ON CARDIAC FUNCTION IN COLLEGE STUDENTS: A RANDOMIZED CONTROLLED TRIAL

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Abstract

Young adults who are sedentary frequently have elevated resting cardiovascular loads. Although protracted diaphragmatic breathing or Dheergha Swasam is frequently added to yogic asana practice, its additional cardiovascular benefits over yogic practice alone are rarely separated in a controlled setting. Methods: Yogic practices with Dheergha Swasam (YPDSG, n = 30), yogic practices without Dheergha Swasam (YPG, n=30), or a no-intervention control group (CG, n=30) were randomly assigned to 90 healthy female college students (18 to 21 years old). For 12 weeks, intervention groups trained for 60 minutes five days a week. Systolic blood pressure (SBP), diastolic blood pressure (DBP) and resting heart rate (RHR) were measured at baseline and after the intervention. The results were analyzed using a 3 (Group) × 2 (Time) mixed ANOVA with Bonferroni post hoc tests. Results: RHR, SBP and DBP showed significant Time × Group interactions (all $p < 0.001$, partial $\eta 2 = 0.70 - 0.81$). Both YPDSG and YPG showed significant pre to post reductions on all three outcomes (all $p < 0.001$), whereas the control group showed no significant change (all $p = 1.000$). At post-test, YPDSG showed significantly greater reductions than YPG on RHR, SBP and DBP (all $p \leq 0.031$). Conclusion: A 12-week structured yoga practice program significantly lowered resting heart rate and blood pressure in healthy female college students relative to an untrained control and the addition of Dheergha Swasam produced significantly greater reductions than yogic practice alone on all three cardiovascular measures. These results support systematic yoga practice, particularly when combined with extended diaphragmatic breathing, as an in expensive approach to early cardiovascular risk reduction in wellness programs for students.

Keywords: Yoga, Dheergha Swasam, Pranayama, Resting Heart Rate, Blood Pressure, College Students.

1. Introduction

The physiological antecedents of cardiovascular disease, such as elevated resting heart rate, elevated blood pressure and heightened sympathetic tone are becoming more noticeable in young, seemingly healthy populations exposed to sedentary academic routines and chronic examination – related stress (Bhutkar & Bhutkar, 2024). Cardiovascular disease is still the leading cause of premature mortality worldwide. According to Lin and Gao (2023), university students are a population in transition that is often characterized by psychological strain, prolonged sitting and irregular sleep patterns. These factors all contribute to sympathovagal imbalance and set an early trajectory toward hypertension and related cardio metabolic disorders. There is strong evidence that yoga, a mind – body practice that combines postures (asana), breath extension (pranayama) and meditative attention, lowers blood pressure and resting heart rate in a variety of demographics. In comparison to waitlist control, a recent systematic review and meta – analysis of thirty randomized controlled trials in people with pre hypertension or hypertension found clinically significant drops in systolic blood pressure, diastolic blood pressure and heart rate after yoga – based intervention (Wu et al., 2025). According to complementary physiological research, even a short, one – session yoga practice that combines pranayama and asana can reduce blood pressure and resting heart rate in healthy adults. This suggests that autonomic balance is rapidly modulated rather than merely long – term structural adaptation (Rajeswari et al., 2024). Slow, diaphragmatic and prolonged breathing exercises – generally referred to as Dheergha Swasam in the yogic tradition – are among the different pranayama techniques that are suggested to have a unique autonomic effect beyond asana practice alone. Mechanistically, slow, deep breathing improves baroreflex sensitivity and heart rate variability while suppressing sympathetic outflow by lengthening the respiratory cycle, increasing tidal volume and enhancing vagal afferent traffic through stretch – sensitive pulmonary receptors (Hamasaki,2020; Yu et al., 2021). The immediate drops in blood pressure and heart rate seen with slow breathing therapies in both clinical and non – clinical populations are believed to be caused by this diaphragm – vagus coupling (Kang et al., 2023). The role of controlled breath regulation in regulating cardiac autonomic status and lowering resting blood pressure is further supported by studies that isolate particular pranayama techniques, such as Nadi Shodhana and the sequential practice of Kapalabhati with Nadi Shodhana (Rani & Ramaiah, 2023; Subbalakshmi et al., 2005). Few randomized trials have directly isolated the additive cardiovascular contribution of a specific deep – breathing component (Dheergha Swasam) when layered on to an otherwise identical yogic asana protocol, despite this body of evidence. This is especially true for young, healthy female college students, who are often underrepresented in yoga – cardiovascular research compared to clinical or older adult samples. The specific benefit of incorporating structured deep breathing into regular yogic training is unclear in this population because the majority of available trials either compare yoga as a composite package against an inactive control (Malshe, 2024) or look at breathing techniques separately from asana practice (Bhavanani et al., 2023). Clarifying whether Dheergha Swasam offers benefits beyond yogic asana practice alone has direct translational relevance for curriculum and campus health policy, given that university wellness programs are increasingly looking for affordable, scalable interventions for cardiovascular risk reduction (Cocchiara et al., 2019; Csala et al., 2021). In order to compare the effects of a 12 week yoga practice program with and without Dheergha Swasam against a no – intervention control on resting heart rate, systolic blood pressure and diastolic blood pressure in healthy female undergraduate college students, the current randomized controlled trial was conducted. It was predicted that both active intervention groups would exhibit notable drops in blood pressure and resting heart rate in comparison to the control group with the Dheergha Swasam group seeing the largest drop.

