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Twelve-Week MSRT Effects on Heart Rate, Blood Pressure and Sleep Quality in Injured National Athletes

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Abstract

Purpose. Athletic injuries often lead to both physiological and psychological impairments, necessitating holistic rehabilitation strategies. Mind Sound Resonance Technique (MSRT), is a yoga-based meditative technique, that has shown promise in enhancing autonomic regulation and psychological resilience. However, its impact on cardiovascular health and sleep quality in injured athletes remains unexamined. This study aimed to examine the effects of a 12-week MSRT intervention on heart rate, blood pressure, and sleep quality in national-level injured athletes.

Material & Methods. A randomized controlled trial was conducted with 36 injured athletes (aged 18-25 years) assigned to either a Yoga Practice Group (YPG) and a Control Group (CG). The YPG underwent supervised MSRT sessions for 12 weeks, while the CG followed their standard rehabilitation routine. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and sleep quality (SQ) were assessed at baseline, 4th, 8th, and 12th weeks using validated instruments, including the Pittsburgh Sleep Quality Index (PSQI). Data were analyzed using Repeated Measures ANOVA.

Results. Significant time × group interaction effects were observed in HR ($F=87.44$, $p<0.001$, $\eta^2p=0.72$), SBP ($F=42.06$, $p<0.001$, $\eta^2p=0.55$), DBP ($F=48.76$, $p<0.001$, $\eta^2p=0.58$), and SQ ($F=71.31$, $p<0.001$, $\eta^2p=0.67$). The YPG exhibited a notable decrease in HR (62.88±1.49 bpm to 55.44±1.46 bpm), SBP (124.27±1.48 mmHg to 120.61±0.69 mmHg), and DBP (84.11±0.75 mmHg to 80.55±0.61 mmHg). Sleep quality improved significantly (PSQI: 17.27±0.89 to 11.44±1.04, $p<0.001$), whereas the CG showed minimal changes.

Conclusions. The findings suggest that MSRT is an effective adjunct to conventional rehabilitation, promoting cardiovascular recovery and sleep enhancement in injured athletes. Future studies should explore the sustained effects of MSRT benefits over time and its relevance to various injury profiles.

Keywords: Mind Sound Resonance Technique, Sports Rehabilitation, Cardiovascular Health, Sleep Quality, Injured Athletes.

Introduction

Athletic injuries pose significant challenges to elite athletes, often leading to both physical and psychological distress that can impact their recovery trajectory and overall well-being (Reardon et al., 2019). While traditional rehabilitation protocols mainly emphasize physical recovery, there is growing recognition of the need for comprehensive approaches that address both the physiological and psychological aspects of injury healing (Al-Worafi, 2025; Chatterton & Brewer, 2020; Schwab Reese et al., 2012). Mind Sound Resonance Technique (MSRT) is a holistic intervention rooted in yoga, and has gained recognition as a valuable complementary method in therapeutic applications. MSRT combines the elements of mindfulness, sound vibrations, and relaxation techniques to create a comprehensive healing environment (Anusuya et al., 2021). The technique involves the use of specific sound frequencies and mantras that resonate with different body parts, potentially influencing the autonomic nervous system and various physiological parameters (Wang et al., 2018). Recent neuroimaging studies have demonstrated that sound-based meditation techniques like MSRT can modulate neural networks associated with stress response and autonomic regulation (Afonso et al., 2020).

Previous studies have demonstrated the efficacy of MSRT in various contexts. Research by Peabody et al. (2023) showed significant improvements in heart rate variability and stress reduction among healthcare professionals after a 10-week MSRT intervention (Peabody et al., 2023). Positive outcomes in sleep architecture and cardiovascular parameters have been reported among individuals with chronic stress conditions (Rao et al., 2017). A systematic review by Han et al. (2023) analysing mind-body interventions found promising evidence for sound-based therapies in reducing anxiety and improving sleep quality (Han et al., 2023). However, these studies primarily focused on non-athletic populations, creating a notable research gap in understanding MSRT's effects on injured athletes. The few studies that have investigated sound-based therapies in sports rehabilitation (Yoon & Song, 2018) have typically employed shorter intervention periods (4-6 weeks) and lacked comprehensive physiological monitoring (Yoon et al., 2018). A recent meta-analysis highlighted the need for longer-duration studies examining the effects of complementary therapies on athletic recovery (Ye et al., 2024).

