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High-Intensity Interval Training v/s Steady-State Cardio in Rehabilitation of Neurological Patients

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Abstract

Neuropathy is nerve damage that can cause chronic neuropathic pain, which is challenging to cure and has a significant financial burden. Exercise therapies, including High-Intensity Interval Training (HIIT) and steady-state cardio, are being explored as potential treatments for neuropathic pain. This systematic review compares the effectiveness of HIIT and steady-state cardio for improving function in neurological patients. This article provides an overview of the systematic review conducted on the effects of exercise on neuropathic patients, with a focus on high-intensity interval training (HIIT) and steady-state cardio. The authors conducted a comprehensive search of various databases, identified relevant studies based on predetermined inclusion criteria, and used the EPPI automation application to process the data. The final selection of studies was based on validity and relevance, with redundant articles removed. The article reviews four studies that compare high-intensity interval training (HIIT) to moderate-intensity continuous training (MICT) on various health outcomes. The studies found that HIIT can improve aerobic fitness, cerebral blood flow, and brain function in stroke patients; lower diastolic blood pressure more than MICT and improve insulin sensitivity and skeletal muscle mitochondrial content in obese individuals, potentially helping with the prevention and management of type 2 diabetes. In people with multiple sclerosis, acute exercise can decrease the plasma neurofilament light chain while increasing the flow of the kynurenine pathway. The available clinical and preclinical data suggest that further study on high-intensity interval training (HIIT) and its potential to alleviate neuropathic pain is justified. Randomized controlled trials are needed to investigate the type, intensity, frequency, and duration of exercise, which could lead to consensus and specific HIIT-based advice for patients with neuropathies.

Keywords

Neurological Diseases, Neuropathies, High-Intensity Interval Training (HIIT), Steady-State Cardio, Exercise

1. Introduction

Neuropathy, also known as nerve damage, can be the consequence of a wide variety of illnesses, including diabetes, as well as Medical treatments [1]. The International Association for the Study of Pain defines neuropathic pain in neurological patients as "a lesion or illness of the somatosensory system", and it often manifests as spontaneous numbness, tingling/shooting pain, or scorching pain. Because an illness or injury to the somatosensory system may result in neuropathic pain [2]. Both the intricacy of treating chronic neuropathic pain and the severity of its associated symptoms may put a major strain on one's finances [3]. Neuropathic pain is brought on by maladaptive nociception, which is caused by injury or potential harm to the somatosensory system [4]. Peripheral nerve sensitization (hyperexcitability of peripheral nerves) and/or central hypersensitivity (hyperexcitability of nociceptive spinal neurons) are thought to result from nerve damage brought on by pathological conditions (such as diabetes or HIV), exterior conditions (such as chemotherapy), or both [5] [6]. However, any remnant fibers or fibers that are proximal to the injured region might produce ectopic signals, causing the patient to feel pain even when no external stimulus is present [4]. When injured nerves continue to degenerate, regions of sensory loss develop, and when the nerve is completely severed, these areas of sensory loss become permanent. Action potentials may be created in response to low-level inputs, the type of inputs that would not normally cause a pain signal to be triggered. This is made possible by changes in the sensitivity of ion channels in the periphery [7].

Unfortunately, the majority of diseases presently have no therapeutic options backed by evidence-based causal research. Significant new research on the therapeutic potential of exercise therapies for patients with polyneuropathy has been undertaken since the last review was completed in 2014. Even though the cluster of disorders cannot be reversed, a person may take steps to help prevent or manage neuropathy via food, lifestyle, and therapy. Exercise has been shown to reduce the chance of acquiring chronic diseases including type 2 diabetes, cardiovascular disease, and cancer, as well as to enhance sleep, cognition, and physical function [8]. Patients with neuropathic pain may discover that exercise is an effective therapeutic choice due to these advantages. The hallmarks of neurological patients include HIIT (High-Intensity Interval Training) and Steady-State Cardio. HIIT is rapidly surpassing steady-state training as the most popular type of exercise because of the potentially huge benefits, it may have on exercise capacity in a very short length of time [9]. Thus, the purpose of this syste-

matic review is to evaluate the relative benefits of HIIT (High-Intensity Interval Training) and conventional steady-state cardio in enhancing functional outcomes in neurological patients.

