FIEGA, Jakub, LUBASZKA, Zuzanna, MICHALSKA, Milena, ŻUREK, Urszula, SZEWCZYK, Dorota and SIKORSKA, Ewa. Influence of sport activity on hypertension - literature review. Journal of Education, Health and Sport. 2023;33(1):100-117. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2023.33.01.011
https://apcz.umk.pl/JEHS/article/view/44917
https://zenodo.org/record/8204504

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 17.07.2023 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical Culture Sciences (Field of Medical sciences and health sciences); Health Sciences (Field of Medical Sciences and Health Sciences).
Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 17.07.2023 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159.
Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 04.07.2023. Revised:30.07.2023. Accepted: 31.07.2023. Published: 08.08.2023.

Influence of sport activity on hypertension - literature review

1) Jakub Fiega
ORCiD: 0009-0007-9188-1382
e-mail: fiegajakub@gmail.com
Wojewódzki Szpital Zespolony w Kielcach, ul. Grunwaldzka 45, 25-736 Kielce, Poland

2) Zuzanna Lubaszka
ORCiD: 0009-0008-3034-1697
e-mail: zuzannalubaszka97@gmail.com
Wojewódzki Szpital Zespolony w Kielcach, ul. Grunwaldzka 45, 25-736 Kielce, Poland

3) Milena Michalska
ORCiD: 0000-0002-8052-5661
e-mail: milena.michalska@interia.eu
Państwowy Instytut Medyczny MSWiA ul. Wołoska 137, 02-507, Warszawa, Poland

4) Urszula Żurek
ORCiD: 0009-0008-3482-5381
e-mail: ula.zurek@gmail.com
Warszawski Szpital Południowy, ul. rtm. Witolda Pileckiego 99, 02-781 Warszawa, Poland

5) Dorota Szewczyk
ORCiD: 0009-0008-9269-2687
e-mail: dorota.szewczyk10@gmail.com
Międzyleski Szpital Specjalistyczny w Warszawie, ul. Bursztynowa 2, 04-749, Warszawa, Poland

6) Ewa Sikorska
ORCiD: 0000-0003-2352-650X
e-mail: ewa.sikorska@wum.edu.pl
Katedra i Zakład Fizjologii Doświadczalnej i Klinicznej, Warszawski Uniwersytet Medyczny, ul. Banacha 1B, 02-097 Warszawa, Poland

Abstract

One of the most widespread illnesses, hypertension can cause other cardiovascular conditions that shorten life expectancy and lower quality of life. Primary hypertension is the most typical type, and while there are some risk factors, we cannot determine what is the primary cause. We should first change our lifestyles before using medications. Sport activity is the strategy that has the most potential. Numerous researchers have attempted to evaluate its impact on hypertension control. They all concurred that engaging in almost any sport can aid in the management of hypertension. Other studies looked at the best sports to keep hypertension under control. They experimented with isometric exercises, tai chi, brisk walking, and aerobic exercise. Matching the appropriate sport to the level of hypertension can be important too.

Athletes experience hypertension as well, despite the fact that exercise is beneficial for the condition. Because of anti-doping regulations, there are some restrictions on how they can be treated.

In addition to exercise, other lifestyle changes are crucial in the treatment of hypertension. It involves changing one's diet, attempting to lose weight, and avoiding stressful situations.

Aim of the study

The purpose of the following paper is to review the research on how various forms of sport activity affect the maintenance of hypertension. It also describes how hypertension affects athletes.

Materials and methods

The following English keywords and its Polish equivalents were used to search Google Scholar's medical databases: hypertension, sport activity, athletes, resistant hypertension. The articles most pertinent to the subject have been chosen.

Keywords: hypertension, sport activity, athletes, resistant hypertension

Hypertension

Hypertension, also referred to as high blood pressure, is a chronic medical condition marked by elevated artery blood pressure levels. It happens when the pressure of the blood against the artery walls becomes excessively high over time, putting more strain on the heart and blood vessels.

Hypertension can be divided into two main categories. The most prevalent type of hypertension is primary (essential) and its exact cause is frequently unknown. As a result of a confluence of genetic and environmental factors, it develops gradually over time. Secondary hypertension is a type of hypertension that develops as a result of an underlying medical condition, such as kidney disease, hormonal imbalances, specific medications or other conditions that raise blood pressure.

Uncontrolled hypertension can result in serious medical issues. Cardiovascular diseases like heart attacks and strokes, kidney damage, vision impairment, and cognitive decline are examples of these.

Risk factors

The risk of hypertension development can be affected by a number of factors. Age, family history, unhealthy lifestyle elements such as an unhealthy diet, inactivity, obesity, excessive alcohol consumption and tobacco use are a few of these. There is also a higher risk of hypertension in people who have certain chronic diseases like diabetes and sleep apnea.

