

---

**TEMPORAL CHANGES IN PHYSIOLOGICAL RESPONSES  
FOLLOWING PASSIVE MEDITATION TECHNIQUES IN TEAM  
SPORTS ATHLETES: A COMPARATIVE TIME TREND ANALYSIS**

---

**Dr Payel Das\*<sup>1</sup>, Dr. Vivek Pandey<sup>2</sup>**

---

<sup>1</sup>Assistant Professor, Lakshmbai National Institute of Physical Education, Gwalior.<sup>2</sup>Professor (retired), Lakshmbai National Institute of Physical Education, Gwalior.

Article Received: 4 February 2026, Article Revised: 24 February 2026, Published on: 17 March 2026

**\*Corresponding Author: Dr Payel Das**

Assistant Professor, Lakshmbai National Institute of Physical Education, Gwalior.

DOI: <https://doi-doi.org/101555/ijarp.4633>**ABSTRACT**

The present study investigated the temporal effects of passive meditation techniques on selected physiological and neurophysiological variables among team sport athletes. Thirty-six university-level female athletes (age: 21–25 years) from team sports were selected using stratified random sampling and randomly assigned into four groups: breathing meditation, mantra chanting meditation, visualization meditation, and a control group (n = 9 each). The intervention was conducted for 12 weeks, five days per week, with practice duration gradually increasing from 5 to 35 minutes. Resting heart rate (RHR), resting respiratory rate (RRR), systolic blood pressure (SBP), and alpha brain wave activity were measured at baseline, after 6 weeks, and after 12 weeks. A two-way mixed repeated measures ANOVA was applied to examine the interaction effect of time and meditation technique. The results revealed a significant Time × Group interaction for RHR, RRR, SBP, and alpha brain waves ( $p < .05$ ). Breathing and visualization meditation groups showed significant reductions in RHR, RRR, and SBP and a significant increase in alpha brain wave activity over the 12-week period, whereas the mantra meditation group demonstrated gradual improvements mainly after prolonged practice. The findings suggest that passive meditation techniques, particularly breathing and visualization meditation, are effective in enhancing cardiorespiratory efficiency and promoting neurophysiological relaxation among athletes. These practices may serve as beneficial complementary strategies for improving physiological recovery and mental regulation in sports performance.

**KEYWORDS:** Passive meditation, physiological responses, alpha brain waves, breathing meditation, visualization meditation, athletes.

**INTRODUCTION:**

Modern competitive sport requires athletes to maintain optimal physical and psychological readiness. High competitive pressure often leads to anxiety and heightened physiological arousal, including increased heart rate, respiratory rate, and blood pressure, which may negatively influence concentration and performance (Rainer Martens et al., 1990).

Meditation is widely recognized as an effective mind–body practice that promotes psychological stability and physiological regulation. It modulates the autonomic nervous system by reducing sympathetic activity and enhancing parasympathetic dominance, resulting in decreased physiological stress indicators and improved relaxation responses (Herbert Benson, 2000). Meditation is also associated with neurophysiological changes, particularly increased alpha brain wave activity, which reflects improved relaxation and attentional regulation (Antoine Lutz et al., 2008).

However, limited research has examined the comparative effects of different passive meditation techniques across time in athletes, particularly regarding the interaction effect of time and meditation training on physiological and neurophysiological variables. Therefore, the present study investigates the temporal effects of passive meditation techniques on physiological and neurophysiological responses among team sport athletes.

**METHODS AND MATERIALS:**

For the purpose of the study, thirty-six (36) female athletes of University level from Gwalior District were selected from the selected team games aged ranged from 21-25 with mean and SD  $22 \pm 3.4$ . The subjects were selected using a stratified random sampling followed by randomly placed in equal number among four groups (3 training groups and 1 control group) nine in each group. The randomly assigned treatment was given to them.