2. Methodology

2.1. Data Collection

Since this is still a relatively new area of research, this review will be helpful for professors and clinicians who are anxious to add to the body of literature. To accomplish this, the authors combed through databases (Google Scholar, Research gate, Electronic Databases Premier, PUBMED, & Web of Science) from their inception to the present through a search of pertinent content; the most recent search was done on February 1st, 2023 (for 2018-2023). Experimental and observational research addressing how exercise or physical activity affects neuropathic patients (the searched term was "HIIT", "steady state cardio" OR "moderate-intensity continuous training", "exercise for neurological patients", "poly neuropathies" were included in the pertinent literature. Search phrases included those about pain, physical activity (such as "exercise", "resistance training", and "aerobic activity"), and neuropathy (such as "diabetic peripheral neuropathy", "DPN", "chemotherapy-induced peripheral neuropathy", "CIPN, "MICT" and HIV"). Animal models of neuropathy, randomized controlled testing, nociceptive testing, and case-controlled studies were all criteria for including included studies.

2.2. Data Cleaning and Processing

Contradictory or out-of-domain articles were flagged by the tool as invalid, and they were rejected in compliance with this finding. The inclusion criteria for studies that are deemed appropriate for systematic reviews are research articles that have been published or reviews/reports that have been published in English that are appropriate in characterizing HIIT and steady state cardio, in particular research papers addressing neuropathies. Studies that are hard to find, don't have references that can be trusted, or are prohibitively expensive are not included. Such criteria have been used in several past studies [10] [11] [12] [13].

2.3. Systematic Review

The material was constructed using data obtained from a huge variety of various sources; however, any articles that were discovered to be redundant were removed from the compilation. EPPI, which stands for Evidence for Policy and Practice Information, is an automation application that was utilized to do the additional processing that was required [14]. Using a flowchart that focuses on the 2020 PRISMA checklist, articles are discarded if they do not satisfy the requirements for identification, filtering, validity, and, eventually, accessing the necessary information. These criteria include identification, filtration, and validity. As a result, the topics discussed will be limited to those that are of the utmost

relevance to the discussion at hand. On the body of work that was chosen, comprehensive research was carried out because, in addition to being pertinent, it was essential to have a solid reputation (Figure 1).

3. Results and Discussion

The selection of the studies included in this systematic review came about as a result of the screening procedure as well as an in-depth investigation of the relevant literature. It was necessary to retrieve data from the years before fulfilling the prerequisites for the baseline research. In addition to the 22 articles that were found to be eligible for full-text eligibility, four papers were found to be ineligible because they were too similar to previously published works. After carrying out a comprehensive investigation, it was found that 5 of the texts did not include the required degree of detail for the baseline study. This was revealed as a result of the research. Four of them were deemed invalid by the computerized analysis tool, one of the sections displayed an intervention that was different