According to estimates, 30-45% of people in Europe have hypertension, and the condition is more common as people get older and have higher blood pressure (BP) [1]. Cardiovascular (CV) diseases such as coronary artery disease, myocardial infarction and stroke have hypertension as one of their major risk factors. In recent years, hypertension has been directly linked to about 25% of heart attacks in the European region, and hypertension-related CV disease is thought to be the cause of about 40% of all annual deaths in Europe [2]. The number of people with hypertension is expected to rise to 60% by 2025, making it crucial to manage it properly in order to prevent disease [3].

Resistant hypertension

A medical condition known as resistant hypertension is characterized by persistently elevated blood pressure despite the use of numerous antihypertensive drugs. It is considered resistant when a person needs three or more different classes of medications, including a diuretic, to control their blood pressure but their blood pressure remains high.

Resistant hypertension is a condition that can develop for a number of reasons. Inconsistent or improper medication use is one common factor which we have to exclude. This occurs when people do not take their prescription medications as prescribed. Treatment resistance can also be influenced by lifestyle choices like smoking, drinking too much alcohol, not getting enough exercise, and eating poorly.

Resistant hypertension can be exacerbated and made more difficult to control by underlying medical conditions. These conditions may include obesity, sleep apnea, hyperaldosteronism, and chronic kidney disease. A number of drugs, including decongestants, hormonal contraceptives, and nonsteroidal anti-inflammatory drugs (NSAIDs), can reduce the efficacy of antihypertensive drugs and increase the likelihood that a patient will become resistant to treatment.

Resistant hypertension may also result from secondary conditions like renal artery stenosis, primary aldosteronism, or pheochromocytoma. To determine and treat the underlying cause of these conditions, specific diagnostic procedures are needed, such as imaging studies or hormone level assessments.

Sport activity in treatment of resistant hypertension

Researchers in Portugal looked at the impact of exercise training on patients with ambulatory resistant hypertension [4]. Patients diagnosed with resistant hypertension between the ages of 40 and 75 who were seen at the hospital's outpatient clinics for the condition were

prospectively enrolled [5]. The diagnosis of resistant hypertension was confirmed at the initial screening, which also included automated 24-hour ambulatory blood pressure monitoring and the 8-item Morisky Medication Adherence Scale to track medication compliance. Patients had to have controlled blood pressure while taking four or more antihypertensive drugs in order to qualify. Another option was patients who had to have a mean systolic blood pressure of 130 mm Hg or higher on 24-hour ambulatory BP monitoring and/or 135 mm Hg or higher during the daytime hours while taking maximally tolerated doses of at least three antihypertensive medications, including a diuretic [5]. During the course of the study, neither medication adherence nor the antihypertensive medication schedule changed.

The exercise group's patients underwent a 12-week aerobic exercise training regimen that included three sessions of closely supervised exercise per week. Each workout consisted of a 10-minute warm-up, followed by 40 minutes of cycling or walking at 50% to 70% of VO2 max (11 to 14 on the Borg scale) and a 10-minute cool-down. Patients began with 20 minutes of exercise at 50% of their maximum oxygen uptake (VO2 max), and progressed weekly, alternating between an increase in session length of 5 minutes and an increase in intensity of 5% of VO2 max, until they reached 40 minutes at 70% of VO2 max, if tolerated. The control group received standard care, which included recommendations from their doctors on the best or most tolerable drug treatments as well as guidance on appropriate lifestyle behavior.

The difference in 24-hour ambulatory systolic blood pressure between groups was 7.1 mm Hg, with a mean change of -6.2 mmHg in the exercise arm vs +0.9 mmHg in the control arm. Similar to this, the exercise arm's 24-hour ambulatory diastolic blood pressure was significantly lower than the control arm's by 5.1 mm Hg.

In the exercise arm compared to the control arm, there was a significant decrease in daytime ambulatory systolic blood pressure of 8.4 mm Hg, diastolic blood pressure of 5.7 mm Hg, and office blood pressure of 10.0 mm Hg. Office diastolic blood pressure and ambulatory blood pressure at night did not differ between groups [4].

Sport activity in various forms of hypertension

A group of individuals with various forms of hypertension participated in a different study [6]. With the following inclusion and exclusion criteria, subjects were chosen who had arterial hypertension (controlled or uncontrolled) diagnosed more than a year prior: adult, primary healthcare user, signed informed consent, and no exclusion criteria such as having

experienced an event of ischaemic heart disease (6 months), severe acute or inter-recurrent acute disease necessitating hospital admission or medical rest, an outbreak of osteoarthritis that would restrict ambulation, pulmonary disease, or pulmonary embolism.