The subjects were tested on resting heart rate, resting respiratory rate, systolic blood pressure and alpha brain wave with the help of polar FT heart rate monitor, digital sphygmomanometer, Medicaid Bio-feedback machine respectively. The resting respiratory rate was measured by observing the chest rise of inhalation of breath of the subjects. The subjects were tested repeatedly at initial stage before starting the training, after 6 weeks and after 12 weeks on selected variables simultaneously.

For the purpose of the study four different kinds of passive meditation techniques as training programmes (including control group) were given to the athletes selected from different sports. The following training programmes on passive meditation techniques were intervened according to the ‘Hindu Traditional Meditation Protocol’ as per Bihar School of Yoga, Munger, Bihar by Swami Satyananda Saraswati. Different passive meditation intervention including Guided Meditation on Mantra Chanting of ‘Gayatri Mantra’, guided meditation on breathing and guided meditation on mantra chanting were given to the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> group respectively. The 4<sup>th</sup> group was given no intervention as control group. The training interventions were given 5 days a week starting from 5 minutes and gradually increased upto 35 minutes for 12 weeks. Two-way mixed repeated measure design was employed to analyze the interaction effect of time and treatment on selected variables at 0.05.

**RESULTS:**

The tables on descriptive statistics, F table of interaction and pair-wise comparison among different time period at each level of passive meditation intervention are shown in the table below with description:

**Table 1. Interaction Effect of Time × Meditation Technique on Study Variables. (Repeated Measures ANOVA)**

Variable	Effect	F (df)	p	Partial η <sup>2</sup>
RHR	Time × Group	6.50 (4.71)	< .001	.351
RRR	Time × Group	13.96 (5.81)	< .001	.567
SBP	Time × Technique	5.54 (4.74)	< .001	.342
Alpha Wave	Time × Group	3.87 (4.88)	< .003	.266

RHR = Resting Heart Rate; RRR = Respiratory Rate; SBP = Systolic Blood Pressure. Greenhouse–Geisser (GG) corrected degrees of freedom are reported due to violation of sphericity. Partial η<sup>2</sup> represents effect size.

The interaction effect of Time × Meditation Group/Technique was also significant for RHR  $F(4.71) = 6.50, p < .001$ , RRR  $F(5.81) = 13.96, p < .001$ , SBP  $F(4.74) = 5.54, p < .001$ , and Alpha Waves  $F(4.88) = 3.87, p = .005$ .

**Table 2. Descriptive Statistics (Mean ± SD) of Study Variables Across Time and Meditation Groups.**

Variable	Time	Breathing (n=9)	Mantra(n=9)	Visualization (n=9)	Control (n=9)
RHR (bpm)	0 week	66.30 ± 3.59	68.70 ± 2.00	67.20 ± 3.39	65.70 ± 3.92
	6 Weeks	62.70 ± 3.92	65.10 ± 4.68	63.60 ± 2.95	64.70 ± 3.68
	12 Weeks	60.30 ± 4.24	62.40 ± 4.43	60.20 ± 2.82	64.60 ± 3.92
RR (breaths/min)	0 week	14.55 ± 1.33	15.11 ± 1.05	14.67 ± 1.22	14.45 ± 1.33
	6 Weeks	10.11 ± 1.36	12.11 ± 1.54	11.56 ± 1.33	14.05 ± 1.13
	12 Weeks	8.22 ± 1.09	10.11 ± 1.69	9.89 ± 1.36	13.96 ± 1.12
SBP (mmHg)	0 week	110.00 ± 4.95	109.33 ± 7.89	109.33 ± 6.52	106.00 ± 6.82
	6 Weeks	103.89 ± 5.69	102.22 ± 9.01	104.00 ± 7.51	106.67 ± 6.00
	12 Weeks	99.67 ± 5.74	96.44 ± 8.73	100.55 ± 6.84	105.33 ± 7.58
ABW (µV)	0 week	27.89 ± 12.80	25.67 ± 13.29	26.44 ± 13.38	26.89 ± 11.97
	6 Weeks	39.11 ± 9.89	35.22 ± 10.91	36.11 ± 10.84	28.11 ± 10.75
	12 Weeks	50.11 ± 8.33	42.22 ± 10.12	47.33 ± 12.08	30.22 ± 9.65