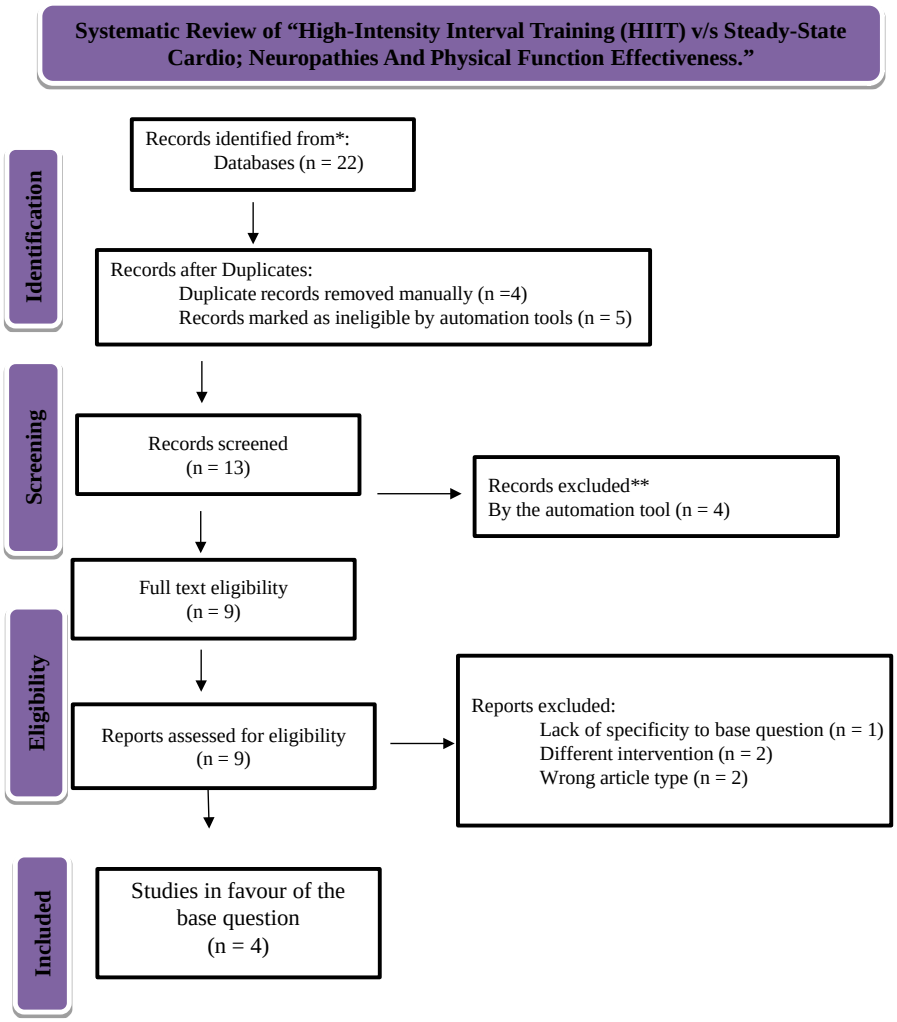

Figure 1. Systematic review of "High-Intensity Interval Training (HIIT) v/s steady-state cardio; neuropathies and physical function effectiveness.

from the one that was being researched, and two of them were of the inappropriate article type. Following the completion of the in-depth systematic review, a total of two studies were able to be integrated into the investigation, bringing the total number of studies considered to four. Research that adheres to the project's guiding principles to a considerable degree was prioritized for inclusion in the project. As a result, studies such as these were chosen to be included in the project because they adhere to the project's guiding principles to such a degree. The research that was found to be most congruent with the tenets of the project was singled out for further analysis. Following this, the research was partitioned into four separate modules, and a list of these modules can be found in **Table 1**.

In a randomized controlled trial among stroke patients, Hsu *et al.* [15] performed the analysis to identify the efficacy of RIIT v/s MICT. People who had suffered from a chronic stroke in the past were used as subjects in an experiment that was carried out in a clinical setting to evaluate the benefits of performing a variety of aerobic exercise routines. Neurologists were able to determine whether the patient had suffered from a hemorrhagic stroke or an ischemic stroke based on the results of the brain CT. After that, the neurologists referred to the TOAST classification system to determine the ischemic stroke subtype. A total of 36 supervised sessions of either MICT or HIIT on a bicycle ergometer were performed by the participants. The individuals averaged between two and three sessions per week. According to the findings, an improvement in aerobic fitness can be achieved by making use of an exercise program that contains high-intensity exercise training. This is the case since high-intensity exercise training requires more energy to perform. As a result of this physiological adaptation, regional cerebral blood flow was improved, which led to an increase in the brain's use of oxygen. As a direct consequence of this, both executive and motor functions improved. An increase in the amount of brain-derived neurotrophic factors (BDNF) that is released from neurons as a response to the changes described above may further result in the growth and branching of neuron dendrites, both of which are essential for the recovery of function in the central nervous system in patients who have suffered a stroke. BDNF is a protein that is produced by neurons as a response to the changes described above. These results have been shown in past in various studies [16] [17] [18].