Physicians and nurses from the participating PCCs invited hypertensive subjects to take part in the study more than six months before the intervention. Each PCC's study nurse was contacted by volunteers who agreed to participate to determine whether they met the requirements for participation. The research coordinator used a computer program to randomly assign each participant to either the IG or the CG in a 3:1 ratio.

The PA intervention program followed international guidelines for PA and consisted of supervised group walking sessions (396 METs/min/week over 120 min, in 2 sessions of 60 min), as well as monthly socio-cultural events [7]. The participants were supervised by nurses and PA specialists during all of the pre-planned activities. The walks involved making five-kilometer loops around the city. Participating in sociocultural activities included going to museums, libraries, cultural exhibitions, tourist destinations, and dance classes. 15 to 30 people were included in each group.

The medical professionals provided CG with standard clinical care [8].

A study was conducted to evaluate the impact of the PA intervention program on HRQoL and CV health using multiple linear regression models. Independent of baseline values, this program decreased the CVD risk score by 1.19 ($p = 0.024$) and the level of SBP by 8.68 mmHg ($p = 0.001$). Independent of baseline levels for each component or domain, the intervention had a positive impact on the quality of life in the physical function, bodily pain, general health and vitality.

These findings demonstrate the PA intervention program's significant impact on all models [6].

Patients from the Baoshan Community Health Service Center who had essential hypertension were the subject of another study [9]. 46 patients were chosen, and they were divided into two groups at random: Patients in the treatment group (TRG) participated in a 12-week brisk walking training program (60 minutes of brisk walking, three times a week for a total of 12 weeks), while patients in the control group (CON) did not participate in exercise intervention training. Pre- and post-intervention 3-minute step tests at low and high intensities were performed. 23 subjects without a 12-week brisk walking training program who had normal blood pressure (NBP) were chosen to compare the effects of exercise intervention.

Measurements after 12 weeks of training showed that the SBP of the training group was reduced during resting by 8,3 mmHg, low intensity exercise by 15,6 mmHg and high intensity exercise by 22.6 mmHg. The HR of the TRG was significantly reduced by 3.6 beats per minute during resting, low, and high intensity exercise, and by 8.7 beats per minute and 11.3 beats per minute, respectively. After 12 weeks of brisk walking, TRG's daily steps, o2max, moderate physical activity time, and physical activity energy expenditure all increased significantly by 6000 steps, 2.4 ml/kg/m, 40 minutes, and 113 kcal, respectively. TRG's body fat percentage and sedentary time both fell by 2% and 60 minutes per day, respectively, at the same time [9].

Recommended exercise methods

It is important to take into account which sport has the greatest impact on hypertension when recommending physical activity. Many studies have attempted to provide an answer to that question. I will quote a few of them throughout this review.

Whole-body aerobic exercise

The first article is a review that suggests safe and efficient whole-body aerobic exercise at moderate intensity (i.e., 50-65% of maximum oxygen intake, 30-60 min per session, 3-4 times a week) that primarily focuses on the major muscle groups is the best for the prevention and treatment of hypertension [10]. Resistance training should be done as an additional form of exercise at a moderate intensity without holding one's breath, but it should not be done by hypertensive patients who are experiencing chest symptoms like pain.

Matching appropriate sport to certain patient

Another study attempted to determine which sports should be used for which patients [11]. There is enough proof from meta-analyses to conclude that aerobic exercise is a helpful and efficient treatment option for lowering blood pressure in both people with normotension and patients with hypertension and high-normal BP. Age, sex, ethnicity, and comorbidities should all be taken into consideration when prescribing exercise, in addition to patient preferences and the infrastructure that is available. The choice of exercise should be prioritized according to each person's initial blood pressure level. Patients with hypertension appear to benefit most from aerobic exercise, but separate, high-quality meta-analyses each suggest that combined exercise [12] and DRT [13] may produce comparable potential BP benefits. It is noteworthy that non-white patients with hypertension appear to gain more from

dynamic resistance training. Due to the lack of research on alternative exercise types for patients with high-normal BP, dynamic resistance training may be necessary. Even though the effects on lowering blood pressure may currently be overstated, individuals with normal blood pressure who are at an elevated risk for cardiovascular disease can engage in isometric resistance training [11].

Both aerobic and resistance training are therapeutic modalities that have been shown to be secure and successful in the primary and secondary prevention of hypertension.

