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RESEARCH ARTICLE

EFFECTS OF EXERCISE TRAINING ON THE AUTONOMIC NERVOUS SYSTEM IN HYPERTENSION: A COMPREHENSIVE REVIEW

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Abstract

Background: Cardiovascular diseases, significant health burdens globally, and conditions, including prevalent heart failure and hypertension, lead to increased hospitalizations, especially in the elderly, and account for substantial medical expenditures in developed nations. The emergence of hypertension as major global health challenges has intensified the focus on understanding and managing these conditions. Central to this endeavour is the exploration of the autonomic nervous system's role, particularly sympathetic nerve activity (SNA), in the pathophysiology of these diseases.Exercise training, a key non-pharmacological approach, has shown promise in mitigating these effects and reducing CVD risks, though the exact mechanisms remain under investigation.

Objectives: To evaluate the effects of exercise training on sympathetic nervous activity on hypertensive individuals

Method:A comprehensive review of observational, experimental, randomized control trial, cross-sectional studies were performed. SCOPUS, Google scholar, EBSCO and PubMed were searched using the terms exercise training, autonomic nervous activity, hypertension.

Result: A total of 426 studies were identified of which 13 studies were published between 2010-2023 and were included in the study. Out of 426 studies, 12 studies which were included in our study showed positive effects of exercise training on the autonomic nervous system on hypertensive individuals

Conclusion: This study concluded that there is significant relation between the exercise training and autonomic nervous system in hypertension.

Introduction:-

Cardiovascular diseases, significant health burdens globally, and conditions, including prevalent heart failure and hypertension, lead to increased hospitalizations, especially in the elderly, and account for substantial medical expenditures in developed nations [(1)]. Depending on whether one adopts a pathophysiological or clinical approach, there are various definitions for hypertension. Pathophysiological hypertension is characterised by persistently elevated blood pressure. In the context of medicine, hypertension is defined as a systolic pressure that is sustained above 150 mm Hg and a diastolic pressure that is sustained above 90 mm Hg. [(2)]

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The emergence of hypertension as a major global health challenge has intensified the focus on understanding and managing these conditions. Central to this endeavour is the exploration of the autonomic nervous system's role, particularly sympathetic nerve activity (SNA), in the pathophysiology of these diseases. [3]

The idea of "autonomic balance" originates from the well-known fact that both the sympathetic and parasympathetic nerve systems regulate the heart. While the parasympathetic nervous system is stimulated to lower heart rate, blood pressure, and contractility, the sympathetic nervous system is stimulated to raise heart rate, blood pressure, and myocardial inotropism. Heart rate, blood pressure, cardiac shape and function, and myocardium electrical stability are all regulated by these two systems. Reduced vagal (parasympathetic) activity and increased sympathetic activity are the hallmarks of autonomic imbalance, which is linked to cardiovascular disorders such hypertension, arrhythmias, ischemia/reperfusion damage, and heart failure.

Exercise training, a key non-pharmacological approach, has shown promise in mitigating these effects and reducing CVD risks, though the exact mechanisms remain under investigation [4]. This review aims to systematically examine how exercise training influences sympathetic nerve activity in heart failure patients.

This review delves into a series of pivotal studies conducted between 2014 and 2018, each investigating the impact of various interventions, notably exercise, on SNA and overall cardiovascular health. These studies not only highlight the potential therapeutic benefits of exercise but also pave the way for a more nuanced understanding of the complex interplay between lifestyle interventions and autonomic function in cardiovascular diseases.

The review encapsulates a range of studies conducted between 2023 and 2010, focusing on the impact of various exercise modalities and interventions on sympathetic nerve activity (SNA) in different contexts, predominantly hypertension. This collection of studies aims to explore the effectiveness of exercise and other interventions in modulating the autonomic nervous system, offering insights into potential therapeutic approaches.

REVIEW

This review has been done by collecting articles from various search engines such as Pub Med, Google Scholar, and Ebsco using the words “exercise training, sympathetic nerve activity, hypertension”. There was a collection of 426 articles. By separation of inclusion criteria and exclusion criteria, 10 articles were reviewed.

List of articles reviewed

Sr. No	Year	Author	Intervention	Result	Analysis
1	2023	Karhaman et al [5]	Inspiratory muscle training	Improvement in respiratory strength, BP,	It is found that the result and analysis is significant .
2	2021	Waclawovsky et al [6]	Aerobic training (Cycle ergometer) or Resistance Exercise e	Regular aerobic exercise has been shown to improve BP and endothelial function in hypertensive pa- tients	It is found that the result and analysis is significant
3	2020	Martinez Aguirre-Betolaza[7]	High-Volume Moderate- Intensity Continuous Training group High-Volume High- Intensity	It was found that no significant improvement shown in BPV.	It is found that the result and analysis are significant

