Chapter 13

Non-pharmacological management of hypertension

Benjamin JR Buckley and Stephanie J Finnie

doi:

Abstract: The importance of a healthy lifestyle is well understood for the primary and secondary prevention of cardiovascular disease. Numerous studies have emphasised the importance of lifestyle changes as an integral component of lowering blood pressure in both patients with hypertension and prehypertension. Non-pharmacological interventions are an integral part of preventing and managing not only hypertension but also in reducing cardiovascular mortality and morbidity. The importance of physical activity, exercise training, and a healthy diet need to be reemphasised as powerful primary and secondary preventive tools. Therefore, physicians and other healthcare practitioners must allow time with patients to discuss patient goals related to non-pharmacological/lifestyle modifications.

Keywords: hypertension, prevention, lifestyle, exercise, diet, nutrition.

Key points

- Lifestyle modifications are a first line therapy for optimal hypertension management.
- Improvements in lifestyle, including increasing physical activity levels and improving diet, contribute to lowering overall cardiovascular disease risk in addition to improved blood pressure control.
- Regular exercise, maintenance of healthy body weight, and adhering to a healthy diet complement pharmacologic treatment.

13.1 Introduction

The importance of a healthy lifestyle is well understood for the primary and secondary prevention of cardiovascular disease. Indeed, a meta-epidemiological study including 16 meta-analyses, with nearly 400,000 participants, found no difference in mortality between exercise and drug interventions in the secondary prevention of cardiovascular disease and diabetes.

As the majority of patients with hypertension who take blood pressure medication fail to reach treatment goals, non-pharmacological interventions are a promising addition to improve management and clinical outcomes. Numerous randomised controlled trials and real-world, population-based studies have emphasised the importance of lifestyle changes as an integral component of lowering blood pressure in both patients with hypertension and prehypertension. Lifestyle modification is therefore the first line antihypertensive treatment outlined in the 2020 Global Hypertension Practice Guidelines, developed by the International Society of Hypertension. In this chapter, we discuss novel evidence and recommendations related to lifestyle modification, including exercise and nutritional components, as important antihypertensive therapies. Despite such guidelines, it has been estimated that nearly a third of the population are insufficiently physically active to maintain good health and prevent non-communicable diseases such as cardiovascular disease, diabetes, and cancer. .

13.2 Exercise

The World Health Organization 2020 physical activity guidelines include 150-300 minutes of moderate-intensity physical activity, 75-150 minutes of vigorous-intensity physical activity, or a combination of the two, per week. This is in addition, to resistance exercise on 2 days per week. In the treatment and prevention of hypertension, the International Society of Hypertension and American College of Sports Medicine recommends moderate-intensity aerobic exercise (e.g., walking, jogging, cycling, yoga, or swimming) for 30 minutes on 5–7 days per week. The aerobic training should also be supplemented with resistance or strength-based exercise on 2–3 days per week. Patients with uncontrolled severe hypertension (i.e., systolic $\geq$180mmHg and/or diastolic $\geq$110 mmHg) however, should contact their physician before starting an exercise programme.

A 2019 network meta-analysis of 391 randomised controlled trials assessed the effects of exercise and medication on systolic blood pressure. Of which, 197 of studies evaluated exercise interventions (10,461 participants) and 194 studies evaluated antihypertensive medications

(29,281 participants). Compared with non-exercise controls, all types of exercise (including combination of endurance and resistance) and all classes of antihypertensive medications were effective in lowering baseline systolic blood pressure. Among hypertensive populations, there were no significant differences in the systolic blood pressure-lowering effects of commonly used antihypertensive medications (-8.8 mmHg) when compared with exercise (-9 mmHg) (endurance (-8.7 mmHg), dynamic resistance exercise (-7.2 mmHg), or combined exercise (-13.5 mmHg)). However, when including non-hypertensive populations in the analyses, antihypertensive medication was more effective at reducing blood pressure. Therefore, the blood pressure lowering effects of exercise seem to be more potent in hypertensive patients, which is nevertheless a promising message.

Interestingly, exercise also promotes acute cardioprotective effects. A meta-analytic investigation found that regardless of participant, measurement, and intervention characteristics, a single bout of exercise elicits an acute 4.8 mmHg reduction in blood pressure. A range of risk factors contribute to hypertension, including atherosclerosis, insulin resistance, dyslipidaemia, upregulated sympathetic drive, and decreased beta cholinergic receptor sensitivity. Centrally, all of these factors can be influenced by regular exercise training, yet unlikely explain the observed acute antihypertensive effects. Moreover, the impact of exercise on traditional cardiovascular risk factors does not completely explain the beneficial effect of exercise on major adverse cardiovascular events and mortality. To this end, the potent antihypertensive effects of regular exercise may, at least in part, be explained through improvement in vascular function. Specifically, regular exercise training is associated with upregulation of endothelium-derived nitric oxide synthase, a potent vasodilator, which is critical to vascular tone.