Table 2. presents the descriptive statistics (Mean ± SD) of Resting Heart Rate, Respiratory Rate, Systolic Blood Pressure, and Alpha Brain Wave across three time points (initial, 6 weeks, and 12 weeks) for the breathing, mantra, visualization, and control groups. The results indicate that the meditation groups showed gradual reductions in resting heart rate, respiratory rate, and systolic blood pressure over time, whereas the control group showed minimal change. In contrast, alpha brain wave activity increased notably in the meditation groups, particularly in the breathing and visualization groups, while only a slight increase was observed in the control group.

**Table 3. Bonferroni Post-Hoc Pairwise Comparisons of Time Effect within Meditation Groups.**

Variable	Group	F -value	sig	0–6 Weeks Mean Diff.	P	0–12 Weeks Mean Diff.	P
RHR	Mantra	14.715	.003*	3.60	.108	6.30	< .001
	Breathing	133.826	.000*	3.60	< .001	6.00	< .001
	Visualization	43.304	.000*	3.60	< .001	7.00	< .001
RRR	Breathing	116.773	.000	4.44	< .001	6.33	< .001
	Mantra	72.000	.000	3.00	.021	5.00	< .001
	Visualization	113.188	.000	3.11	<.001	4.78	< .001
SBP	Breathing	46.934	.000*	6.11	.003	10.33	< .001
	Mantra	10.773	.001*	7.11	.031	12.89	.013
	Visualization	36.144	.000*	5.33	.007	8.78	< .001
ABP	Breathing	59.320	.000*	-11.22	.001	-22.22	< .001
	Mantra	8.164	.004*	-9.56	.044	-16.56	.018
	Visualization	16.067	.000*	-9.67	.016	-20.89	.008

Table 3. presents the Bonferroni post-hoc pairwise comparisons of time effects within each meditation group for RHR, RRR, SBP, and Alpha brain waves. The results indicate that breathing and visualization meditation groups showed significant improvements from baseline to 6 weeks and 12 weeks in most physiological variables. Resting heart rate, respiratory rate, and systolic blood pressure decreased significantly over time, while alpha brain wave activity increased significantly, particularly in the breathing and visualization groups. The mantra meditation group also showed improvement, though some changes were comparatively smaller. Overall, the findings demonstrate that meditation interventions produced significant physiological relaxation and enhanced alpha brain wave activity over the 12-week period.

**DISCUSSION:**

The results indicated that resting heart rate (RHR), resting respiratory rate (RRR), and systolic blood pressure (SBP) significantly decreased from baseline to 6 weeks and further to 12 weeks in the breathing meditation and visualization meditation groups. These reductions may be attributed to the progressive increase in practice duration, which enhanced relaxation and shifted autonomic balance toward parasympathetic dominance. This shift reduces metabolic activity, oxygen consumption, and sympathetic activation, leading to lower cardiovascular and respiratory responses. Slow and deep breathing increases tidal volume and

stimulates lung stretch receptors, activating the Hering–Breuer reflex, which helps reduce respiratory rate and improve baroreflex sensitivity (Berg & Orshan, 1977; Bernardi et al., 1998; Kamkin et al., 2005). Additionally, improved peripheral blood flow and reduced vascular resistance during meditation contribute to decreased systolic blood pressure and better physiological recovery (Stephanie, 2004).

In the mantra chanting meditation group, significant reductions in RHR, RRR, and SBP were mainly observed after 12 weeks of practice. Rhythmic chanting of the Gayatri Mantra may gradually regulate breathing patterns and neural oscillations, promoting parasympathetic activation and relaxation. However, initial stages of mantra practice may involve greater cognitive effort due to attention on pronunciation and rhythmic recitation, which may delay early physiological adaptations (Thomas & Rao, 2016).