The novelty of the current study lies in its focused examination of MSRT's effects on national-level injured athletes over an extended twelve-week period. This study focuses on assessing key physiological indicators (blood pressure and heart rate) along with sleep quality, offering a more holistic insight into MSRT's effects on athletic recovery (Vinaya et al., 2024). The extended intervention period of twelve weeks, compared to shorter durations in previous studies, allows for more thorough evaluation of this technique's longitudinal effects (Lin et al., 2024; Pomportes et al., 2017). This study primarily seeks to quantitatively assess the impact of a twelve-week MSRT intervention on blood pressure, heart rate, and sleep quality in national-level injured athletes. By offering evidence-based insights, this research aims to fill the existing knowledge gap regarding the effectiveness of MSRT as a complementary rehabilitation strategy for elite athletes recovering from injuries. With recent studies highlighting the crucial role of sleep quality in athletic recovery, this parameter holds particular significance for investigation (Harinath et al., 2004). By examining these factors, this study aims to enhance the expanding body of research advocating for integrative methods in sports rehabilitation and may help shape more holistic recovery strategies for injured athletes (Metri et al., 2020). The findings may have significant implications for sports medicine practitioners and athletic trainers working with elite athletes during their recovery period.

Material and methods

Participants

A total of 36 national level athletes from football, basketball, volleyball, handball, and lawn tennis, who had sustained injuries and routinely attended a local community hall in Gwalior (India) for rehabilitation training, voluntarily took part in the study. G*Power software (version 3.1.9.4, University of Kiel, Germany) was utilized for a priori power analysis to establish the required sample size prior to participant recruitment. This analysis employed an effect size of 0.46, an alpha error probability of 0.05, and a statistical power of 0.95, in accordance with the method described by Kang (Kang, 2021). To offset participant attrition, the study's sample was first deemed to consist of 54 people; but, finally 36 athletes were shortlisted for the research. Every athlete has 6 to 10 years of playing experience. Among the 36 athletes participated in the study, where 5 athletes were diagnosed with Rotator Cuff Tendinopathy, 6 with Biceps Tendinopathy, 3 with Lateral Epicondylitis, 2 with Medial Epicondylitis, 6 with Olecranon Bursitis, 8 with Carpal Tunnel Syndrome, 4 with Achilles Tendinopathy, and 2 with Peroneal Tendinitis. All the participants' age ranged from 18 to 25. After thoroughly evaluating the study's objectives, potential benefits, risks, and long-term effects, the participants gave their signed consent. The research was conducted in compliance with the Helenski Declaration (World Medical Association, 2013).

Table 1. **Demographic Characteristics of Participants in the YPG and CG**

Measures	YPG	CG	*p* value
Age (Yrs)	22.11±1.53	21.88±1.36	*0.64*
Weight (kg)	77.66±3.66	76.88±3.46	*0.51*
Height (cm)	1.71±0.07	1.71±0.06	*0.96*
Experience	7.27±1.52	7.19± 1.04	*0.80*