Material and Methods:

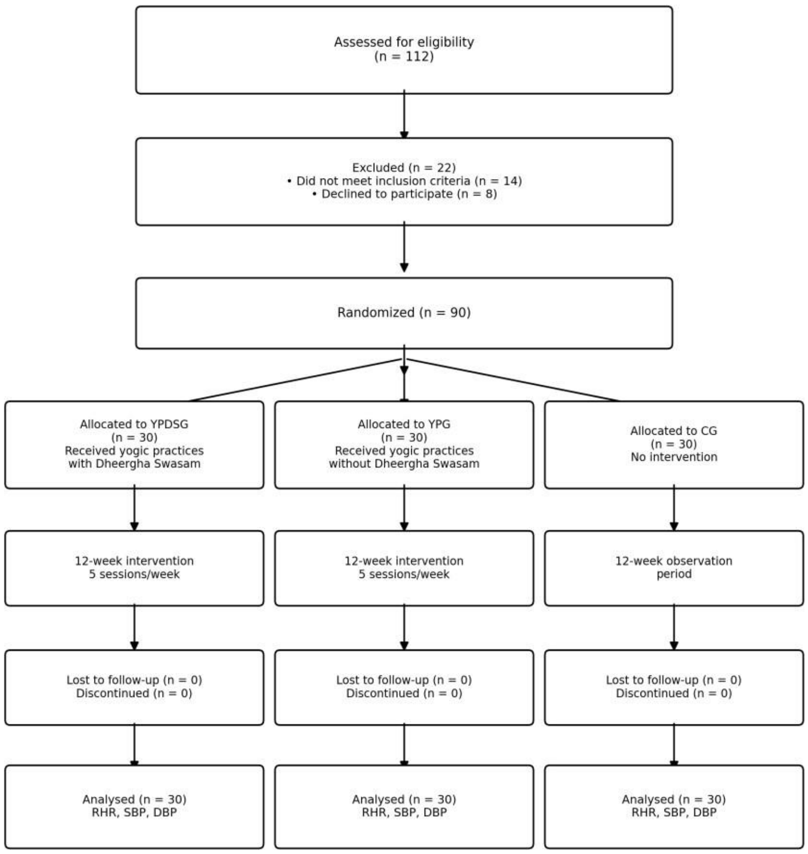
Study Design and Participants: In order to investigate the impact of yoga practices, both with and without dheergha Swasam, on resting cardiovascular parameters in female college students over a 12 week period, this study used a parallel – group, three-arm randomized controlled trial design. All participants gave written informed consent prior to enrollment, and the study was approved by the Institutional Human Ethics Committee of Meenakshi Academy of Higher Education and Research (MAHER), Chennai (Reference No: MAHER/IEC/PHD/70/NOV24; DHR Registration No: EC/NEW/INST/2023/3553; CDSCO Registration No: ECR/1906/INST/TN/2023; Approved 27 January 2025). Purposive sampling was used to choose 90 female college students between the ages of 18 to 21 from Sri Venkateswaraa College of Technology in Tamil Nadu, India, based on specified qualifying criteria. Healthy female college students between the ages of 18 to 21 who were enrolled in the research institution and willing to give written informed permission were the requirements for inclusion. A history of cardiovascular, pulmonary, neurological or musculoskeletal conditions; consistent yoga or structured exercise within the previous three months; and current use of drugs known to impair heart function were the exclusion criteria. Three equal groups of thirty were randomly assigned to eligible participants after baseline screening: a yogic practices with Dheergha Swasam group (YPDSG), a yogic practices without Dheergha Swasam group (YPG) and a no-intervention control group (CG). Figure 1 summarizes the participant flow.

