

Advancing the Integration of Non-Invasive Methods for Post-Exercise Cardiac Autonomic Recovery: A Comprehensive Examination of Medical Validity, Physiological Significance, and Reproducibility

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Abstract

Assessing post-exercise cardiac autonomic recovery serves as a practical medical tool to gauge cardiovascular health. A diminished heart rate recovery, indicative of autonomic dysfunction, has been observed across a spectrum of cardiovascular conditions, correlating with heightened risks of cardiac and overall mortality. Consequently, in recent years, non-invasive methods for appraising cardiac autonomic recovery following exercise, based on either heart rate recovery or heart rate variability indices, have been proposed. However, for these techniques to be effectively integrated into routine clinical practice there is a need for more comprehensive discussions regarding their medical validity, physiological significance, mathematical formulations, and reproducibility.

Keywords: Exercise; Cardiovascular health; Mortality; Heart rate

Introduction

Hence, the purpose of this methodological overview is to present some of the most commonly utilized approaches for assessing post-exercise cardiac autonomic recovery in the literature and thoroughly discuss their strengths and weaknesses. Individuals with cardiovascular conditions often manifest autonomic dysfunction, including sympathetic activation and vagal withdrawal, leading to adverse outcomes. This evaluation aims to underscore the significance of sympathovagal balance as a crucial consideration in the management of cardiovascular disease patients undergoing cardiac rehabilitation. Numerous studies have demonstrated that exercise training, as a non-pharmacological intervention, plays a pivotal role in enhancing sympathovagal balance and can normalize levels of sympathetic activity markers measured through methods such as micron urography, heart rate variability, or plasma catecholamine levels [1,2].

Results and Discussion

This modification has a positive impact on the prognosis of cardiovascular disease. Generally, cardiac rehabilitation programs involve moderate-intensity and continuous aerobic exercise. Supplemental activities, such as high-intensity interval training, breathing exercises, relaxation techniques, and transcutaneous electrical stimulation, can enhance sympathovagal balance and should be integrated into cardiac rehabilitation programs. Presently, exercise training programs in cardiac rehabilitation are personalized to optimize fitness outcomes. The sports science concept of the heart rate variability (HRV)-vagal index, used to manage exercise sessions with a performance goal, should be implemented in cardiac rehabilitation to improve cardiovascular health and autonomic nervous system function [3].

Among workers, a worksite cardiovascular exercise intervention improved cardiac autonomic regulation during work and leisure but not during sleep. The health implications of this contrasting change in autonomic regulation require further investigation. Currently recognized as a complementary non-pharmacological intervention for preventing cardiac disorders, long-term aerobic training provides cardiovascular protection through remote ischemic preconditioning (RIPC) mechanisms. However, RIPC induced by acute exercise remains poorly understood.

Despite resistance exercise (RE) being widely recommended by several public health guidelines, there is no evidence indicating that RE mediates RIPC. Therefore, we explored whether RE induces cardiac RIPC through a nitric oxide synthase (NOS)-dependent mechanism. Exercise-based cardiac rehabilitation (CR) plays a crucial role in improving function and preventing mortality in cardiovascular disease (CVD) patients. Outpatient (Phase II and III) CR is nearly non-existent in India due to various reasons such as time constraints, cost, distance, education level, and resource scarcity. Cardiologists or cardiac surgeons can directly advise patients and their family members to engage in an optimal dose of exercise in low-resource settings, specifically in rural, low-income, or low-educated patient populations [4,5].

The talk check, a cost-free and subjective tool for exercise prescription, is gaining popularity in cardiac rehabilitation (CR) due to its simplicity. This concise overview provides insights into its background, administration, physiological mechanisms, reliability, validity, and safety among cardiac patients, while addressing the limitations of the 'talk test.' The review also explores the theoretical applications of the talk test in both primary and secondary prevention of cardiovascular disease (CVD) and advocates for its use as a self-monitoring tool for exercise intensity within the Indian CR community.