YPG; Yoga Practice Group, CG; Control Group

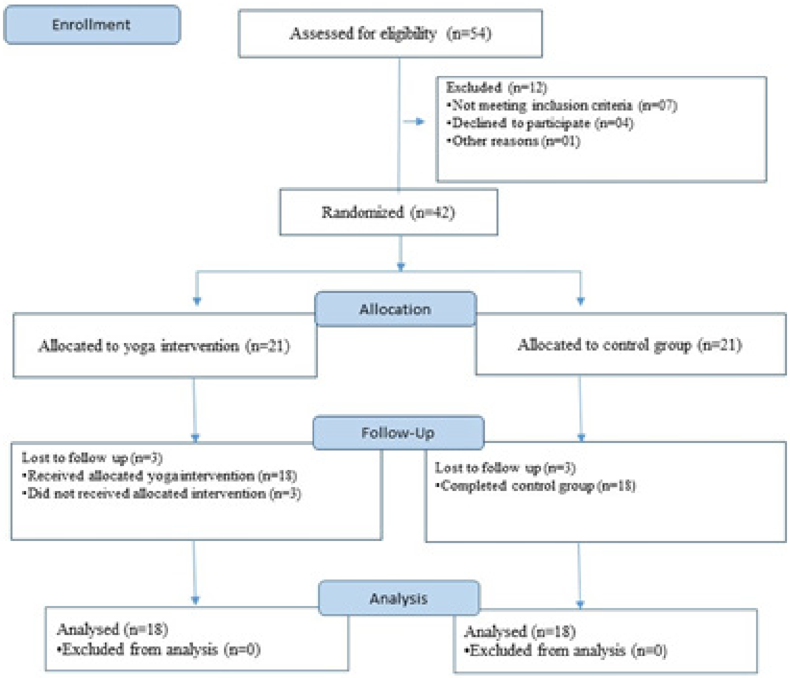

Figure 1. **Flow Diagram Based on CONSORT Guidelines Depicting Participant Enrollment, Allocation, Follow-Up, and Analysis**

Criteria for Inclusion and exclusion

Procedure

The study utilized an experimental framework featuring a two-group pre-test and post-test setup. Participants underwent assessments at four intervals: prior to the intervention, at the four-week mark, at the eight-week mark, and upon completion of the twelve-week MSRT program, conducted from December 9, 2023, to March 2, 2024. To ensure the exclusive influence of the MSRT program, participants were instructed to avoid any additional physical interventions. The study consisted of two groups: the Yoga Practice Group, referred to as the Yoga Practice Group (YPG), and the Control Group (CG). The baseline pre-test was administered within three days before the training program began. Subsequent data collection took place at consistent intervals: after four weeks of the MSRT program, at the eight-week mark, and finally at the twelve-week point. Post-tests were administered within three days following the completion of each respective interval to evaluate the effects of the intervention over time. The Omron HEM-7120, a fully automated digital blood pressure monitor, was used to measure systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) (Wang et al., 2020). The Omron HEM-7120 serves as a reliable and precise instrument for measuring both blood pressure and heart rate (P. Zhang et al., 2021). The Pittsburgh Sleep Quality Index (PSQI) evaluated sleep quality at two points: before and right after each intervention (Buysse et al., 2008). The tool obtained wide endorsement from researchers because it shows excellent reliability together with validity and sensitivity when measuring sleep patterns. Research evidence shows that the overall scores of this instrument demonstrate strong internal consistency because the Cronbach's alpha meets 0.78 (C. Zhang et al., 2020).

The YPG in this study received the yoga practice intervention from the study participants with great attention and skill. A certified professional with qualifications as a doctor of naturopathy and yoga was given the duty of teaching the yoga poses following predetermined, standardized protocols. The participants received a brief introduction outlining the basic principles of the yoga routine prior to starting the practice. The attendees were advised to start a daily practice regimen after this introduction. This structured training routine was designed to last 30 minutes per day Table 2 and be implemented over a 12-week period. Crucially, this practice's window of time was set between 6:25 to 7:00 a.m., and participants had to work out during these times without eating 5 days a week. This period of time was selected in accordance with accepted yoga practice guidelines. A certified yoga and naturopathy physician served as a dedicated supervisor to ensure the consistency and accuracy of the practice sessions. These guided sessions were conducted over a 12-week period, utilizing a detailed checklist booklet as a tool to maintain consistency and adherence to the prescribed yoga practices. Furthermore, a rigorous exclusion criterion was enforced. The necessity of sticking to the yoga routine was high-

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Table 2. Detailed Protocol of MSRT Yoga Intervention Practiced by Participants