Randomization: A computer-generated random allocation sequence was used to assign participants who met the eligibility requirements to the three groups. This process was used to reduce selection bias and guarantee that baseline attributes were distributed fairly among groups.

Intervention protocol: For twelve weeks in a row, the intervention groups (YPDSG & YPG) trained five days a week in a well-ventilated yoga hall under the guidance of a licensed yoga instructor. The YPDSG workouts between 6 AM to 7 AM, whereas YPG trained between 7 AM to 8 AM. OM chanting, an organized series of kriyas and asanas [Tadasana kriya, Ardha Chakra Pada Hastasana kriya, Kati Chakrasana kriya, Mukha Dhouthi, Ardha kati Chakrasana, Dwi Pada Peetam, Utthitha Padasana, Pawana Muktasana (single leg and double leg variations), Bhujangasana, Ardha Salabhasana, Dhanurasana, Viparitakarani Mudra, Matsyasana, Sasanga Ushtrasana, Nadi Shuddhi pranayama and a final relaxation Shanti asana]. While the YPG followed the same asana and pranayama structure without specific deep-breathing component, the YPDSG regimen also included Dheergha Swasam (long diaphragmatic breathing) practice integrated within the sequence. The training protocol is summarized in Table 1. Throughout the trial period, the control group carried on with their regular daily routines without engaging in any systematic yoga or breathing exercises.

Figure Legends:

Figure 1. Consort flow diagram of participant enrolment, randomization, allocation and analysis across the yogic practices with dheergha swasam group (YPDSG), yogic practices without dheergha swasam group (YPG) and control group (CG).



Tables:

Table 1. Training Protocol for the 12 week Yogic Practice Intervention:

Name of the yogic practices	Counts of breath	Round	Duration (Including relaxation between each asana)
Om Chanting	3	1	3 minutes
Tadasana kriya	18	1	1 minute
Artha chakra Pada hastasana kriya	18	1	1 minute
Kati chakrasana kriya	18	1	1 minute
Mukha dhouthi	18	1	1 minute
Ardha kati chakrasana	18	2	3 minutes
Dwi pada peetam	18	2	3 minutes
Utthitha padasana	18	2	3 minutes

Pawana muktasana single leg (Left & Right)	18	2	3 minutes
Pawana muktasana double leg	18	2	3 minutes
Bhujangasana	18	2	3 minutes
Artha salabhasana	18	2	3 minutes
Dhanurasana	18	2	3 minutes
Viparitakarani & matsyasana	18	2	4 minutes
Sasanga ushtrasana kriya	18	2	3 minutes
Kapalabhati kriya	120	3	5 minutes
Nadi shuddhi pranayama	-	7	7 minutes
Shanthi asana	-	2	10 minutes
Total			**60 minutes**

Outcome Measures:

All participants had their resting heart rate (RHR, beats/min), systolic blood pressure (SBP, mmHg) and diastolic blood pressure (DBP, mmHg) measured at baseline (week 0) and after the 12 week intervention period (week 12). Participants were seated and at rest for at least five minutes before the measurements were taken.

Statistical Analysis:

For each group, descriptive statistics (mean ± standard deviation) were calculated for RHR, SBP and DBP before and after the intervention. To investigate the main effects of time and group, as well as their interaction, a 3 (Group: YPDSG, YPG, CG) × 2 (Time: pre, post) mixed –design analysis of variance (ANOVA) was performed independently for each outcome variable. Pre to Post change scores were compared between groups using Bonferroni-corrected pairwise post hoc comparisons where the omnibus interaction was significant. The effect size was measured using partial eta-squared (η^2). The threshold for statistical significance was fixed at $p < 0.05$

Results:

There was no loss to follow-up in any of the 90 female college students (mean age 18 to 21) who finished the study (Figure 1). Table 2 displays the descriptive statistics for resting heart rate (RHR), systolic blood pressure (SBP) and diastolic blood pressure (DBP) for the yogic practices with Dheergha Swasam group (YPDSG), the yogic practices without Dheergha Swasam group (YPG) and the control group (CG) before and after the intervention. For every outcome measure, baseline values were similar among the three groups. All three outcomes showed a statistically significant Time × group interaction (Table 3): RHR, F = 140.62, p < 0.001, partial η^2 = 0.76; SBP, F = 99.82, p < 0.001, partial η^2 = 0.70; DBP, F = 189.16, p < 0.001, partial η^2 = 0.81. All three variables also showed significant main effects of time and group (all p ≤ 0.001), indicating that the pattern of pre to post change differed significantly between groups.

