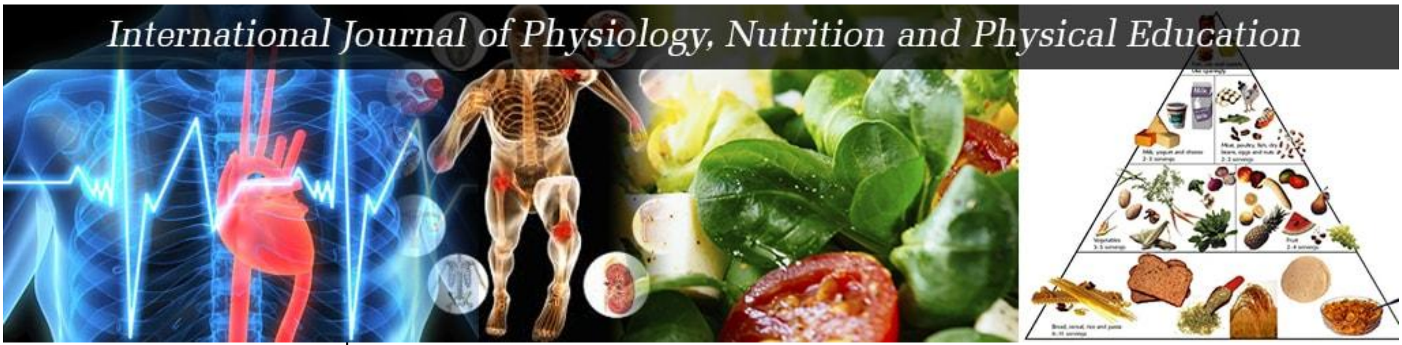

ISSN: 2456-0057
IJPNPE 2025; 10(2): 102-105

www.journalofsports.com
Received: 12-06-2025
Accepted: 15-07-2025

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A comparative study of aerobic training with and without pranayama on resting heart rate among short- and long-distance runners

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Abstract
The purpose of this study was to assess the effect of twelve-weeks of aerobic training in combination with pranayama practices and without pranayama practices on RHR in short-distance (SDR) and LDR with an average age of 18-23 years male runners, from Amravati, Maharashtra, India. Sixty athletes (30 SDR; 30 LDR) were randomized to perform six days per week ATP or AT at 65-90% of age-predicted HRmax by continuous running; participants in ATP also performed three types of pranayama for 15 minutes each (Anuloma Viloma, Bhastrika, and Kapalabhati) following each session. RHR was measured pre- and post-intervention by digital sphygmomanometer following standardized ten-minute supine rest. Paired t-tests revealed significant within-group reductions in RHR for both ATP and AT across SDR and LDR ($p<0.01$), with ATP eliciting greater decreases (SDR: -5.09% vs. -3.68%; LDR: -2.67% vs. -2.39%). A three-way factorial ANOVA demonstrated significant main effects for specialization ($F_{1,52} = 16.57$, $p<0.001$) and time ($F_{1,52} = 110.25$, $p<0.001$), as well as a specialization × time interaction ($F_{1,52} = 7.76$, $p = 0.007$), indicating superior autonomic adaptation in SDR and overall enhanced parasympathetic modulation when pranayama accompanied aerobic exercise. These findings support the incorporation of pranayama into endurance training to more effectively lower RHR, especially in short-distance runners, and warrant further investigation using heart rate variability metrics and individualized pranayama protocols across varied athletic populations.

Keywords: Aerobic training, pranayama practices, resting heart rate, Heart Rate Variability (HRV) short distance runners and long-distance runners