Brisk walking and thai chi

Another study compares the effects of brisk walking and thai chi on hypertensive patients [14]. It consists of 246 adults (mean age 64.4 9.8, range 30-91, 45.5% men) with hypertension and at least two but not more than three modifiable cardiovascular disease risk factors (obesity, dyslipidemia, diabetes, and smoking). Participants were randomly assigned to Tai Chi (n = 82), brisk walking (n = 82), or control (n = 82) groups. The Tai Chi and brisk walking groups exercised 150 minutes per week at a moderate intensity for 3 months; daily home practice was encouraged for another 6 months. The main outcome was blood pressure. Fasting blood sugar, glycated hemoglobin, total cholesterol, triglycerides, high- and low-density lipoproteins, BMI, waist circumference, aerobic endurance, perceived stress, quality of life, and exercise self-efficacy were secondary outcomes. Data were gathered at the start of the study, three months after the intervention, and then again six and nine months later.

In comparison to the control group, Tai Chi significantly reduced blood pressure - systolic by 13.33 mmHg and diastolic by 6.45 mmHg. There was also influence on fasting blood sugar (-0.72 mmol/L), glycated hemoglobin (-0.39%), and perceived stress at 9 months, while also improving perceived mental health and exercise self-efficacy. In comparison to the brisk walking group, the Tai Chi group showed significantly greater decreases in blood pressure, fasting blood sugar, glycated hemoglobin and perceived stress. The other cardiovascular disease risk factors did not differ significantly over time between groups in any meaningful ways.

To lower the risk of cardiovascular disease and encourage adults to lead healthy lifestyles, nurses must play a significant role in promoting exercise. Tai chi can be suggested as a suitable form of exercise for creating a healthy life free of cardiovascular disease because it is more effective than brisk walking at lowering several cardiovascular disease risk factors and enhancing psychosocial wellbeing [14].

Wu-style tai chi

The next study was done to determine whether Wu-style Tai Chi (Tai Chi combined with Daoyin) is a more effective form of exercise than simplified Tai Chi. [15] Wu style Tai Chi movements are softer and more continuous than simplified Tai Chi. Older and middle-aged people's cardiovascular systems can benefit more physiologically from it. It is a form of the traditional Tai chi that has been practiced since ancient China, as opposed to the 1956 version of Tai chi that was simplified. Daoyin (along with qigong and movement instruction, used in ancient Chinese medicine to treat diseases) is inherently a part of traditional Wu style Tai Chi.

A randomized clinical trial was created by researchers to contrast the effects of exercise after six weeks in the Wu-style Tai Chi group and the effects in the simplified Tai Chi group. Each group attended a 60-minute class that met three times a week for six weeks. At six weeks, all of the primary outcomes were significantly better for the Wu-style Tai Chi group participants than they were at baseline. Additionally, there were significant differences between baseline and 6 weeks in TCHO (mmol/L), SBP (mmHg), and LDL-C (mmol/L) within the simplified Tai Chi group. The Wu-style Tai Chi group significantly differed from the simplified Tai Chi group at more serum tests and blood pressure test indices between baseline and six weeks.

Wu-style Tai Chi exercise, when compared to the simplified Tai Chi group, not only significantly reduced LDL-C (mmol/L) levels in cardiovascular disease patients, but also significantly decreased SBP (mmHg) levels that contribute to cardiovascular disease. Improvements were notable in the blood lipid and blood pressure tests. Tai chi exercise was performed without any negative side effects, demonstrating its safety and benefit for people with cardiovascular disease. Wu-style Tai Chi could significantly reduce hypertension and hyperlipidemia after 6 weeks of practice.

The findings indicate that Wu style Tai Chi has a more thorough therapeutic approach and a better impact on treating cardiovascular diseases than simplified Tai Chi [15].

Heated water-based exercise

The purpose of another study was to examine the hypotensive effects of heated water-based exercise in older people with hypertension [16]. 15 older hypertensives who were receiving medication had their blood pressure (BP) and their hemodynamic response to heated water-based exercise (HEx) compared to land-based exercise (LEx) assessed. Randomly chosen groups of participants underwent 30 minutes of moderate-intensity HEx

(in-pool walking), LEx (walking on a treadmill), and non-exercise control (CON) intervention. Before, right away after, and 45 minutes after interventions, resting blood pressure, arterial stiffness, endothelial reactivity, and heart rate variability (HRV) were measured. Following interventions, ambulatory blood pressure was monitored for 24 hours. Only in measurements made 45 minutes after HEx resting systolic (but not diastolic) blood pressure decreased by 9.9±3.1 mmHg. After HEx, 24-hour systolic and diastolic, daytime diastolic, and nighttime systolic BP were all lower than LEx and CON. Daytime systolic blood pressure was also lower after HEx than CON. There was no difference in nighttime diastolic between interventions.

These findings imply that HEx may have significant implications for controlling blood pressure in elderly hypertensives receiving medication [16].