Bonferroni-corrected post hoc comparisons (Table 4) showed that RHR decreased significantly from pre to post in both YPDSG [mean difference = 5.133, 95% CI (4.444, 5.823), p < 0.001] and YPG [mean difference = 2.033, 95% CI (1.344, 2.723), p < 0.001], whereas CG showed no significant pre to post change YPDSG [mean difference = -0.267, 95% CI (-0.956, 0.423), p = 1.000]. At post-test, RHR was significantly lower in YPDSG than in YPG [mean difference = -2.667, 95% CI (-4.685, -0.648), p = 0.002] and both intervention groups had significantly lower post-test RHR than CG (CG vs. YPDSG: mean difference = 5.500, 95% CI (3.481, 7.519), p < 0.001; CG vs. YPG mean difference = 2.833, 95% CI (0.815, 4.852), p < 0.001; For SBP, a similar pattern was observed: both YPDSG (mean difference = 8.833, 95% CI [7.543, 10.123], p < 0.001) and YPG (mean difference = 4.833, 95% CI [3.543, 6.123], p < 0.001) showed significant pre to post reductions, while CG did not (mean difference = 0.300, 95% CI [-0.990, 1.590], p = 1.000). Post-test was significantly lower in YPDSG than in YPG (mean difference = 3.333, 95% CI [-6.497,-0.169], p = 0.031) and both intervention groups differed significantly from CG (CG vs. YPDSG: mean difference = 10.333, 95% CI [7.169, 13.497], p < 0.001; CG vs. YPG: mean difference = 7.000, 95% CI [6.273, 7.860], p < 0.001) and YPG (mean difference = 4.033, 95% CI [3.240, 4.827], p < 0.001) showed significant pre to post reductions, while CG showed no significant change (mean difference = -0.133, 95% CI [-0.927, 0.660], p = 1.000). Post-test DBP was significantly lower in YPDSG than in YPG (mean difference = -1.800, 95% CI

[-3.328,-0.272], p = 0.009) and both intervention groups differed significantly from CG (CG vs. YPDSG: mean difference = 8.067, 95% CI [6.538, 9.595], p < 0.001; CG vs. YPG: mean difference = 6.267, 95% CI [4.738, 7.795], p < 0.001).

Overall, compared to the untrained control group, both 12 week yogic practice programs with and without Dheergha Swasam produced clinically and statistically significant decreases in resting heart rate and blood pressure. Furthermore, the addition of Dheergha Swasam conferred a significant additional advantage over yogic practice alone: YPDSG showed significantly greater post-test reductions than YPG on all three outcomes. (RHR, SBP, DBP).

Table 2. Descriptive Statistics of Outcome Measures Across Groups

Variable	Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)
RHR (beats/min)	YPDSG	77.73 ± 2.61	72.60 ± 2.62
	YPG	77.30 ± 2.18	75.27 ± 2.39
	CG	77.83 ± 2.68	78.10 ± 2.75
SBP (mmHg)	YPDSG	121.17 ± 3.67	112.33 ± 4.29
	YPG	120.50 ± 3.67	115.67 ± 4.07
	CG	122.97 ± 3.86	122.67 ± 3.81
DBP (mmHg)	YPDSG	80.23 ± 1.59	73.17 ± 2.57
	YPG	79.00 ± 1.44	74.97 ± 1.47
	CG	81.10 ± 1.40	81.23 ± 1.65

Note. YPDSG = Yogic Practices with Dheergha Swasam Group; YPG = Yogic Practices without Dheergha Swasam Group; CG = Control Group; RHR = resting heart rate; SBP = systolic blood pressure; DBP = diastolic blood pressure. Values are presented as mean ± standard deviation.

