Section A-Research paper
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Beyond Blood Pressure: Unleashing the Potential of Physical Therapy in Hypertension Care - A Narrative Review

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ABSTRACT

As hypertension continues to rise worldwide, it is essential to explore novel approaches such as adjuvant therapies to reduce resistance to hypertension and enhance activities of daily living. Among these adjuvant therapies, slow breathing, moderate aerobic exercise, relaxation techniques, and respiratory muscle strength training protocol have shown promising results in improving blood pressure, autonomic balance, and baroreflex sensitivity in hypertensive patients.

METHODS - In order to carry out this analytical review, an exhaustive exploration was performed using the PubMed, Scopus, Google Scholar databases, with a specific emphasis on articles written and published from the year 2000 to 2022. In this review, 20 articles were scrutinized, with a major emphasis on investigating the incidence and prevalence rates of essential hypertension, and examining the efficacy of adjuvant therapies in reducing blood pressure. Among these articles, 4 systematic reviews, 12 randomized controlled trials, and 6 longitudinal surveys were selected and evaluated.

RESULTS- The findings of the analysis indicate that adjuvant therapies are effective interventions, particularly in improving inspiratory muscle strength in the IMT group compare to P-IMT was also improved.Moreover, the research demonstrated a noteworthy decrease in both SBP and DBP among patients with essential hypertension, with most interventions spanning 8-10 weeks.

CONCLUSION-The efficacy of integrating various techniques to reduce essential hypertension was reviewed. Although there is a limited amount of research on the effectiveness of IMT compared to traditional aerobic exercise, it has been proven to lower sympathetic activity and enhance Baroreflex activity of the ANS, which results in a

substantial reduction of both SBP and DBP by 9mmHg and 4mmHg, respectively. These findings suggest that including these interventions in the management of hypertension can improve patient outcomes and reduce dependence on medication.

Keywords- Essential hypertension, IMT- Inspiratory muscle training, ANS, sympathetic activity, Adjuvant therapies, SBP-Systolic Blood pressure, DBP- Diastolic Blood Pressure.

1. Introduction

Non-CommunicableDiseases are a major cause of mortality worldwide, with cardiovascular diseases being the primary culprit, responsible for more than 44% of all cases.Unlike Western countries, individuals in low- and middle-income countries are developing cardiovascular diseases at a younger age. The World Health Organization reports that non-communicable diseases contribute to 71% of worldwide deaths, with 77% of these deaths occurring in low- and middle-income countries. Additionally, nearly 30% of non-communicable diseases related deaths occur before the age of 60.[1, 2].

The Global Burden of Disease Study highlights that non-communicable diseases contribute to an increasing number of disability-adjusted life years, rising from 29.2% in 1990 to 57.9% in 2019. To address this public health challenge, the World Health Assembly implemented the Global Action Plan for the Prevention and Control of non-communicable diseases in 2013 with the goal of reducing global hypertension prevalence rates by 25% by 2020. Despite these efforts, research indicates that the prevalence of hypertension among adults is predicted to rise from 26.4% in 2000 to 29.2% in 2025[3].

In developed nations, hypertension ranks as the fourth leading cause of premature mortality, while in developing countries, it stands at seventh. The Directorate General of Health, Government of India, has projected that the prevalence of hypertension among the population in India will be 190 per 1000 by the year 2025. Despite significant advances in pharmacological treatments, hypertension affects about one-third of the adult population worldwide and remains a leading cause of premature mortality. However, mounting evidence suggests that lifestyle interventions can be beneficial in preventing and complementing the treatment of hypertension[6].

Numerous studies have suggested that an imbalanced autonomic system plays a crucial role in hypertension development. This imbalance is characterized by elevated sympathetic activity and is not limited to early or borderline hypertension but also contributes to persistent hypertension.The reduced sensitivity of the baroreflex could be a potential explanation for this autonomic imbalance, as it becomes reset to higher blood pressure levels in individuals with hypertension, thereby reducing its capacity to regulate heightened sympathetic activity[5].