Isometric resistance training

In a different article, researchers conducted a systematic review of studies to examine the effectiveness of isometric resistance training in the treatment of hypertension [17].
In people with hypertension, IRT significantly decreased office systolic, diastolic, and mean arterial blood pressure by 7.5, 3.2, and 7.2 mmHg, respectively. However, neither the heart rate nor the 24-hour mean ambulatory systolic and diastolic blood pressure were significantly decreased by an IRT program. These results are in line with earlier studies which discovered a 6–10 mmHg decrease in office systolic, a 3-6 mmHg decrease in office diastolic, and a 1-3 mmHg decrease in mean arterial blood pressures after an IRT program [18].

Hypertension in a group of athletes

Diseases affect athletes the same way as they do everyone else. Although participating in sport activity can help with hypertension, many athletes also struggle with this condition. It is the most prevalent disease in this population [19].

Risk factors of hypertension among this group of people

Numerous studies were conducted to determine the prevalence of hypertension in athletes. In the largest hypertension study ever done on European athletes researchers determined that 3% of the competitive athlete population (n = 2040, 64% men) had hypertension [20]. In a large-scale (n = 138,390) systematic review examiners established that the prevalence of hypertension among athletes was similar to that of the sedentary population, but they also discovered that BP levels varied significantly among athletes who

were involved in various sports [21]. Especially in power sports, higher systemic BP levels appeared to be correlated. In fact, compared to endurance athletes, athletes who engage in weightlifting, rowing, and American-style football have higher blood pressure and are more likely to develop prehypertension or hypertension, with prevalence rates of hypertension ranging from 8.8 to as high as 25.6% [22].

The increased prevalence of hypertension in these athletes may be due to their increased body mass index (BMI), which is typically higher in strength athletes and football players in particular.

It may also be due to their chronic abuse of NSAIDs (non-steroidal anti-inflammatory drugs), supplements, and illegal drugs.

Additionally, hypertension primarily affects male athletes, and blood pressure levels show a linear relationship with height, BMI, and the volume of training performed each week [23]. Additionally, risk factors include diabetes mellitus, smoking, dyslipidemia, abdominal obesity, and a favorable family history of early-onset cardiovascular disease [24]. The use of oral contraceptives is a risk factor for hypertension that is specific to gender. According to a study, 5% of women using oral contraceptives over the course of 5 years experience hypertension [25].

Young athletes who have confirmed hypertension must undergo secondary hypertension evaluation, whereas older athletes must undergo full cardiovascular risk stratification [26].

Better overall health

There is less mortality among athletes overall, and endurance athletes in particular benefit from longer lifespans, according to a number of studies. Cross-country skiers and runners are typical examples of this category. It is interesting to note that the most noticeable decreases are seen at low to moderate exercise levels. These results need to be viewed in the context of the healthier lifestyle that athletes generally lead compared to the sedentary population, which is demonstrated by the significantly lower prevalence of unhealthy habits like smoking, diet-related factors, or sedentary behavior [19].

This may not be true for all athletes, as evidenced by a study that found power sport participants did not benefit from the same health advantages as endurance athletes. All-cause and CVD mortality were not significantly different from those of the general population [27]. Participating in power sports was even linked, when compared to this population, to a higher risk of cardiovascular disease. In fact, compared to other sports, the majority of small studies

seem to indicate that certain power sports, like American football, may have higher mortality rates [27].

WHO recommendations

Exercise should be a regular part of every patient's routine because the advantages far outweigh the risks. The previous set of recommendations was increased by the WHO to 150–300 minutes of moderate-intensity aerobic exercise and an additional two or more days per week of muscle-strengthening training [19].

Treatment of athletes with hypertension

The general ESC recommendations for treating hypertension should be followed when treating athletes. Non-pharmacological measures such as limiting salt intake, getting enough exercise, losing weight if it is necessary, abstaining from alcohol and tobacco, adopting healthier eating practices, quitting supplements, anti-inflammatory medications and performance-enhancing drugs should always be the first step. Furthermore, if they are not already included in the training regimen, a high potassium intake and endurance exercises may be advantageous [28]. Antihypertensive medications should be taken into consideration if the implemented lifestyle changes do not sufficiently lower the BP after three months. However, there are some situations where drug therapy should be started right away, like newly diagnosed stage 3 hypertension or people who are at high to very high risk of cardiovascular complications.

Diuretics may only be used by athletes with a therapeutic use exemption (TUE), as they are prohibited as doping agents under the World Anti-Doping Agency (WADA)-Code due to their potential to conceal performance-enhancing substances in the bloodstream during laboratory testing. First-line treatment options should include angiotensin-converting enzyme (ACE) inhibitors [25]. It is advised to use an angiotensin II receptor antagonist (ARB) in patients who cannot tolerate ACE inhibitors. Both substances have not been shown to significantly affect energy metabolism or limit maximal oxygen uptake.