Compromised cardiovascular health can be indicated by increased arterial stiffness as well as poor blood pressure (BP) throughout 24 hours. To enhance cardiovascular diseases risk variables like cardiorespiratory fitness and vascular function, there is some evidence to suggest that HIIT may be a preferable option to moderate intensity continuous training (MICT). On the other hand, there is a dearth of research that contrasts the effects of HIIT and MICT on central arterial stiffness and/or 24-hour blood pressure response. A meta-analysis was used in a study [19] that was published to examine the effects of HIIT and MICT on central arterial stiffness and 24-hour blood pressure. Studies that were less than four weeks long, included both high-intensity interval training (HIIT) and moderate

Table 1. Systematic review of RIIT and steady state cardio among neurological patients.

Title of the screened study	Objective of the study	Characteristics of the study	Findings of the study	Reference
"A randomized controlled trial found that high-intensity interval training improved serum brain-derived neurotrophic factors among stroke patients"	The outcomes of HIIT (high-intensity interval cardio training) and MICT (moderate-intensity continuous training) upon stroke patients' cerebral oxygenation, peak cardiac output (CO), & serum brain-derived neurotrophic factor were studied.	Sample size = 23 Age limit = 55 years Study type = randomized controlled trial	In stroke patients, HIIT enhanced aerobic capacity by increasing the amount of oxygen extracted from the systemic tissue. After HIIT, there was an increase in the amount of oxygen that the brain used in the hemisphere that had been engaged.	(Hsu *et al.*, 2021)
"Atherosclerotic arterial stiffness and High-Intensity Interval Training and 24 h blood pressure responses: A systematic review and meta-analysis"	HIIT and MICT will be compared with regard to central arterial stiffness & 24 hour blood pressure results.	Study type = Meta-analysis Pulse arterial stiffness, as well as wave index, were used to measure central arterial stiffness following both high-intensity interval training & moderate-intensity continuous training and/or 24 hour blood pressure outcome measurements.	When compared to MICT, HIIT results in a greater drop in diastolic blood pressure during the night. In addition, it was discovered that HIIT led to a drop in daytime blood pressure that was almost significantly bigger than that of MICT.	(Way *et al.*, 2019)
"Exercise Reroutes to Kynurenine Pathway & Diminishes Plasma Neurofilament Chain with Multiple Sclerosis"	The goal of this research was to evaluate the acute and training effects of high-intensity interval training as well as conventional physical rehabilitation affecting plasma neurofilament light chain & kynurenine pathway of tryptophan degeneration metabolites in patients.	Study type= Randomized trail A total of 69 people living with MS with scores between 3.0 and 6.0 on the Expanded Disability Status Scale were randomly allocated to either the HIIT or MCT group.	Acute exercise resulted in a decrease in pNfL and an increase in the flux through the KYN pathway, which leads to the production of neuroprotective kynurenic acid (KA). Changes in pNfL were found to have a positive correlation with changes in KA and a negative correlation with the ratio of quinolinic acid to KA.	(Joisten *et al.*, 2021)
"Effects of Endurance Exercise Modalities on Arterial Stiffness in Patients Randomized Controlled Trial for Patients With Unipolar Depression"	To explore the impact of different types of exercise on the severity index of depression and arterial stiffness in patients who suffer from unipolar depression.	Sample size = 34 Study type = Randomized trail	Both training regimens were found to have significant impacts on the lowering of symptoms of depression. While high intensity interval training was more successful in reducing the degree of depression, Additional decreases in peripheral arterial stiffness were seen after metabolic conditioning exercise.	(Hanssen *et al.*, 2018)

intensity interval training (MICT), and reported central arterial stiffness, as assessed by pulse wave velocity as well as augmentation index and/or 24-hour blood pressure outcome measures. According to the findings, HIIT is associated

with a greater reduction in diastolic blood pressure during the night as compared to MICT. In addition, it was discovered that HIIT led to a drop in daytime blood pressure that was almost significantly bigger than that of MICT. When comparing HIIT with MICT in terms of changes to central arterial stiffness, researchers found no significant differences between the two.