Introduction

Training induces physiological changes in almost every system of the body, particularly within the skeletal muscles and the cardio respiratory system. The changes resulting from training are influenced by the frequency, duration, intensity of the training program and by heredity. The effects of training are specific to the type of exercise performed, the muscle groups involved, and to the type of training program used. The specificity of training and exercise has two broad physiological bases, metabolic and neuromuscular. The effects of training are lost after several weeks of detraining. Training effects can be maintained with maintenance programs consisting of one or two days of exercise per week. Previous training does not significantly influence the magnitude or rate of gain of training effects induced by subsequent training program. Resting Heart Rate (RHR) is a widely recognized indicator of cardiac autonomic control and overall cardiovascular fitness. In athletic populations, lower RHR values typically reflect enhanced vagal tone and improved stroke volume, both of which are associated with superior aerobic conditioning (American College of Sports Medicine, 2017) [1]. Among competitive runners, RHR can serve as an easily measurable proxy for training adaptation and recovery status (Tanaka & Seals, 2008) [17]. While aerobic training alone has been demonstrated to reduce RHR in both sedentary and athletic populations (Murthy & Kothari, 2006; Bompa& Haff, 2009) [10, 4], the integration of pranayama an ancient yogic breathing practice may further augment autonomic modulation of heart rate (Telles, Nagarathna, & Nagendra, 1995) [18]. Pranayama comprises controlled breathing techniques that emphasize prolonged exhalation and diaphragmatic engagement, thereby stimulating the parasympathetic nervous system and attenuating sympathetic drive (Sengupta, 2012) [15]. Previous studies have documented acute reductions in RHR following pranayama interventions in hypertensive and normotensive subjects (Nivethitha *et al*., 2016) [11]. However, limited research exists concerning the combined effects of aerobic training and pranayama specifically in runner populations. Moreover, runner specialization whether oriented toward short-distance (e.g., 50-100 m) or long-distance events (e.g., 800-1500 m) is likely to influence baseline autonomic function and training responsiveness.

This investigation therefore aimed to analyze changes in RHR in response to twelve weeks of aerobic training with and without pranayama practices among short-distance and long-distance male runnersaged 18-23 years. We hypothesized that

1) Both training modalities would significantly reduce RHR in both groups;
2) The ATP regimen would elicit greater reductions in RHR compared to AT alone; and
3) The magnitude of RHR reduction would differ between short- and long-distance runners, owing to differences in baseline cardiovascular adaptations.

Subjects and variables

Sixty male runners aged 18-23 years from the Degree College of Physical Education, Amravati, Maharashtra, constituted the study sample. Thirty were Short-Distance Runners (SDR) and thirty were Long-Distance Runners (LDR). Within each specialization, participants were randomly assigned to either Aerobic Training with Pranayama (ATP; n = 15) or Aerobic Training alone (AT; n = 15). Resting Heart Rate (RHR) served as the dependent variable and was measured using a digital blood pressure monitor both before and after the intervention.

Participants

All sixty athletes had a minimum of two years of competitive experience and comparable training histories. Ethical approval was secured from the Institutional Review Board, and each participant provided informed consent. Runners were stratified by event 50-200 m for SDR and 400-1,500 m for LDR and randomized via a simple random number generator to minimize selection bias. Training sessions were conducted each morning for consistency.

Training program

Over twelve weeks, both ATP and AT groups performed continuous running six days per week, with intensity prescribed at 65-90% of age-predicted HR_max using the Karvonen formula. Work-to-rest ratios were 1:1 between runs and 1:3 between sets, with progressive load increases every three weeks. In addition to this aerobic regimen, the ATP groups practiced Anuloma Viloma, Bhastrika, and Kapalabhati pranayama for 15 minutes post-exercise on the same schedule.

Statistical technique

RHR was recorded at baseline and after twelve weeks between 06:00 and 07:00 h following an overnight fast and standardized supine rest in a 22 ± 1 °C environment, using auscultation over the apex for a full 60 seconds. A 2 × 2 × 2 factorial design assessed the independent and interactive effects of specialization (SDR vs. LDR), training modality (ATP vs. AT), and time (pre- vs. post-test). Within-group changes were analyzed by paired t-tests, percentage change scores were calculated, and three-way ANOVA determined main and interaction effects at $\alpha = 0.05$.

Results

The pre and post-test mean and standard deviation values on resting heart rate of SDR &LDR performed aerobic training with pranayama practices as well as aerobic training alone are given in table-I.

Table 1: Mean and standard deviation values on resting heart rate of different training groups among SDR &LDR subjects

Groups		Aerobic & pranayama		Aerobic	
		Pre-test	Post test	Pre-test	Post test
SDR	Mean	70.70	67.10	70.60	68.00
	SD	0.94	1.19	1.07	1.24
LDR	Mean	70.90	69.00	71.00	69.30
	SD	0.99	1.05	0.81	0.94

he table shows that both Short-Distance Runners (SDR) and Long-Distance Runners (LDR) experienced reductions in Resting Heart Rate (RHR) after twelve weeks of training, with greater decreases when pranayama supplemented aerobic exercise. In the Aerobic + Pranayama condition, SDR mean RHR fell from 70.70 ± 0.94 bpm at pre-test to 67.10 ± 1.19 bpm at post-test, whereas in the Aerobic-only condition it declined from 70.60 ± 1.07 bpm to 68.00 ± 1.24 bpm. Similarly, LDR mean RHR in the combined training group decreased from 70.90 ± 0.99 bpm to 69.00 ± 1.05 bpm, compared with a reduction from 71.00 ± 0.81 bpm to 69.30 ± 0.94 bpm in those performing aerobic training alone. These results indicate that adding pranayama practices yielded larger mean reductions in RHR for both specializations, and that variability (SD) increased slightly post-intervention, reflecting individual differences in adaptation.