Calcium channel blockers (CCB) may be used as a first-line therapy as an alternative or in addition. A study found that VO2 max and endurance performance were unaffected by these agents, despite the fact that CCB therapy can reduce cardiac contractility and thereby compromise cardiac output [19].

For athletes participating in a variety of competitive skill sports, such as shooting and archery, beta-blockers are prohibited by the World Anti-Doping Agency (WADA). Beta-

blockers may be viewed as a third-line therapy for athletes participating in non-skill sports due to their potential to reduce cardiac output and aerobic exercise performance. Furthermore, significant bradycardia is frequently seen in endurance athletes, which this class of medications may exacerbate [19].

Other lifestyle interventions

As was previously mentioned, blood pressure levels are affected by more than just hypotensive medications. Modifications to our lifestyle should be the first intervention.

The use of lifestyle interventions for the prevention and adjuvant treatment of hypertension is being backed by more and more evidence [29]. In order to prevent and manage hypertension, regular exercise and physical activity are strongly recommended. In people who are overweight or obese, losing weight to the normal range lowers the risk of developing hypertension but longer-term research is required to determine how effective this method is.

The Dietary Approaches to Stop Hypertension (DASH) diet is the most effective dietary strategy for preventing hypertension and lowering blood pressure in people with pre-hypertension or hypertension. Restricting sodium intake lowers blood pressure, especially in patients with hypertension. The risk of hypertension may be increased by shift work, short sleep duration, poor sleep quality, and other forms of circadian disruption. Although some types of psychological stress, such as post-traumatic stress disorder, appear to be linked to a higher risk of hypertension, there is not enough evidence to support the claim that stress management techniques can actually lower blood pressure. [29] Other research suggests that alcohol consumption should be restricted. For those who choose to consume alcohol, the recommended daily intake should be no more than two standard drinks (14 for men and 9 for women) per week [30].

Conclusions

Patients should be encouraged to participate in sports because numerous studies have shown that such an intervention has a beneficial impact on the treatment of hypertension. Furthermore, physical activity combined with other lifestyle changes should be considered first-line treatment because it can sometimes save patients from unnecessary hypotensive medications. Training has a positive impact on risk factors for cardiovascular disease, such as obesity reduction. The appropriate sport activity must be chosen for each patient.

Author Contributions

Writing & editing: J.F., Z.L., M.M., U.Ż., D.S, E.S. All authors have read and agreed to the published version of the manuscript.

Funding

This article received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

References

1) Mancia, G., Fagard, R., Narkiewicz, K., Redón, J., Zanchetti, A., Böhm, M., Christiaens, T., Cifkova, R., De Backer, G., Dominiczak, A., Galderisi, M., Grobbee, D. E., Jaarsma, T., Kirchhof, P., Kjeldsen, S. E., Laurent, S., Manolis, A. J., Nilsson, P. M., Ruilope, L. M., Schmieder, R. E., … Task Force Members (2013). 2013 ESH/ESC Guidelines for the management of arterial hypertension: the Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Journal of hypertension*, *31*(7), 1281–1357. https://doi.org/10.1097/01.hjh.0000431740.32696.cc
2) Yusuf, S., Hawken, S., Ounpuu, S., Dans, T., Avezum, A., Lanas, F., McQueen, M., Budaj, A., Pais, P., Varigos, J., Lisheng, L., & INTERHEART Study Investigators (2004). Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet (London, England)*, *364*(9438), 937–952. https://doi.org/10.1016/S0140-6736(04)17018-9
3) Kearney, P. M., Whelton, M., Reynolds, K., Muntner, P., Whelton, P. K., & He, J. (2005). Global burden of hypertension: analysis of worldwide data. *Lancet (London, England)*, *365*(9455), 217–223. https://doi.org/10.1016/S0140-6736(05)17741-1
4) Lopes, S., Mesquita-Bastos, J., Garcia, C., Bertoquini, S., Ribau, V., Teixeira, M., Ribeiro, I. P., Melo, J. B., Oliveira, J., Figueiredo, D., Guimarães, G. V., Pescatello, L. S., Polonia, J., Alves, A. J., & Ribeiro, F. (2021). Effect of Exercise Training on Ambulatory Blood Pressure Among Patients With Resistant Hypertension: A Randomized Clinical Trial. *JAMA cardiology*, *6*(11), 1317–1323. https://doi.org/10.1001/jamacardio.2021.2735