Steps of MSRT Practice	Duration
1. Prayer "Om Tryambakamyajamahesugandhim Pustivardhanam, Urvarukamivabandhanat Mrtyomuksiyamamrtat Om SantihSantihSantih".	1 Minute
2. Quick relaxation technique – Internally focus on abdominal breathing with closed eyes.	3 Minutes
3. A) Loud chanting of A, U, M and AUM (3 rounds). Feel complete body resonance. B) Ahata – Anahata of A, U, M and AUM next time A, U, M – AUM (3 rounds). Experience the resonance even during the Anahata (mental) phase.	26 Minutes
4. A) Loud chanting of Mrtyunjaya Mantra (MM) Om Tryambakamyajamahesugandhim Pustivardhanam, Urvarukamivabandhanat Mrtyomuksiyamamrtat Om SantihSantihSantih. (3 rounds) Sense the pattern of resonant waves flowing through your body. B) Ahata – Anahata of Mrtyunjaya Mantra MM-, MM-, MM (3 rounds) Experience the rhythmic flow of resonance waves, even during the Anahata phase.	
5. Anahata AUM (9 rounds) Mentally chant AUM while sensing its resonant vibrations flowing through the body.	
6. Ajapajapa AUM to SILENCE (9 rounds). Experience the resonant waves of OM rising, spreading throughout the body, and gently dissolving into silence (9 rounds)	
7. maintain SILENCE	
8. RESOLVE	
9. Prayer "SarvebhavantuSukhinah SarveSantuniramayah Sarve Bhandari Pasyanthu Ma KascitdukhaBhagbhavet Om SantihSantihSantih".	

lighted by the exclusion from the final analysis of those who did not practice for more than 12 days throughout the trial. Participants in the CG followed only their standard rehabilitation routines without any additional interventions. They continued with their standard recovery practices without structured relaxation techniques such as yoga, meditation, or guided breathing (Cook & Champion, 2025). To ensure adherence, CG participants were required to report biweekly on their daily activities. This method guaranteed that any observed effects were due to the MSRT intervention rather than external influences. A placebo-controlled intervention was not included due to practical constraints and the study's focus on evaluating MSRT in real-world rehabilitation settings.

Statistical analysis

Statistical analysis was performed using IBM SPSS Version 26 (Tounaoua et al., 2025). Descriptive statistics, such as mean and standard deviation, were computed for all pre-test and post-test assessments in both the experimental and control groups. To examine changes over time (at the 4th, 8th, and 12th weeks) and differences between groups, Repeated Measures ANOVA was utilized. This analysis assessed both the main effects of time and the interaction effects between time and group (Time*Groups). Before conducting the analysis, assumptions for Repeated Measures ANOVA, such as sphericity and normality, were evaluated. A significance threshold of $p<0.05$ was used for all analyses, while partial eta-squared (η^2p) was calculated to assess the magnitude of the observed effects (Cohen, 1988). Pairwise comparisons with Bonferroni adjustments were performed to examine significant differences between specific time points (Pre, 4th

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week, 8th week, and 12th week).

Results

Table 3 presents the pre- and post-intervention mean values with standard deviations (SD) for Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, and Sleep Quality in both the Control and Yoga Practice Groups. For Heart Rate, the Control Group showed no change, maintaining a consistent value of 63.66±1.49 pre-intervention and 63.66±1.08 post-intervention. In contrast, the Yoga Practice Group experienced a decrease from 62.88±1.49 pre-intervention to 55.44±1.46 post-intervention. Regarding Systolic Blood Pressure, the Control Group exhibited minimal variation, with values of 125.27±1.17 pre-intervention and 125.44±0.85 post-intervention. Meanwhile, the Yoga Practice Group showed a notable reduction, decreasing from 124.27±1.48 pre-intervention to 120.61±0.69 post-intervention. For Diastolic Blood Pressure, the Control Group remained relatively stable, with readings of 83.72±1.17 pre-intervention and 83.83±0.85 post-intervention. The Yoga Practice Group, however, experienced a slight decline, dropping from 84.11±0.75 pre-intervention to 80.55±0.61 post-intervention. Lastly, Sleep Quality improved in both groups. The Control Group's score decreased from 16.83±1.24 pre-intervention to 14.83±1.24 post-intervention, whereas the Yoga Practice Group showed a more substantial improvement, reducing from 17.27±0.89 pre-intervention to 11.44±1.04 post-intervention. Overall, the Yoga Practice Group demonstrated greater improvements across all measured parameters compared to the Control Group.