Table 3. Mixed ANOVA Results for the Outcome Measures

Variable	Effect	SS	MS	F	p	Partial η²
RHR	Time	238.05	238.05	303.89	< .001	0.78
	Group	238.41	119.21	9.78	< .001	0.18
	Time× Group	220.30	110.15	140.62	< .001	0.76
SBP	Time	975.34	975.34	356.06	< .001	0.80
	Group	1219.73	609.87	22.03	< .001	0.34
	Time× Group	546.84	273.42	99.82	< .001	0.70
DBP	Time	601.34	601.34	580.33	< .001	0.87

Variable	Effect	SS	MS	F	p	Partial η²
	Group	750.63	375.32	75.16	< .001	0.63
	Time× Group	392.01	196.01	189.16	< .001	0.81

Note. SS = sum of squares; MS = mean square; df for Time = 1; df for Group = 2; df for Time × Group = 2.

Table 4. Bonferroni Post Hoc Comparisons: Within-Group Pre-Post Change and Post-test Between-Group Differences:

Variable	Comparison	Mean Difference	95% CI Lower	95% CI Upper	p (Bonf.)
RHR	YPDSG Pre – YPDSG Post	5.133	4.444	5.823	< .001
	YPG Pre – YPG Post	2.033	1.344	2.723	< .001
	CG Pre – CG Post	−0.267	−0.956	0.423	1.000
	YPDSG Post – YPG Post	−2.667	−4.685	−0.648	.002
	CG Post – YPDSG Post	5.500	3.481	7.519	< .001
	CG Post – YPG Post	2.833	0.815	4.852	< .001
SBP	YPDSG Pre – YPDSG Post	8.833	7.543	10.123	< .001
	YPG Pre – YPG Post	4.833	3.543	6.123	< .001
	CG Pre – CG Post	0.300	−0.990	1.590	1.000
	YPDSG Post – YPG Post	−3.333	−6.497	−0.169	.031
	CG Post – YPDSG Post	10.333	7.169	13.497	< .001
	CG Post – YPG Post	7.000	3.836	10.164	< .001
DBP	YPDSG Pre – YPDSG Post	7.067	6.273	7.860	< .001
	YPG Pre – YPG Post	4.033	3.240	4.827	< .001
	CG Pre – CG Post	−0.133	−0.927	0.660	1.000
	YPDSG Post – YPG Post	−1.800	−3.328	−0.272	.009
	CG Post –	8.067	6.538	9.595	< .001

Variable	Comparison	Mean Difference	95% CI Lower	95% CI Upper	p (Bonf.)
	YPDSG Post				
	CG Post – YPG Post	6.267	4.738	7.795	< .001

Note. CI = confidence interval; p (Bonf.) = Bonferroni-corrected p-value. For each variable, the first three rows show within-group pre–post comparisons (YPDSG, YPG, CG); the last three rows show between-group comparisons of post-test values.

Discussion:

This randomized controlled trial investigated whether adding Dheergha Swasam (extended diaphragmatic breathing) to a typical 12 week yoga practice routine produced a greater cardiovascular benefit than yoga practice alone, relative to a no-intervention control, in healthy female college students. In line with the larger body of research connecting yoga practice to beneficial autonomic and hemodynamic adaptation, both intervention groups showed significant decreases in resting heart rate, systolic blood pressure and diastolic blood pressure compared with the control group (Wu et al., 2025). Consistent with the study hypothesis, the Dheergha Swasam group also showed significantly greater reductions than the yogic-practice-only group on all three outcomes, indicating that the addition of structured deep breathing conferred a measurable cardiovascular benefit beyond that produced by the shared asana and pranayama components alone.

The suggested mechanism by which regular yoga practice alters autonomic balance toward parasympathetic dominance is consistent with the observed decreases in blood pressure and resting heart rate. Slow, rhythmic breathing lengthens the respiratory cycle and increases vagal afferent signaling through pulmonary stretch receptors, thereby improving baroreflex sensitivity and reducing sympathetic vasomotor tone (Hamasaki, 2020; Yu et al., 2021). Independent of an explicit breath-focused component, asana practice itself has been linked to enhanced cardiac autonomic regulation, particularly postures involving prolonged static holds and controlled movement (Chauhan et al., 2024). Because YPDSG and YPG shared an identical asana and kapalabhati/Nadi Shuddhi pranayama framework, differing only in the addition of a Dheergha Swasam phase, the significantly greater reductions observed in YPDSG indicate that the extended diaphragmatic breathing component contributed an incremental autonomic benefit over and above the pranayama techniques common to both regimens.