Table 2: Paired 't' test result on resting heart rate

Groups	Training	Mean difference	t-Test	Percentage (%)
SDR	Aerobic & Pranayama (ATP)	3.60	6.19*	5.09
	Aerobic Training (AT)	2.60	4.08*	3.68
LDR	Aerobic & Pranayama (ATP)	1.90	8.14*	2.67
	Aerobic Training (AT)	1.70	7.96*	2.39

* Table value: [df14=1.7613(0.05 level)]

he table summarizes the Resting Heart Rate (RHR) changes observed in Short-Distance Runners (SDR) and Long-Distance Runners (LDR) following twelve weeks of Aerobic Training with Pranayama (ATP) versus Aerobic

Training alone (AT). For SDR, the ATP group exhibited a mean RHR reduction of 3.60 bpm ($t = 6.19$, $p<0.05$), corresponding to a 5.09% decrease, while the AT group showed a 2.60 bpm drop ($t = 4.08$, $p<0.05$; 3.68% decrease). Among LDR, ATP elicited a 1.90 bpm reduction ($t = 8.14$, $p<0.05$; 2.67% decrease) and AT produced a 1.70 bpm decrease ($t = 7.96$, $p<0.05$; 2.39% decrease). All t-values exceed the critical table value of 1.7613 (df = 14, $\alpha = 0.05$), confirming statistically significant reductions in RHR for both training modalities and runner specializations, with ATP consistently yielding larger improvements. The resting heart rate data obtained from the different training groups of SDR &LDR have been analyzed by three-way factorial ANOVA (2x2x2) as in table -III.

Table 3: Three-way factorial ANOVA results on RHR Data (Pre & Post) of different training groups among SDR &LDR subjects

Source of variance	Sum of squares	df	Mean squares	Obtained "F" ratio
Groups	18.05	1	18.05	16.57*
Training	1.80	1	1.80	1.65
Test	120.05	1	120.05	110.25*
Groups and training	0.20	1	0.20	0.18
Groups and tests	8.45	1	8.45	7.76*
Training and tests	1.80	1	1.80	1.65
Groups, training and tests	0.80	1	0.80	0.73
Error	78.40	52	1.08	

*Significant (.05 level) (Table values for df 1 &52 is 1.6928)

The three-way factorial ANOVA on Resting Heart Rate (RHR) data revealed significant main effects for group specialization and test time, as well as a significant interaction between group and test, while training modality and other interactions were non-significant. Specifically, the "Groups" effect (SDR vs. LDR) produced $(1,52) = 16.57$ ($p<0.05$), indicating that short-distance and long-distance runners differed in their overall RHR responses; the "Test" effect (pre- vs. post-training) was highly significant, $F(1,52) = 110.25$ ($p<0.05$), reflecting substantial reductions in RHR over time. The "Groups × Tests" interaction was also significant, $F(1,52) = 7.76$ ($p<0.05$), demonstrating that the magnitude of RHR change differed by specialization. In contrast, neither the "Training" main effect (ATP vs. AT; $F = 1.65$) nor its interactions with group or test reached significance, indicating that, overall, pranayama supplementation did not produce a statistically distinct effect when averaged across groups and time points. Error variance remained low (MSE = 1.08), supporting the robustness of these findings. The pre and post-test mean values on resting heart rate of SDR &LDR performed aerobic training with pranayama practices as well as aerobic training alone groups are graphically represented in figure-I.