Regarding neurophysiological responses, alpha brain wave activity increased significantly in the breathing and visualization meditation groups, reflecting enhanced relaxation, attentional regulation, and reduced neural excitation. Meditation combined with slow breathing improves cerebral blood flow and decreases oxygen utilization, facilitating dominant alpha rhythms associated with mental calmness (Cahn & Polich, 2006; Foxe & Snyder, 2011; Felix & Hamuni, 2015). In contrast, no significant increase in alpha waves was observed in the mantra meditation group, possibly due to increased cognitive and auditory processing during chanting, which is often associated with higher beta and gamma wave activity (Dudeja, 2017; Brain Sci., 2020).

Overall, the findings suggest that breathing and visualization meditation techniques produce stronger physiological and neurophysiological relaxation responses over time compared with mantra meditation.

## **CONCLUSION:**

The present study examined the comparative effects of different passive meditation techniques on physiological and neurophysiological variables across multiple time periods among university-level female athletes. The findings revealed that breathing meditation and visualization meditation produced significant reductions in resting heart rate, resting respiratory rate, and systolic blood pressure from baseline to 12 weeks, indicating improved autonomic regulation and enhanced relaxation responses. These techniques were also associated with a significant increase in alpha brain wave activity, suggesting improved mental calmness and attentional control. In contrast, mantra chanting meditation demonstrated gradual physiological improvements, with significant changes mainly observed

after prolonged practice. Overall, the results indicate that passive meditation practices, particularly breathing and visualization techniques, are effective interventions for improving cardiorespiratory efficiency and promoting neurophysiological relaxation in athletes. These findings highlight the potential role of meditation-based interventions as supportive training strategies for enhancing physiological recovery and mental regulation in sports performance contexts.

## REFERENCES

1. Adhana, R.; Agarwal, M. et.al. (2017). Effect of Slow Breathing Training on Heart Rate, Spontaneous Respiratory Rate and Pattern of Breathing. *PMCID: PMC5709795*. 13(4): 298–309. doi: 10.1183/20734735.009817.
2. Bernardi L, Spadacini G, Bellwon J, Hajric R, Roskamm H, Frey AW. (1998). Effect of Breathing Rate on Oxygen Saturation and Exercise Performance in Chronic Heart Failure. *Journal of Hypertension*. 22(11):1308–1311.
3. Bernardi, L, Porta C, Spicuzza, L. (2002). Slow Breathing Increases Arterial Baroreflex Sensitivity in Patients with Chronic Heart Failure. *Circulation*. 105 (2):143-5.
4. Bhattacharya, S.; Pandey, U.S; Verma, N.S. (2002). Improvement in oxidative status with yogic breathing in young healthy males. *Indian Journal of Physiological Pharmacological*. 46:349–54.
5. Brown, R.P, Gerbarg, P.L. (2005). Sudarshan Kriya Yogic breathing in the Treatment of Stress, Anxiety, and Depression: Part II-Clinical Applications and Guidelines. *Journal of Alternate Complement Medicine*. 11(4):711-7.
6. Eckberg DL, Eckberg MJ. (1982). Human sinus node responses to repetitive, ramped carotid baroreceptor stimuli. *American Journal of Physiology*. 242(4):638-44.
7. Filaire, E., Alix, D., Rouveix, M., & Le Scanff, C. (2007). Motivation, Stress, Anxiety, and Cortisol Responses in Elite Paragliders. *Perceptual and Motor Skills*. 104:1271-1281.
8. Filaire, E., Sagnol, M., Ferrand, C, Maso, F. et.al. (2001). Psychophysiological Stress in Judo Athletes during Competitions. *Journal of Sports Medicine and Physical Fitness*. 41:263-268.
9. Grossman P, Taylor EW. (2007). Towards understanding respiratory sinus arrhythmia: relations to cardiac vagal tone, evolution and bio behavioral functions. *Bio-Psychological Journal*. 74(2):263-85.