This finding is consistent with physiological research on Nadi Shodhana and kapalabhati, which have independently shown reductions in blood pressure and resting heart rate following even brief practice sessions, attributed to modulation of cardiac autonomic status (Rani & Ramaiah, 2023; Subbalakshmi et al., 2005), and it extends this literature by showing that a dedicated slow diaphragmatic breathing component can produce additional benefit when layered onto an already breath-regulated asana and pranayama program. It is also consistent with narrative and systematic reviews of diaphragmatic and slow breathing interventions, which indicate that slow breathing exerts consistent antihypertensive and heart-rate-lowering effects across both short single-session and longer multi-week protocols (Hamasaki, 2020; Ubolnuar et al., 2021). Because both intervention groups completed an identical 12 week dose of asana and pranayama, the additional reduction observed in YPDSG points to a specific, dose-related contribution of prolonged diaphragmatic breathing to autonomic and hemodynamic regulation rather than a generic effect of movement or relaxation.

The effect sizes observed here are comparable to, and in the case of the Dheergha Swasam group exceed, the magnitude of change reported in recent meta-analytic work. The present normotensive, healthy young sample showed reductions ranging from approximately 4.8 to 8.8 mmHg in systolic blood pressure and 4.0 to 7.1 mmHg in diastolic blood pressure across the two active groups, indicating that meaningful hemodynamic benefit is achievable even in a population without baseline hypertension. Wu et al. (2025) reported pooled reductions of approximately 7.95 mmHg in systolic blood pressure and 4.93 mmHg in diastolic blood pressure following yoga intervention in people with pre-hypertension or hypertension; the YPDSG reductions observed in the present healthy sample (8.83 mmHg systolic; 7.07 mmHg diastolic) approached or exceeded these pooled clinical estimates. Given that elevated blood pressure and resting heart rate, even within the high-normal range, are independently linked to future cardiovascular risk, and that early intervention may alter long-term trajectories, this is clinically relevant (Bhutkar & Bhutkar, 2024).

Over the course of the 12 week study, the control group in this study demonstrated a negligible change in RHR and a slight, non – beneficial change in SBP and DBP. This could be partially explained by the cumulative physiological burden of continuous academic demands in the absence of any structured relaxation or physical activity intervention. This pattern is consistent with research on yoga in populations of nursing and medical students, which found that structured yoga-based interventions significantly reduced psychosomatic and cardiopulmonary strain in comparison to untreated comparison groups subjected to compare academic stressors (Sivakumar et al., 2024).

There are a few restrictions that should be taken into account. First, the sample was limited in its capacity to be applied to male students, older adults or other cultural and institutional contexts because it was taken from a single institution and only included female students in a specific age range. Second, the current research only looked at blood pressure and resting heart rate; the larger psychological well-being component of this study protocol was not examined here and ought to be reported separately using the proper psychometric outcome measures. Third, the trained yoga instructor and outcome assessors were not blinded to group assignment, which could introduce measurement bias but is challenging to eliminate in movement-based therapies. Fourth, the suggested vagal mechanism is still inferential rather than actually shown because heart rate variability or other autonomic markers were not directly recorded. Lastly, a longer follow-up time would assist determine whether the reported benefits are maintained following intervention cessation, as adherence and dose-response connections within the 12 week regimen were not modeled.

Notwithstanding these limitations, the results carry useful implications for promoting student health. Both yogic protocols produced clinically meaningful cardiovascular benefit relative to the untrained control, supporting regular, structured asana and pranayama practice as a viable component of low-cost, group-based wellness programs. However, because the Dheergha Swasam group showed significantly greater reductions in resting heart rate, systolic blood pressure and diastolic blood pressure than the yogic-practice-only group, institutions seeking to maximize cardiovascular benefit within a similar time investment may consider prioritizing programs that explicitly incorporate an extended diaphragmatic breathing component.

Conclusion: A 12 week structured yoga practice program significantly reduced resting heart rate, systolic blood pressure and diastolic blood pressure in healthy female college students relative to an untrained control group, which did not show a comparable improvement. The addition of a dedicated Dheergha Swasam component produced significantly greater reductions than yogic practice alone on all three cardiovascular outcomes, supporting extended diaphragmatic breathing as a valuable addition to yoga-based wellness programs. These results support the inclusion of regular, structured yoga practice, particularly when combined with Dheergha Swasam, in student wellness programs as an accessible, non-pharmacological strategy for early cardiovascular risk reduction. Larger trials with heart rate variability testing and longer follow-up are needed to confirm and extend these findings.

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Conflict of Interest:
There is no conflict of interest disclosed by the authors.

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