Cardiac rehabilitation for patients with heart failure has demonstrated improvements in functional capacity, exercise tolerance, and quality of life. It also reduces hospital admissions and may enhance long-term survival. Despite these documented benefits, the utilization of cardiac rehabilitation remains low, necessitating greater awareness, education, program development, and research [6].

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Received: 30-Nov-2023, Manuscript No: jnp-23-123105; **Editor assigned:** 02-Dec-2023, Pre-QC No: jnp-23-123105 (PQ); **Reviewed:** 16-Dec-2023, QC No: jnp-23-123105; **Revised:** 21-Dec-2023, Manuscript No: jnp-23-123105 (R); **Published:** 28-Dec-2023, DOI: 10.4172/2165-7025.1000654

Citation: Shah A (2023) Advancing the Integration of Non-Invasive Methods for Post-Exercise Cardiac Autonomic Recovery: A Comprehensive Examination of Medical Validity, Physiological Significance, and Reproducibility. J Nov Physiother 13: 654.

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The study delves into the impact of exercise on plasma Klotho and IGF-I, exploring their association with cardiac hypertrophy. The research involves non-athletes and athlete women undergoing acute and chronic exercise, revealing significant effects on left ventricular end-diastolic diameter index (LVEDDI), IGF-I, and Klotho levels. The findings suggest a stimulatory effect of exercise on plasma IGF-I and Klotho, with Klotho acting as a negative regulator for exercise-induced cardiac hypertrophy.

Cancer-induced cardiac cachexia, a syndrome affecting quality of life and survival, prompts the exploration of exercise training as a preventive or therapeutic tool. The review discusses current knowledge on cancer-induced cardiac cachexia, examining molecular pathways modulated by exercise training and suggesting potential avenues for future research in stem cell studies and cardiac regeneration [7,8]. While routine moderate-intensity physical activity offers cardiovascular benefits and reduces all-cause mortality, the impact of exercise doses exceeding current guidelines is not fully understood. The review addresses controversies related to high-dose exercise and cardiovascular morbidity and mortality, discussing research limitations, potential mechanisms mediating exercise-related cardiac injury, and highlighting gaps in knowledge for future studies.

Exercise training emerges as a potential therapeutic strategy to limit cancer-induced cardiac damage. An animal model study using an urothelial carcinoma model subjected to treadmill exercise shows promising results in reversing cancer-induced cardiomyocyte changes, enhancing cardiac oxidative potential, and promoting mitochondrial biogenesis. These adaptations are associated with a reduced incidence of malignant urothelial lesions and less inflammation [9].

For the secondary prevention of cardiovascular disease, habitual engagement in aerobic exercise is crucial. However, anxiety sensitivity, linked to anxiety and stress disorders, may hinder aerobic exercise participation in CR patients. The review emphasizes the importance of addressing anxiety sensitivity in CR programs to promote sustained physical activity. Cardiac autonomic neuropathy (CAN) in type two diabetes mellitus (T2DM) independently predicts all-cause and cardiovascular disease mortality. The study systematically reviews the effects of exercise training on cardiac autonomic function in T2DM patients, aiming to clarify whether exercise can improve autonomic control in this population [10].

Conclusion

A systematic search was conducted on electronic databases (MEDLINE, CENTRAL, PEDro, Scopus, and Web of Science) to

retrieve pertinent evidence. Eligible studies included clinical trials administering exercise training for a minimum of four weeks and assessing outcome measures such as heart rate variability (HRV), baroreflex sensitivity (BRS), and heart rate recovery (HRR). From the initial search, 18 articles were identified as relevant and were subsequently assessed for characteristics and quality. Among these, 15 studies reported that exercise training resulted in significant improvements in autonomic function among individuals with type 2 diabetes mellitus (T2DM). The findings suggest that engaging in exercise enhances cardiac autonomic function in individuals with type 2 diabetes and, therefore, should be integrated into their management programs.

Acknowledgement

None

Conflict of Interest

None

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