10. Hanaan, B. C.; Jacquelyne, P.; and Rebecca J. Compton. (2016). Mindfulness-Of-Breathing Exercise Modulates EEG Alpha Activity during Cognitive Performance. *Wiley Periodicals, Society for Psychophysiological Research*. DOI: 10.1111/psyp.12678
11. Haneishi, K., Fry, A. C, Moore, C. A., Schilling, et.al. (2007). Cortisol and Stress Responses during A Game and Practice in Female Collegiate Soccer Players. *Journal of Strength and Conditioning Research*. 21:583-588.
12. James H.; Fitzpatrick, J.; David D. Gilboe, et.al. (1976). Relationship of Cerebral Oxygen Uptake to EEG Frequency in Isolated Canine Brain. *American Journal of Physiology*. Vol. 231(6).
13. Joseph, C.N; Porta, C; Casucci, G. (2005). Slow Breathing Improves Arterial Baroreflex Sensitivity and Decreases Blood Pressure in Essential Hypertension. 46(4):714-8.
14. Joshi, L.N, Joshi, V.D, Gokhale, L.V. (1992). Effect of Short Term 'Pranayama' Practice on Breathing Rate and Ventilatory Functions of Lung. *Indian Journal of Physiological Pharmacology*. 36:05–108.
15. Kamkin, A. et al. (2005). Electrical Interaction of Mechanosensitive fibroblasts and Myocytes in The Heart. *Basic Respiratory Cardiology*; 100(4):337–45.
16. Knyazev, Gennady G. (2007). Motivation, emotion, and their inhibitory control mirrored in brain oscillations. *Neuroscience and Bio behavioral Reviews*. 31(3):377-395. 10.1016/j.neubiorev.2006.10.004.
17. Lagopoulos, Jim; Xu, Jian, et.al. (2009). Increased theta and alpha EEG activity during nondirective meditation. *Journal of Alternative and Complementary Medicine*. 15(11):1187-1192. 10.1089/acm.2009.0113.
18. Mohsen, D.; Behrooz, B. et.al. (2015). Effects of Increase in Amplitude of Occipital Alpha & Theta Brain Waves on Global Functioning Level of Patients with GAD. *Basic and clinical neuroscience*. 6(1):
19. Oneda, B., Ortega, K.C., Gusmão, J.L. (2010). Sympathetic Nerve Activity is decreased during Device-Guided Slow Breathing. *Hypertension Respiratory*. 33(7):70812.
20. Rafał M.; Katerina S. et.al. (2014). Effect of Meditation on Cognitive Functions in Context of Aging and Neurodegenerative Diseases. *Frontiers in Behavioral Neuroscience*. 8(17). DOI: 10.3389/fnbeh.2014.00017.
21. Rahman, F.; Pechnik, S.; et.al. (2011). Low Frequency Power of Heart Rate Variability Reflects Baroreflex Function, Not Cardiac Sympathetic Innervation. *Clinical Autonomous Respiratory*. 21(3):133-41.

22. Raupach, T, Bahr F, Herrmann P. (2008). Slow Breathing Reduces Sympatho-Excitation in COPD. *The European Respiratory Journal*. 32(2):387-92.
23. Sahib S. Khalsa, David Rudrauf et.al. (2015). The effect of meditation on regulation of internal body states. *PMCID* 6: 924. doi: 10.3389/fpsyg.2015.00924.
24. Stephanie, W.S; Louie, Tai Po, et.al. (2004). The effects of guided imagery relaxation in people with COPD. *Occupational Therapy International*, 11(3):145-159.
25. Susan, T., shobini I. Rao, (2016). Effect of Gayetri Mantra Meditation on Meditation Naïve Subjects. An EEG and F-MRI Pilot Study. *International Journal of Indian Psychology*. 3(2):14-19.
26. Tang, Y., Ma, Y., Wang, J., Feng, S., Yu, Q., Rothbart, M. K., et al. (2007). Short-Term Meditation Training Improves Attention and Self-Regulation. *PNAS Proceedings of the National Academy of Sciences of the United States of America*. 104:17152–17156.
27. Tetsuya, T.; Tetsuhito, M.; et.al. (2004). Changes in EEG and autonomic nervous activity during meditation and their association with personality traits.