Resistant hypertension, which affects about 20% of hypertensive patients even after receiving optimal doses of three or more antihypertensive medications (including one diuretic), is believed to be caused by factors such as longer life expectancies, urbanization, changes in lifestyle and sedentary habits, increased salt consumption, and improved awareness and

detection of hypertension. Those suffering from resistant hypertension face a greater likelihood of adverse health outcomes and increased mortality risk[7].

Reduced sensitivity of the regulatory mechanism that controls blood pressure, known as the baroreflex, has been linked to increased variability in blood pressure and damage to target organs. Additionally, essential hypertension may involve the activation of chemo reflex, which can further increase sympathetic activity and disrupt autonomic balance. However, slow breathing at a rate of 6 breaths per minute has been found to improve sensitivity of the baroreflex, reduce activation of the sympathetic and chemo reflex, and potentially benefit those with hypertension. These findings have significant implications for the management and prognosis of hypertension in a clinical setting[8].

At present, hypertension treatment plans may involve modifying patients' lifestyles through exercise and dietary changes, administering antihypertensive medications, or a combination of these approaches. While device-guided breathing exercises have shown promise in reducing blood pressure levels in hypertensive patients, research exploring the impact of slow breathing on arterial baroreflex in this population remains limited. This study aims to investigate the potential blood pressure-lowering effect of slow breathing at a rate of 6 cycles per minute in both hypertensive and normotensive individuals. Additionally, the study seeks to determine whether this effect is linked to alterations in cardiovascular control mechanisms[10].

In order to combat the rising prevalence of hypertension around the world, novel approaches must be implemented. Among the non-pharmacological interventions, a respiratory strength training program has shown promising outcomes, such as enhancements in blood pressure, autonomic equilibrium, and baroreflex sensitivity in individuals with hypertension over an extended period. Over time, individuals with hypertension may develop a resistance to anti-hypertensive medications, which can lead to the necessity of optimal dosing of three or more drugs, including a diuretic, known as resistant hypertension. To decrease the adverse effects of taking multiple medications, non-pharmacological or adjuvant therapies, such as moderate aerobic training, resistance training, isometric exercise training, inspiratory muscle training, slow breathing, and relaxation techniques have demonstrated encouraging outcomes in lowering blood pressure

This review focuses on physical therapy interventions as non-pharmacological or adjuvant therapies in managing resistant hypertension. Including these interventions in hypertension treatment plans can significantly decrease blood pressure levels and improve patient outcomes while reducing the requirement for additional medication. Studies have demonstrated that guided slow breathing without inspiratory resistive load, as seen in can enhance cardiovascular control. The objectives of this review are to assess the incidence and prevalence of essential hypertension and to evaluate the efficacy of adjuvant therapies in lowering blood pressure[23].

2. Methodology

2.1 Data sources and literature search

We extensively searched electronic databases such as PUBMED, Scopus, Google Scholar, for articles published from 2000 to 2022. After screening for relevance, we included 20 articles that met our criteria while excluding others.

These included 4 systematic reviews, 12 randomized controlled trials, 6 longitudinal surveys, and original articles and reviews. We used various search terms, such as essential hypertension, blood pressure, autonomic dysfunction, baroreflex sensitivity, sympathetic activity, IMT, and adjuvant therapies, to conduct the search.

2.2 Inclusion and Exclusion criteria

The inclusion criteria for our study were journal articles that were systematic reviews, RCTs, or longitudinal surveys, written in English and with full-text availability. We included articles published within the last 22 years, with a minimum of 10 subjects tested, and resting blood pressure levels of greater than 140/90 mmHg.

Exclusion criteria included reviews, conference proceedings, abstracts, thesis, or case reports. We also excluded studies that included patients with secondary causes of hypertension, such as renal disease or endocrine disorders, as well as those involving autonomic dysfunction

2.3 Data analysis

After analysing research findings, the most relevant information was extracted and the accuracy and comprehensiveness of the data were confirmed. The search results were also assessed to determine if they were divergent or perplexing, in order to present a comprehensive overview of the field.

Table 1.1 - The following is a summary of studies that investigated the effects of various adjuvant therapies on reducing blood pressure in essential hypertensive patients.