			Interval Training group Low-Volume High- Intensity Interval Training group		
4	2018	Sidra Masroor et al [8]	Aerobic and Resistance training at moderate intensity	Exercise training effective in reducing sympathetic nerve activity	It is found that the result and analysis is significant
5	2018	Leandro R. et al [9]	Aerobic training	Improvement and decreases in systolic BP	It is found that result and analysis are significant,
6	2018	Katrina A. Taylor [10]	Isometric exercise training	Cardiac autonomic and baroreflex improvement shown	It is shown significance
7	2013	DagmaraHering et al [11]	Acute and long term slow breathing exercise	Acute Slow breathing showed changes in BP and MSNA while long term slow breathing exercise showed changes in BP, HR, MSNA	It has significant difference between groups
8	2012	Priscila R. Mello et al [5]	Respiratory exercises	Showed decreased muscle sympathetic nerve activity	No significant changes in control group
9	2010	Emmanuel G Ciolac et al [12]	Moderate intensity continuous exercise training	Improvement in cardio respiratory fitness, BP, norepinephrine	Showed signigcance
10	1984	Kevin Welsh et al [12]	Isometric handgrip Supine rest Orthostatic stress Treadmill training	Improvement in blood pressure and heart rate	No sigificance

DISCUSSION

The studies that have been evaluated provide a thorough summary of the many types of exercise interventions and how they affect markers of cardiovascular health such as blood pressure (BP), sympathetic nerve activity, and cardiorespiratory fitness [13] . These studies have provided important new information about the effectiveness of various exercise methods in treating cardiovascular diseases and enhancing general health

Systolic and diastolic blood pressure levels have been shown to significantly improve with both routine aerobic exercise and targeted aerobic therapies. This emphasises how vital aerobic exercises like swimming, cycling, and running are for maintaining cardiovascular health and lowering the risk of hypertension [14].

Resistance training has also become recognised as a possible strategy for cardiovascular health, in addition to aerobic exercise. Research has indicated that resistance training, when done at a moderate level of intensity, can

successfully lower sympathetic nervous activity, which is linked to better heart health [15]. This demonstrates how strength training may be used in conjunction with aerobic exercise to create comprehensive cardiovascular fitness programmes.

In addition, certain training techniques including isometric exercise training and inspiratory muscle training have demonstrated significant impacts on baroreflex sensitivity and cardiac autonomic function [16] . These results imply that, in addition to conventional exercise modalities, focused therapies that concentrate on particular muscle groups or physiological systems can have noteworthy advantages for cardiovascular health.

Not every intervention, nevertheless, has had noteworthy outcomes. For instance, some research on high-intensity interval training (HIIT) failed to find any appreciable increases in blood pressure variability, suggesting that the volume and intensity of exercise may be crucial factors in attaining the intended results [17]) . In a similar vein, therapies like slow breathing exercises did not consistently show statistically significant increases in all parameters examined, highlighting the need for additional study to clarify their efficacy and best practices.

Although many interventions, such as inspiratory muscle training and aerobic activities, are generally appropriate to a range of age groups, from younger adults to the elderly, the precise effects on various age groups are frequently not well-described. Our comprehension of how treatments may change in efficacy based on age-related physiological differences is hampered by the absence of age-specific analysis in few studies. For example, while aerobic training at a moderate intensity appears to be beneficial in lowering systolic blood pressure, it is not yet apparent how much younger persons gain from this effect in comparison to older adults. Analogously, research on slow breathing exercises and isometric exercises points to possible advantages for sympathetic nerve activity and cardiac autonomic function, although the subtleties of these effects with ageing are not well investigated.

The majority of the evaluated research demonstrate how exercise interventions have a variety of effects on cardiovascular health outcomes . While resistance and aerobic exercise continue to be the mainstays for promoting sympathetic nervous system activity and blood pressure management, novel tactics focusing on certain physiological systems have the potential to improve cardiovascular function as a whole [18] . In order to optimise the therapeutic advantages of exercise in the prevention and management of cardiovascular disease, future research should continue to investigate a variety of exercise modalities, ideal training regimes, and customised approaches [4] . The recurring theme across these studies is the potential of personalized therapeutic strategies targeting the autonomic nervous system. However, the moderate quality of evidence in many studies indicates a need for further research to solidify these findings and explore new therapeutic avenues.

CONCLUSION

This study emphasises how exercise training can significantly improve cardiovascular health and modulate sympathetic nerve activity, especially in people with heart failure and hypertension. A summary of research shows that many types of exercise, including resistance, aerobic, and isometric training, can lower blood pressure and improve autonomic function. Even though aerobic and weight training have continuously produced favourable results, some interventions—such as high-intensity interval training and slow breathing exercises—need more research to fully understand their effectiveness. Personal exercise regimens that focus on the autonomic nervous system may have significant therapeutic benefits, according to the data, especially when used as a non-pharmacological approach to the treatment of cardiovascular disorders.

Nevertheless, differences in study design and participant characteristics underscore the necessity of further investigation to improve exercise recommendations andand gain a deeper comprehension of how age and other variables affect the effectiveness of exercise. Incorporating these findings into clinical practice can ultimately lead to better cardiovascular disease management techniques, which will enhance patient outcomes and quality of life.

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