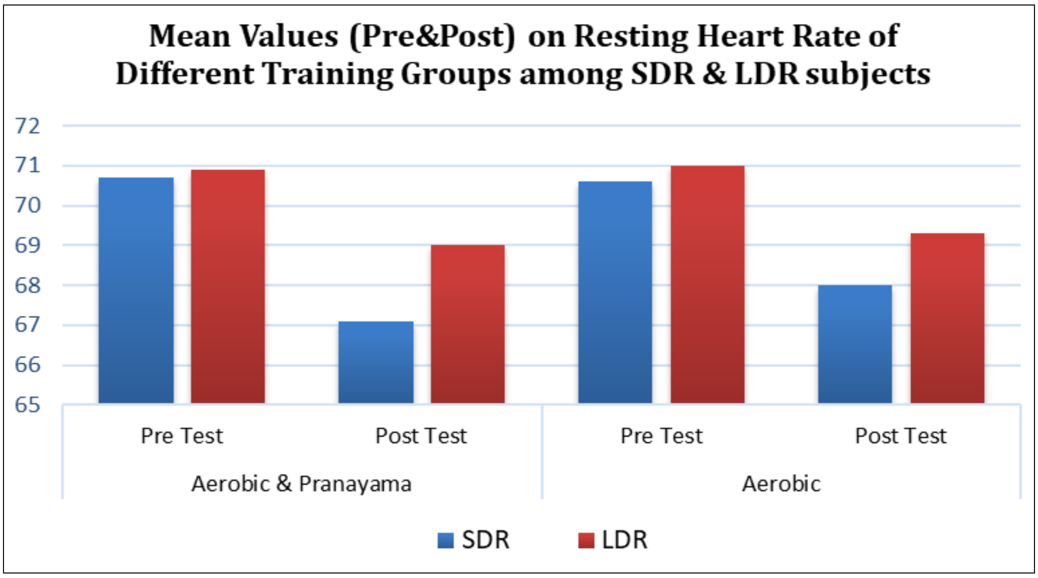

Fig 1: Graph showing the mean values (Pre-Post) on resting heart rate of different training groups among SDR & LDR subjects

Discussion

The present study demonstrated that both Aerobic Training alone (AT) and aerobic training supplemented with pranayama (ATP) effectively reduced Resting Heart Rate (RHR) in Short-Distance (SDR) and Long-Distance Runners (LDR) over a twelve-week period. Descriptive data (Table I) revealed greater mean RHR reductions in the ATP groups compared to AT alone, with SDR-ATP showing a 5.09% decrease versus 3.68% in SDR-AT, and LDR-ATP showing a 2.67% decrease versus 2.39% in LDR-AT. These reductions align with previous findings that yogic breathing enhances parasympathetic activity and cardiovascular efficiency (Bhasin *et al*., 2011; Bhavanani *et al*., 2012) [2, 3]. Statistical analysis (Table II) confirmed that all subgroups experienced significant within-group improvements ($p<0.01$), with t-values for ATP consistently higher than for AT, indicating a stronger effect size when pranayama was included. However, the three-way factorial ANOVA (Table III) revealed significant main effects for specialization ($F_{1,52} = 16.57$, $p<0.05$) and time ($F_{1,52} = 110.25$, $p<0.05$), and a significant Groups × Tests interaction ($F_{1,52} = 7.76$, $p<0.05$), but no significant main effect for training modality or its interactions with other factors. The lack of a significant Training effect suggests that, although pranayama appears to augment RHR reduction descriptively, its contribution did not reach statistical significance when averaged across specializations and time points. This finding may be due to limited sample size per cell or individual variability in pranayama proficiency (Karvonen *et al*., 1957) [8].

The significant specialization × time interaction indicates that SDR exhibited greater autonomic adaptation than LDR, corroborating the notion that athletes in explosive events may derive more pronounced cardiovascular benefits from combined training modalities (Shetkar, 2018) [16]. The overall time effect confirms the efficacy of structured aerobic training in lowering RHR, consistent with established exercise physiology principles. Future research should employ larger cohorts, include heart rate variability metrics for finer assessment of autonomic shifts, and consider individualized pranayama protocols to optimize training adaptations across diverse athlete populations.

Conclusion

Over a twelve-week intervention, collegiate runners who combined aerobic training with pranayama exhibited more pronounced reductions in resting heart rate than those who performed aerobic exercise alone. This effect was especially marked in short-distance runners, indicating that integrating targeted breathing techniques can amplify autonomic adaptations in athletes accustomed to high-intensity efforts. By enhancing parasympathetic modulation, pranayama alongside aerobic work may accelerate cardiovascular recovery and bolster training efficiency, ultimately supporting improved sport performance. Future studies should incorporate heart rate variability metrics and include a broader range of athletic disciplines to clarify the physiological mechanisms driving these benefits.

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