Table 4 presents results from a repeated measures ANOVA analysis on the effects of time and the interaction between time and groups (Time*Groups) on Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure, and Sleep Quality. For Heart Rate, the main effect of time was significant, with an F-value of 86.69 ($p<.001$), $\eta^2=0.21$, and partial eta-squared (η^2p)=0.71. The interaction effect (Time*Groups) was also significant, with an F-value of 87.44 ($p<.001$), $\eta^2=0.22$, and $\eta^2p=0.72$, indicating that changes in heart rate over time varied between groups. In Systolic Blood Pressure, the main effect of time showed an F-value of 38.16 ($p<.001$), with $\eta^2=0.13$ and $\eta^2p=0.52$. The Time*Groups interaction effect was also significant, with an F-value of 42.06 ($p<.001$), $\eta^2=0.15$, and $\eta^2p=0.55$, suggesting differential changes in systolic blood pressure between groups over time. For Diastolic Blood Pressure, the main effect of time yielded an F-value of 43.80 ($p<.001$), $\eta^2=0.23$, and $\eta^2p=0.56$. The interaction effect (Time*Groups) was significant as well, with an F-value of 48.76 ($p<.001$), $\eta^2=0.25$, and $\eta^2p=0.58$, indicating group-specific changes in diastolic blood pressure over time. In Sleep Quality, the main effect of time was highly significant, with an F-value of 295.80 ($p<.001$), $\eta^2=0.51$, and $\eta^2p=0.89$. The interaction effect showed a significant F-value of 71.31 ($p<.001$), $\eta^2=0.12$, and $\eta^2p=0.67$, sug-

Table 3. **Descriptive Statistics of Cardiovascular and Sleep Quality Parameters Pre and Post Intervention in Yoga Practice Groups and Control Groups**

Variables	Groups	Pre data	Post data	Δ (%)
HR	YPG	62.88±1.49	55.44±1.46	−11.83
	CG	63.66±1.49	63.66±1.08	00
SBP	YPG	124.27±1.48	120.61±0.69	−2.94
	CG	125.27±1.17	125.44±0.85	0.13
DBP	YPG	84.11±0.75	80.55±0.61	−4.23
	CG	83.72±1.17	83.83±0.85	0.13
SQ	YPG	17.27±0.89	11.44±1.04	−33.75
	CG	16.83±1.24	14.83±1.24	−11.88

HR: Heart Rate, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, SQ: Sleep Quality

Table 4. **Repeated Measures ANOVA Results for the Effects of Time and Time*Group Interaction on Cardiovascular and Sleep Quality Parameters**

Variables	Cases	SS	F	p	η^2	η^2p
HR	Time	321.24	86.69	< *0.001*	0.21	0.71
	Time*Groups	324.02	87.44	< *0.001*	0.22	0.72
SBP	Time	83.69	38.16	< *0.001*	0.13	0.52
	Time*Groups	92.25	42.06	< *0.001*	0.15	0.55
DBP	Time	69.38	43.80	< *0.001*	0.23	0.56
	Time*Groups	77.25	48.76	< *0.001*	0.25	0.58
SQ	Time	326.13	295.80	< *0.001*	0.51	0.89
	Time*Groups	78.63	71.31	< *0.001*	0.12	0.67

gesting that sleep quality changes over time differed between groups.

Table 5. **Pairwise Comparisons of Cardiovascular and Sleep Quality Parameters over Time in Repeated Measures ANOVA**

Variable	Time		MD	*p*
HR	Pre	4th	0.83	*0.560*
		8th	4.61	*< 0.001*
		12th	7.44	*< 0.001*
	4th	8th	3.77	*< 0.001*
		12th	6.61	*< 0.001*
	8th	12th	2.83	*< 0.001*
SBP	Pre	4th	0.38	*1.000*
		8th	2.83	*< 0.001*
		12th	3.66	*< 0.001*
	4th	8th	2.44	*< 0.001*
		12th	3.27	*< 0.001*
	8th	12th	0.83	*0.178*
DBP	Pre	4th	0.50	*0.321*
		8th	2.33	*< 0.001*
		12th	3.55	*< 0.001*
	4th	8th	1.83	*< 0.001*
		12th	3.05	*< 0.001*
	8th	12th	1.22	*< 0.001*
SQ	Pre	4th	1.22	*< 0.001*
		8th	3.55	*< 0.001*
		12th	5.83	*< 0.001*
	4th	8th	2.33	*< 0.001*
		12th	4.61	*< 0.001*
	8th	12th	2.27	*< 0.001*