5) Carey, R. M., Calhoun, D. A., Bakris, G. L., Brook, R. D., Daugherty, S. L., Dennison-Himmelfarb, C. R., Egan, B. M., Flack, J. M., Gidding, S. S., Judd, E., Lackland, D. T., Laffer, C. L., Newton-Cheh, C., Smith, S. M., Taler, S. J., Textor, S. C., Turan, T. N., White, W. B., & American Heart Association Professional/Public Education and Publications Committee of the Council on Hypertension; Council on Cardiovascular and Stroke Nursing; Council on Clinical Cardiology; Council on Genomic and Precision Medicine; Council on Peripheral Vascular Disease; Council on Quality of Care and Outcomes Research; and Stroke Council (2018). Resistant Hypertension: Detection, Evaluation, and Management: A Scientific Statement From the American Heart Association. *Hypertension (Dallas, Tex. : 1979)*, *72*(5), e53–e90. https://doi.org/10.1161/HYP.0000000000000084

6) Arija, V., Villalobos, F., Pedret, R., Vinuesa, A., Jovani, D., Pascual, G., & Basora, J. (2018). Physical activity, cardiovascular health, quality of life and blood pressure control in hypertensive subjects: randomized clinical trial. *Health and quality of life outcomes*, *16*(1), 184. https://doi.org/10.1186/s12955-018-1008-6

7) Haskell, W. L., Lee, I. M., Pate, R. R., Powell, K. E., Blair, S. N., Franklin, B. A., Macera, C. A., Heath, G. W., Thompson, P. D., & Bauman, A. (2007). Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Medicine and science in sports and exercise*, *39*(8), 1423–1434. https://doi.org/10.1249/mss.0b013e3180616b27

8) Arija, V., Villalobos, F., Pedret, R., Vinuesa, A., Timón, M., Basora, T., Aguas, D., Basora, J., & Pas-a-Pas research group (2017). Effectiveness of a physical activity program on cardiovascular disease risk in adult primary health-care users: the "Pas-a-Pas" community intervention trial. *BMC public health*, *17*(1), 576. https://doi.org/10.1186/s12889-017-4485-3

9) He, L. I., Wei, W. R., & Can, Z. (2018). Effects of 12-week brisk walking training on exercise blood pressure in elderly patients with essential hypertension: a pilot study. *Clinical and experimental hypertension (New York, N.Y. : 1993)*, *40*(7), 673–679. https://doi.org/10.1080/10641963.2018.1425416

10) Sakamoto, S. Prescription of exercise training for hypertensives. *Hypertens Res* 43, 155–161 (2020). https://doi.org/10.1038/s41440-019-0344-1

11) Henner Hanssen and others, Personalized exercise prescription in the prevention and treatment of arterial hypertension: a Consensus Document from the European

Association of Preventive Cardiology (EAPC) and the ESC Council on Hypertension, European Journal of Preventive Cardiology, Volume 29, Issue 1, January 2022, Pages 205–215, https://doi.org/10.1093/eurjpc/zwaa141

12) Corso, L. M., Macdonald, H. V., Johnson, B. T., Farinatti, P., Livingston, J., Zaleski, A. L., Blanchard, A., & Pescatello, L. S. (2016). Is Concurrent Training Efficacious Antihypertensive Therapy? A Meta-analysis. *Medicine and science in sports and exercise*, *48*(12), 2398–2406. https://doi.org/10.1249/MSS.0000000000001056

13) MacDonald, H. V., Johnson, B. T., Huedo-Medina, T. B., Livingston, J., Forsyth, K. C., Kraemer, W. J., Farinatti, P. T., & Pescatello, L. S. (2016). Dynamic Resistance Training as Stand-Alone Antihypertensive Lifestyle Therapy: A Meta-Analysis. *Journal of the American Heart Association*, *5*(10), e003231. https://doi.org/10.1161/JAHA.116.003231

14) Aileen Wai Kiu Chan, Sek Ying Chair, Diana Tze Fan Lee, Doris Yin Ping Leung, Janet Wing Hung Sit, Ho Yu Cheng, Ruth E. Taylor-Piliae, Tai Chi exercise is more effective than brisk walking in reducing cardiovascular disease risk factors among adults with hypertension: A randomised controlled trial, International Journal of Nursing Studies, Volume 88, 2018, Pages 44-52, ISSN 0020-7489, https://doi.org/10.1016/j.ijnurstu.2018.08.009.