The effects of high-intensity interval training and moderate-intensity continuous training on plasma neurofilament light chain and kynurenine pathway of tryptophan breakdown metabolites in persons with multiple sclerosis (pwMS) were also studied [20]. A total of 69 neurological patients with EDSS values between 3.0 and 6.0 were divided evenly between the HIIT and MCT groups. Before, during, and 3 hours after the first training session, as well as after the 3-week training intervention, the plasma concentrations of pNfL and other metabolites of the KYN pathway were measured and analysed. We found that intense exercise reduced pNfL and increased the synthesis of the neuroprotective chemical kynurenic acid (KA). There was a positive link between pNfL and KA shifts, and a negative one between pNfL and the quinolinic acid-to-quinoline acid ratio. In every single trial, HIIT had much better outcomes than MCT. It has been shown that following a three-week training intervention, HIIT increases KYN pathway activity relative to moderate-intensity continuous training (MCT), and this finding has been replicated across several trials [21] [22].

There is an increasing body of evidence, both from cross-sectional and longitudinal research, indicating that persons who engage in regular physical activity have a lower chance of getting depression [23]. A study identifies the effectiveness of HIIT and MCT on the disease [24]. The results exhibited that exercise regimens were found to have significant impacts on the lowering of symptoms of depression. Although high-intensity interval training was more successful in reducing the degree of depression, moderate continuous training was more effective in additionally reducing peripheral arterial stiffness. When it comes to the treatment of depression, both its prevention and its rehabilitation, physical activity should be seen as a very significant technique.

There is no explicit statement on any interests or disputes in the article. However, it is important to note that research on exercise and its potential benefits, including HIIT, may be influenced by various interests, such as funding sources or conflicts of interest. Additionally, there may be disputes or disagreements among researchers or experts in the field regarding the efficacy or safety of HIIT or other exercise interventions. It is always recommended to critically evaluate any sources of information and consider potential biases or conflicts of interest.

4. Shortcomings and Limitations of This Study

However, the information about systematic reviews and the potential limitations and shortcomings of studies comparing high-intensity interval training (HIIT) and steady-state cardio in the rehabilitation of neurological patients.

When it comes to studies comparing HIIT and steady-state cardio in neuro-

logical rehabilitation, there are some potential limitations and shortcomings that may affect the results. Here are some possible issues to consider:

Heterogeneity of the study population: Neurological patients can have a wide range of conditions and impairments, and these may affect the response to exercise training. Studies that include a heterogeneous population may have difficulty identifying the most effective intervention for a particular group of patients.

Variability in the exercise interventions: HIIT and steady-state cardio can be defined in different ways and can be implemented in different forms. Studies that use different protocols or intensity levels may produce different outcomes, making it difficult to compare the interventions.

Lack of standardized outcome measures: Studies may use different outcome measures to assess the effectiveness of HIIT and steady-state cardio. This can make it challenging to compare the results across studies and draw definitive conclusions about the benefits of each intervention.

Small sample sizes: Many studies comparing HIIT and steady-state cardio in neurological rehabilitation have small sample sizes, which can limit the statistical power and generalizability of the findings.

Lack of long-term follow-up: Rehabilitation programs for neurological patients often have long-term goals, such as improving quality of life and reducing the risk of secondary complications. Studies that only measure short-term outcomes may not capture the full impact of HIIT and steady-state cardio on the patient's long-term outcomes.

Overall, while systematic reviews can provide a useful synthesis of the available evidence, it's important to consider the potential limitations and shortcomings of the individual studies that make up the review. Researchers should aim to address these limitations in future studies to improve the quality and reliability of the evidence.

5. Conclusion

Taken together, the clinical and preclinical data show further study is justified. To further convert the database from the preclinical realm into the clinical arena, randomized controlled trials are required. Specifically, there is a requirement for scientific investigation into the optimal frequency, duration, intensity, and mode of exercise for relieving neuropathic pain. Consistent patient reports and clinical findings, in addition to plausible mechanisms, should be included in future research. As a consequence of this, the body of scientific literature might advance toward a consensus, and medical professionals may start to offer patients suffering from neuropathies advice that is specifically based on HIIT.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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