References	Methodology	Population	Intervention	Duration	Results	Conclusion
Chacko N. Joseph, Cesare Porta et al. (2005)	Randomized controlled trial	20 subjects with essential HTN,26 controls	The treatment group was instructed to breathe at a rate of 6 breaths per minute, whereas the P-IMT group breathed normally at a rate of 15 breaths per minute.	15-20 mins, 6 days per week for 6weeks	Slow breathing-reduces SBP by 7mmhg, DBP by 5mmhg	Compared to spontaneous breathing, slow breathing decrease BP and improve baroreflex sensitivity.

Jacquelyn J. Rickson et al.2021	Systematic Review	Review articles published b/w 2000-2020 include meta-analyses and RCTs.	The workout routine involved four sets of two-minute contractions at 30% of maximum voluntary contraction, separated by one-minute intervals of rest.	12-20minutes workout 3 times a week for 12 weeks in a row.	SBP was reduced by 9.1mm hg and DBP by 2.8mm hg.	Individuals with hypertension may experience a reduction in BP by following an Isometric exercise training program
Janaina Barcellos Ferreira et al. 2013	Randomized control trial	The study included 13 participants, with 6in IMT group and 7 in P-IMT group.	The Inspiratory Muscle Training group used a threshold IMT device with an inspiratory load that was set at 30% of PI max, while the Placebo-IMT group did not use any inspiratory load.	30 mins /day, for 8 weeks.	In IMT group increase in inspiratory muscle strength by 40 cmH2O, and reduction in both SBP and DBP by 8mm Hg &5mm Hg,	The use of IMT has been shown impacts on inspiratory muscle strength, SBP, DBP, and autonomic CV regulation in individuals with hypertension.
Nayara Fraccari Pires et al.2022	Randomized cross over trial	The study included 20 participants, with 10 (RH)Res HTN and 10 Non-Res HTN(RH)	The participants underwent 4 different sessions, including 3 exercise sessions (AER-aerobic, RES-resistance, and COM-combination) and a control session.	45mins sessions, with AER performed at 50-60% VO2 max for 3-5 days/ week, and RES performed 2-3 days /week.	Significant reductions in sympathetic modulation were observed in RH patients who performed AER and COM exercises.	Autonomic responses to exercise differ in RH compare to non-RH patients. AER exercise showed greater improvements compared to COM exercise.

3. Results

A comprehensive search was conducted on several databases, including Pub Med, Scopus, Google Scholar, and Medline, to conduct a narrative review on essential hypertension, inspiratory muscle training, sympathetic activity, and adjuvant therapies. The search focused on articles published between 2000 and 2022, using relevant keywords, resulting in 20 articles. Out of these, 4 systematic reviews, 12 randomized controlled trials, and 6 longitudinal surveys that met the inclusion and exclusion criteria were selected. The primary aim of the search was to understand the prevalence and incidence of essential hypertension and examine the impact of adjuvant therapies on blood pressure reduction. Our findings

indicate that slow breathing and inspiratory muscle training (IMT) are effective adjuvant therapies for reducing blood pressure in individuals with essential hypertension.

3.1 Slow Breathing and Spontaneous Breathing

A study conducted on slow breathing at a rate of 6 breaths per minute has indeed shown promising results in terms of its potential beneficial effects on individuals with hypertension. This technique, known as slow breathing or paced respiration, involves intentionally slowing down the breathing rate to a specific rhythm. By doing so, it has been observed to increase baroreflex sensitivity and reduce sympathetic activity and chemo reflex activation.

Baroreflex sensitivity refers to the ability of the body to regulate blood pressure in response to changes in arterial pressure. When baroreflex sensitivity is reduced or reset, as is often seen in hypertension, the body's ability to maintain blood pressure within a normal range is compromised.Additionally, slow breathing was found to reduce sympathetic activity. The sympathetic nervous system is responsible for the "fight-or-flight" response and plays a role in increasing blood pressure. By reducing sympathetic activity, slow breathing can help counteract the excessive sympathetic tone seen in hypertension.