Table 5 shows Bonferroni's post hoc analysis of the treatment group revealed significant improvements across all variables over time. For heart rate, there were significant differences observed between the pre and 8th week (mean difference = 4.61, *p<0.001*), pre and 12th week (mean difference = 7.44, *p<0.001*), and all subsequent comparisons (p<*0.001*), except between pre and 4th week (*p=0.560*). For systolic blood pressure, significant differences emerged from the 8th week onwards compared to pre-treatment and between all subsequent time points (*p<0.001*), except between the 8th and 12th week (*p=0.178*). Similarly, for diastolic blood pressure, significant changes occurred after the 8th week compared to pre-treatment (*p<0.001*), and all other intervals also showed significant differences (*p<0.001*), except between pre and 4th week (*p=0.321*). Sleep quality demonstrated consistent and significant improvements across all time points, including pre to 4th week (mean difference = 1.22, *p<0.001*), and each subsequent comparison (*p<0.001*). These findings indicate progressive physiological and sleep quality enhancements over the 12-week intervention period.

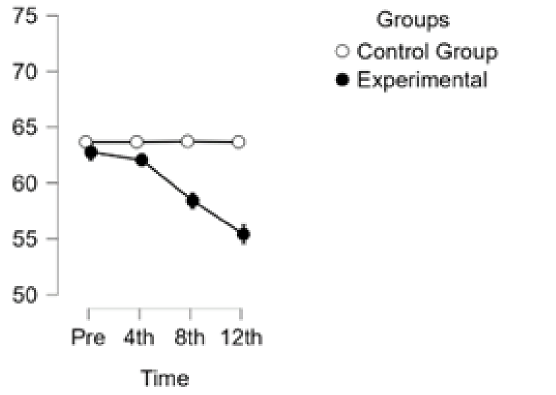

Figure 2. **Visual Depiction of Heart Rate Data**

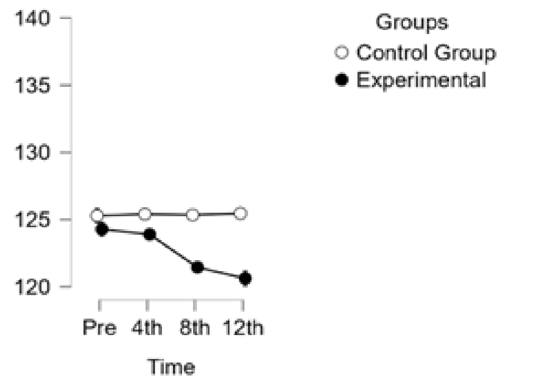

Figure 3. **Visual Depiction of Systolic Blood Pressure**

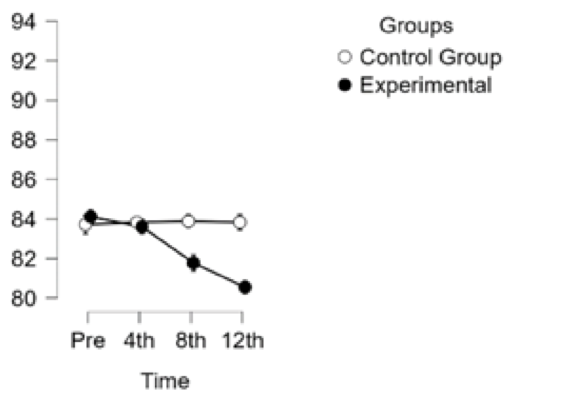

Figure 4. **Visual Depiction of Diastolic Blood Pressure**

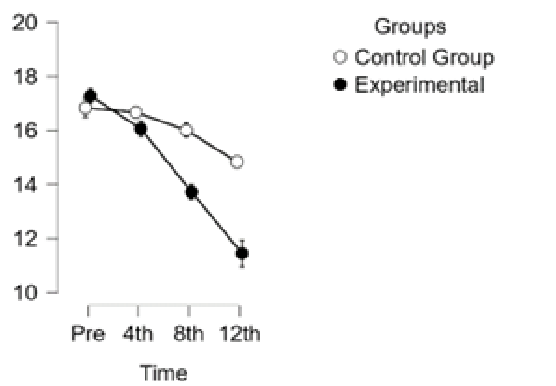

Figure 5. **Visual Depiction of Sleep Quality**

Discussion

The absence of significant improvement in heart rate within the control group throughout the study underscores the necessity of structured interventions in injury rehabilitation. Passive observation or reliance on standard treatment protocols without targeted therapeutic strategies typically fails to induce substantial physiological adaptations (Senthilnathan et al., 2019). In contrast, the Yoga Practice Group initially exhibited insignificant changes for the variable of heart rate between the pre-training phase and the fourth week, which can be attributed to the physiological adaptation period required for MSRT to manifest measurable effects. This foundational phase is critical in injury rehabilitation, as it allows athletes to gradually acclimate to the intervention while their neurophysiological and cardiovascular systems undergo initial adjustments (Trivedi et al., 2023). The significant improvements in the heart rate observed at the 8th and 12th weeks highlight the exclusive role of MSRT in fostering long-term cardiovascular benefits, particularly in injured athletes undergoing rehabilitation. Sustained practice of MSRT appears to enhance parasympathetic nervous system activity, contributing to improved heart rate variability and resting heart rate over time (Harinath et al., 2004). This delayed response aligns with the broader understanding that mind and body interventions like MSRT, yoga, and meditation elicit cumulative benefits through prolonged engagement, gradually reducing sympathetic dominance while enhancing vagal tone (Niva et al., 2021). From an injury prevention and rehabilitation perspective, these findings highlight the significance of incorporating MSRT into rehabilitation programs for injured athletes. The ability of MSRT to promote autonomic balance is particularly relevant for athletes experiencing heightened