15) Wen, J., & Su, M. (2021). A Randomized Trial of Tai Chi on Preventing Hypertension and Hyperlipidemia in Middle-Aged and Elderly Patients. *International journal of environmental research and public health*, *18*(10), 5480. https://doi.org/10.3390/ijerph18105480

16) Ngomane, A. Y., Fernandes, B., Guimarães, G. V., & Ciolac, E. G. (2019). Hypotensive Effect of Heated Water-based Exercise in Older Individuals with Hypertension. *International journal of sports medicine*, *40*(4), 283–291. https://doi.org/10.1055/a-0828-8017

17) Baffour-Awuah, B., Pearson, M. J., Dieberg, G., & Smart, N. A. (2023). Isometric Resistance Training to Manage Hypertension: Systematic Review and Meta-analysis. *Current hypertension reports*, *25*(4), 35–49. https://doi.org/10.1007/s11906-023-01232-w

18) Smart NA, Way D, Carlson D, et al. Effects of isometric resistance training on resting blood pressure: individual participant data meta-analysis. J Hypertens. 2019;37:1927–38

19) Schweiger, V., Niederseer, D., Schmied, C., Attenhofer-Jost, C., & Caselli, S. (2021). Athletes and Hypertension. *Current cardiology reports*, *23*(12), 176. https://doi.org/10.1007/s11886-021-01608-x

20) Caselli, S., Vaquer Sequì, A., Lemme, E., Quattrini, F., Milan, A., D'Ascenzi, F., Spataro, A., & Pelliccia, A. (2017). Prevalence and Management of Systemic Hypertension in Athletes. *The American journal of cardiology*, *119*(10), 1616–1622. https://doi.org/10.1016/j.amjcard.2017.02.011

21) Berge, H. M., Isern, C. B., & Berge, E. (2015). Blood pressure and hypertension in athletes: a systematic review. *British journal of sports medicine*, *49*(11), 716–723. https://doi.org/10.1136/bjsports-2014-093976

22) Williams P. T. (2008). A cohort study of incident hypertension in relation to changes in vigorous physical activity in men and women. *Journal of hypertension*, *26*(6), 1085–1093. https://doi.org/10.1097/HJH.0b013e3282fb81dc

23) Hedman K, Moneghetti KJ, Christle JW, et al. Blood pressure in athletic preparticipation evaluation and the implication for cardiac remodelling. *Heart.* 2019;105:1223–1230. doi: 10.1136/heartjnl-2019-314815

24) Niebauer, J., Börjesson, M., Carre, F., Caselli, S., Palatini, P., Quattrini, F., Serratosa, L., Adami, P. E., Biffi, A., Pressler, A., Rasmusen, H. K., Schmied, C., van Buuren, F., Panhuyzen-Goedkoop, N., Solberg, E. E., Halle, M., Gerche, A., Papadakis, M., Sharma, S., & Pelliccia, A. (2019). Brief recommendations for participation in competitive sports of athletes with arterial hypertension: Summary of a Position Statement from the Sports Cardiology Section of the European Association of Preventive Cardiology (EAPC). *European journal of preventive cardiology*, *26*(14), 1549–1555. https://doi.org/10.1177/2047487319852807

25) Niedfeldt M. W. (2002). Managing hypertension in athletes and physically active patients. *American family physician*, *66*(3), 445–452.

26) Tso, J. V., & Kim, J. H. (2023). Hypertension in Athletes: Clinical Implications and Management Strategies. *Cardiology clinics*, *41*(1), 15–24. https://doi.org/10.1016/j.ccl.2022.08.002

27) Runacres, A., Mackintosh, K. A., & McNarry, M. A. (2021). Health Consequences of an Elite Sporting Career: Long-Term Detriment or Long-Term Gain? A Meta-Analysis of 165,000 Former Athletes. *Sports medicine Auckland, N.Z.)*, *51*(2), 289–301. https://doi.org/10.1007/s40279-020-01379-5

28) Niebauer, J., Börjesson, M., Carre, F., Caselli, S., Palatini, P., Quattrini, F., Serratosa, L., Adami, P. E., Biffi, A., Pressler, A., Schmied, C., van Buuren, F., Panhuyzen-Goedkoop, N., Solberg, E., Halle, M., La Gerche, A., Papadakis, M., Sharma, S., & Pelliccia, A. (2018). Recommendations for participation in competitive sports of athletes with arterial hypertension: a position statement from the sports cardiology section of the European Association of Preventive Cardiology (EAPC). *European heart journal*, *39*(40), 3664–3671. https://doi.org/10.1093/eurheartj/ehy511

29) Valenzuela, P.L., Carrera-Bastos, P., Gálvez, B.G. *et al.* Lifestyle interventions for the prevention and treatment of hypertension. *Nat Rev Cardiol* 18, 251–275 (2021). https://doi.org/10.1038/s41569-020-00437-9

30) Campbell, N. R., Burgess, E., Choi, B. C., Taylor, G., Wilson, E., Cléroux, J., Fodor, J. G., Leiter, L. A., & Spence, D. (1999). Lifestyle modifications to prevent and control hypertension. 1. Methods and an overview of the Canadian recommendations. Canadian Hypertension Society, Canadian Coalition for High Blood Pressure Prevention and Control, Laboratory Centre for Disease Control at Health Canada, Heart and Stroke Foundation of Canada. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne*, *160*(9 Suppl), S1–S6.