Furthermore, the study indicated a reduction in chemo reflex activation. The chemo reflex is a mechanism by which the body responds to changes in blood oxygen and carbon dioxide levels. In hypertension, this reflex can become overactive, leading to hyperventilation and further disturbances in blood pressure regulation. By reducing chemo reflex activation, slow breathing can help restore a more balanced autonomic nervous system function.

The effects of slow breathing on various physiological parameters were investigated in a study involving 20 individuals with essential hypertension and 26 control subjects. The study monitored continuous non-invasive blood pressure (BP), RR interval (a measure of heart rate variability), respiration, and end-tidal CO2 (CO2-et) levels. The participants underwent measurements during both spontaneous breathing and controlled breathing at slower (6 breaths per minute) and faster (15 breaths per minute) rates.

To assess the impact of slow breathing, the autoregressive spectral analysis and the "alpha angle" method to measure baroreflex sensitivity, which refers to the ability of the body to regulate blood pressure in response to changes in baroreceptor input was administered.The results of the study demonstrated that slow breathing had beneficial effects on blood pressure. In hypertensive subjects, systolic and diastolic blood pressure levels decreased during slow breathing. Furthermore, both hypertensive and control subjects exhibited an increase in baroreflex sensitivity during slow breathing, without experiencing hyperventilation. Specifically, baroreflex sensitivity increased from 5.8±0.7 to 10.3±2.0mm Hg ($P<0.01$) in hypertensive individuals and from 10.9±1.0 to 16.0±1.5 mm Hg ($P<0.001$) in control subjects[10].

3.2 Hypertension and Isometric Exercises

According to the 2017 guidelines from the American College of Cardiology/American Heart Association, hypertension (HTN) is classified into stages based on progressively higher blood

pressure levels. Stage 1 HTN is characterized by a systolic blood pressure (SBP) ranging from 130-139 mmHg or a diastolic blood pressure (DBP) ranging from 80-89 mmHg. On the other hand, stage 2 HTN is defined by an SBP of 140 mmHg or higher, or a DBP of 90 mmHg or higher[25]

Isometric or static muscle contraction refers to the sustained activation and tension development in muscles, without any change in muscle length or joint angle. Including isometric training activities can be a cost-effective and easily accessible option when compared to other forms of strength training programs.Leg extension torque, Handgrip dynamometry are practical methods utilized to assess muscular strength and function in real-world situations[6,25].

Kelley and Kelley conducted an early review of isometric exercise training (IET), which demonstrated positive effects on blood pressure (BP). The interventions involved isometric handgrip dynamometer exercises lasting 8-10 weeks, with three weekly sessions consisting of four sets of bilateral contractions lasting two minutes each. The intensity was set at 30-40% of maximal voluntary contraction (MVC), with 1-3 minutes of rest between sets. The intervention group showed a significant reduction of approximately 10% in both resting systolic and diastolic blood pressure. The mean difference for systolic blood pressure was 13.4 mmHg (95% CI, -15.3 to 11.0 mmHg; $p < 0.01$), and for diastolic blood pressure, it was 7.8 mmHg (95% CI, -16.5 to -3.0 mmHg; $p < 0.01$)[24].

Isometric exercise training (IET) has been shown to effectively reduce resting blood pressure by clinically significant levels when performed for more than 8-12 weeks, regardless of the specific exercise type, For example-leg extension, wall squat, handgrip. IET has comparable effects to high-intensity interval training and traditional moderate-intensity continuous aerobic exercise in reducing resting blood pressure, even among individuals with hypertension or controlled hypertension[6].

3.3 Hypertension and IMT

When healthy individuals are subjected to inspiratory muscle fatigue, it leads to an elevation of muscle sympathetic nerve activity, heart rate, and mean arterial pressure, along with a gradual decrease in arterial blood flow to the resting limbs. Experimental research indicates that a fatigued diaphragm is associated with an increase in sympathetic outflow. These findings suggest that inspiratory muscle fatigue may trigger an increase in the metaboreflex, which in turn stimulates peripheral sympathetic activity. Therefore, improving respiratory muscle function through IMT may increase resistance to fatigue and reduce sympathetic outflow[7,27].