stress responses due to injury, which can negatively impact cardiovascular regulation and overall recovery efficiency. Injuries often trigger physiological and psychological stress, leading to increased sympathetic drive and prolonged recovery periods. By fostering a state of relaxation, MSRT mitigates these stressors, thereby supporting cardiovascular stability and facilitating a more efficient healing process (Goshvarpour & Goshvarpour, 2024). The pronounced improvements observed in the later phases of the intervention suggest that MSRT operates within a dose-response framework, where consistent and prolonged practice leads to more profound physiological benefits. This aligns with existing literature emphasizing the role of mindfulness-based techniques in modulating heart rate through mechanisms such as increased baroreceptor sensitivity and enhanced heart rate variability (Rajagopalan et al., 2023). Given that optimal recovery from injury requires both physical and psychological resilience, MSRT emerges as a valuable tool in injury rehabilitation programs, not only for cardiovascular regulation but also for overall stress management and recovery enhancement.

The Yoga Practice Group exhibited varied responses to the MSRT, demonstrating its potential as a valuable tool in injury prevention and rehabilitation. Notable improvements in systolic and diastolic blood pressure suggest that MSRT can contribute to cardiovascular stability, which is essential for athletes recovering from injuries. However, the absence of significant changes in blood pressure parameters between pre-training and the fourth week of intervention indicates that short-term application may be insufficient to induce immediate cardiovascular adaptations (Krishna et al., 2014). This aligns with existing research emphasizing the gradual physiological benefits of mindfulness-based interventions, particularly in enhancing autonomic regulation and promoting recovery (Anjana et al., 2022). From the eighth week onward, significant reductions in systolic blood pressure were observed, with post hoc analysis confirming that improvements stabilized between the eighth and twelfth weeks. This plateau effect suggests that MSRT supports cardiovascular adaptation over time, a crucial factor in injury rehabilitation where sustained recovery is necessary for long-term athletic performance (Bhavanani et al., 2011). The more pronounced improvements in diastolic blood pressure across different time points highlight the cumulative impact of MSRT, reinforcing its role in optimizing vascular function and reducing stress-induced cardiovascular strain. Given that injury recovery often involves heightened sympathetic activity and increased cardiovascular demand, the differential response of systolic and diastolic blood pressure suggests that MSRT could aid in modulating arterial stiffness and vascular resistance (Levine et al., 2017). These results emphasize the importance of MSRT as a drug-free approach to enhancing cardiovascular health in injured athletes. By promoting relaxation, improving autonomic balance, and supporting long-term hemodynamic stability, MSRT can serve as an effective adjunct in rehabilitation programs. Its integration into injury management strategies may not only accelerate recovery but also reduce the risk of secondary complications, ultimately facilitating a smoother transition back to peak athletic performance.

Over 12 weeks, the Yoga Practice Group showed notable enhancements in sleep quality, attributed to MSRT, a meditative approach that is vital for injury prevention and rehabilitation by improving psychophysiological parameters. In contrast, the control group, which lacked intervention, maintained their routines and experienced no improvements, reinforcing the importance of structured rehabilitation programs in addressing sleep disturbances that often hinder recovery. This aligns with research indicating that without targeted techniques, injured athletes frequently struggle with persistent sleep issues arising from stress, pain, and inflammation factors that can delay healing and increase the risk of re-injury (Behera et al., 2023). MSRT's progressive impact underscores its effectiveness as a rehabilitation tool for promoting better sleep quality, which is essential for physiological recovery and injury prevention. The overall impact of MSRT may be due to its ability to alleviate stress and enhance relaxation, which are essential factors in reducing secondary complications such as muscle tension, delayed tissue healing, and autonomic imbalance. By activating the parasympathetic nervous system and reducing excessive activation of the hypothalamic pituitary adrenal axis, both of which are associated with sleep disturbances and impaired recovery, MSRT plays a direct role in facilitating more effective healing in injured athletes (Vinaya et al., 2024). The gradual improvements observed at 4, 8, and 12 weeks align with the hypothesis that consistent meditative practices promote neuroplastic adaptations in the brain, enhancing activity in regions responsible for emotional regulation while reducing activity in areas associated with stress responses. These neurological changes play a crucial role in rehabilitation, as emotional distress and psychological strain can intensify injury-related challenges and delay the return to play process. Moreover, injured athletes frequently experience disrupted circadian rhythms due to physical inactivity and psychological distress, which can further delay recovery (Perry et al., 2022). The rhythmic nature of MSRT and its focus on resonance can aid in re-establishing these rhythms, thereby optimizing sleep quality and, by extension, promoting faster tissue repair and reducing the likelihood of secondary injuries. It is particularly noteworthy that the Yoga Practice Group likely benefited from improved autonomic regulation, a critical factor in injury rehabilitation. Similar interventions have demonstrated success in reducing sympathetic overdrive and enhancing heart rate variability, both essential for restoring homeostasis and facilitating tissue recovery following injury (Ghosh et al., 2024). By improving autonomic balance, MSRT can help injured athletes achieve a more restorative sleep cycle, ensuring that physiological repair mechanisms function optimally. The notable disparity between both groups highlights the importance of specialized interventions such as MSRT in both injury prevention and rehabilitation. Given that injured athletes face unique physiological and psychological barriers to recovery, incorporating meditative techniques into rehabilitation programs can address sleep disturbances, enhance cardiovascular function, and reduce overall stress, ultimately promoting a more efficient healing process (Pundir & Chauhan, 2023). These findings align with growing evidence supporting the role of chanting-based yogic practices in improving heart rate regulation, blood pressure stability, and sleep quality are the key components in injury recovery and long-term musculoskeletal health.

Conclusions

The 12-week MSRT intervention yielded significant improvements in cardiovascular parameters and sleep quality among injured national-level athletes, outperforming the control group. The results suggest that MSRT is a valuable complementary tool for sports rehabilitation, addressing both physiological recovery and psychological well-being. One limitation of the study is the absence of a placebo-controlled intervention, which could have further isolated the effects of MSRT from psychological expectancy effects. However, the study aimed to evaluate MSRT as a real-world rehabilitation tool, and resource constraints prevented the inclusion of an additional placebo condition. Future studies should consider using an active control group with a general relaxation technique to better differentiate the specific effects of MSRT. Future studies should investigate the long-term sustainability of these effects, explore MSRT's mechanisms through neuroimaging, and evaluate its application across different injury types and athletic disciplines. These findings underscore MSRT's potential to enhance recovery protocols and optimize athlete care.

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