There exists a close association between respiratory and cardiovascular modulation, with respiratory pattern modifications resulting in alterations in cardiovascular control. This relationship is believed to be mediated by the interaction between baroreceptor and chemoreceptor sensitivity, which affects the mechanisms of blood pressure control. Our study further revealed an increase in parasympathetic modulation following IMT compared to P-IMT. While research on this topic is limited, our findings align with prior studies that have

examined the effects of breathing exercises on individuals with hypertension. It is well-established that respiratory patterns can modify autonomic cardiovascular modulation[7,28].

4. Future Research

It is important to note that the effects of isometric exercise on systemic vascular resistance in individuals with hypertensioncan vary. While techniques such as inspiratory muscle training, aerobic exercise, and slow breathing have shown the ability to reduce blood pressure, it is crucial to recognize that other forms of exercise may also have a significant impact. Therefore, it is not the intention of this review to diminish the effects of other types of exercise, nor to suggest that isometric exercise should replace them. It is worth mentioning that there is a lack of extensive studies conducted specifically on the Indian population, and the available sample sizes are relatively small when considering the high incidence and prevalence of the disease.

4.1 Implications of Future Research

In the realm of non-pharmacological interventions for hypertension, inspiratory muscle training has emerged as a highly promising option. This approach not only produces beneficial physiological changes but also boasts various advantages, including its cost-effectiveness, suitability for home-based use, and minimal exertion requirement. Moreover, exploring the potential decrease in the reliance on pharmacological treatment to prevent resistant hypertension and investigating its impact on the overall quality of life for individuals with hypertension are crucial areas that warrant further exploration in the realm of holistic approaches**.**

5. Conclusions

Hypertension, a global health concern of increasing prevalence, is a non-communicable disease associated with numerous complications like cardiovascular disease and stroke. Numerous studies have explored interventions to manage hypertension, including exercise training, breathing techniques, and medication. Isometric exercise training has demonstrated good response in reducing blood pressure inhypertensive individuals. Breathing techniques like slow breathing and inspiratory muscle training have also shown effectiveness in blood pressure reduction. Antihypertensive medication remains a crucial intervention. However, lifestyle modifications, such as regular physical activity, a healthy diet, and limited alcohol and tobacco consumption, play vital roles in preventing and managing hypertension.

This narrative review aimed to investigate the potential of isometric exercises, slow breathing, aerobic training, and inspiratory muscle training as supporting treatments for managing essential hypertension. Through the analysis of 12 randomized controlled trials and 4 systematic reviews, significant improvements in blood pressure management were observed, particularly highlighting the effectiveness of isometric exercise and IMT for individuals with hypertension in mid-life. Furthermore, the underlying mechanisms of IMT exercise appear to be linked to multiple factors that require further exploration. The review

also offers safe and effective protocols for the application of isometric exercise training, which can be incorporated alongside the American College of Sports Medicine (ACSM) physical activity guidelines for individuals with hypertension.

Observations of IMT have demonstrated modifications in breathing patterns among both young and older individuals. Older individuals experienced a decrease in their resting spontaneous respiratory rate, while both groups exhibited a shorter inspiratory time during IMT. These changes in breathing patterns could potentially impact heart dynamics, as previous research has suggested a relationship between respiratory rhythm and heart rate, referred to as cardiorespiratory coupling[29].

Research indicates that certain factors, such as a shorter inspiratory time and acute resistive loading, have been associated with an increase in cardiac vagal modulation. Additionally, slow or guided breathing has been found to acutely enhance arterial baroreflex sensitivity. While there is limited research comparing the efficacy of inspiratory muscle training to conventional aerobic training, it has been demonstrated to effectively reduce both systolic and diastolic blood pressure by 9mmHg and 4mmHg, respectively. This reduction is believed to be achieved by decreasing sympathetic activity.

6. Acknowledgements

The study findings are presented with transparency and integrity, without any instances of fabricating, falsifying, or inappropriately manipulating the data**.**

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