A combination of endurance and resistance training may be more protective than either modality alone. One explanation is that each modality elicits a cardioprotective effect via different mechanisms. Resistance exercise is often a *forgotten tool* in the promotion of physical activity and exercise training. A recent prospective study, including 72,560 men and 59,764 women who were followed up for 4 years, found an inverse association with skeletal muscle mass and blood pressure as well as the number of new patients receiving antihypertensive medication. These findings corroborate previous longitudinal evidence, such as the Tobago Health Study, which found that skeletal muscle attenuation was a risk factor for incident hypertension. When the sample was categorised into ascending quartiles of skeletal muscle

mass, there was a clear dose-response relationship, with increased muscle mass associated with a lower incidence of hypertension in both females and males. Thus, resistance training, which is known to attenuate sarcopenia (and even enhance skeletal muscle mass), is a promising additional therapy for primary and secondary antihypertensive therapy. Skeletal muscle mass may therefore help elucidate the antihypertensive properties of chronic resistance training. Although the precise mechanisms explaining the relationship between muscle mass and hypertension are not yet fully understood, insulin resistance, inflammatory pathways, myokines, and arterial stiffness are likely involved.

Whilst antihypertensive drugs have dominated the hypertensive therapy research arena, its affects are limited to blood pressure, often elicit negative side-effects, and do not affect muscle mass, vascular function, nor indeed mental wellbeing. In contrast, exercise offers a systemic benefit (physical, mental, and potentially social), enhances vascular function and muscle mass, subsequently contributing to blood pressure lowering properties, at a relatively low cost. Therefore, renewed attention is warranted for exercise as a non-pharmacological strategy to better prevent and manage hypertension via the promotion of muscle mass and vascular function.

13.3 Diet and Nutrition

A 2016 systematic review and meta-analysis of 24 randomised controlled trials including nearly 24,000 participants, estimated that the overall effect of dietary interventions on systolic blood pressure was -3.1 mmHg. However, studies evaluating the effect of diet on blood pressure are highly heterogeneous, with differences in the duration of interventions, measures of adherence, and participant demographics having a substantial impact on the effect. Indeed, the DASH diet (Dietary Approaches to Stop Hypertension), which promotes the reduction of sodium and the inclusion of foods rich in nutrients that may help lower blood pressure, such as potassium, calcium and magnesium, had the largest effect on systolic blood pressure (-7.6 mmHg). A 2019 Cochrane systematic review and meta-analysis (30 randomised controlled trials; 12,461 participants) investigated the effect of the Mediterranean diet for the primary and secondary prevention of cardiovascular disease. They found a mean reduction of 3 mmHg on systolic blood pressure. A diet rich in whole grains, fruits, vegetables, polyunsaturated fats and dairy products and low in sugar, saturated fat and trans fats, in accordance with the Mediterranean diet, is recommended by the International Society of Hypertension. Table 13.3

summarises the quality of evidence for several nutritional components and their ability to reduce blood pressure or prevent hypertension.

Aligned with the notion that a Mediterranean diet is protective for hypertension, a systematic review and meta-analysis of 7 trials and 32 observational studies found that a vegetarian diet was associated with a reduction in mean blood pressure compared to an omnivore diet. Specifically, the 7 clinical trials (311 participants) found that a vegetarian diet was associated with an average reduction of 4.8 mmHg (systolic) and 2.2 mmHg (diastolic) blood pressure. Whereas the 32 observational studies (21,604 participants) demonstrated an associated reduction of 6.9 and 4.7 mmHg for systolic and diastolic blood pressure, respectively.

In addition to macro diet recommendations such as the DASH, Mediterranean, and vegetarian diets, individual food groups and even specific nutrients may also have a beneficial effect on lowering blood pressure (Table 13.3). For example, increasing the intake of leafy vegetables and beetroot, which are high in nitrates (a potent vasodilator), have been shown in meta-analytic data of placebo-controlled randomised trials, to be associated with a dose-dependent reduction in blood pressure (average effect -4.4 mmHg).

The effectiveness of restricting dietary sodium has also been demonstrated in more than one Cochrane systematic review and meta-analysis. Sodium reduction from high level intake (201 mmol/day) to below the recommended upper level of 100 mmol/day was associated with a decreased systolic blood pressure by only 1 mmHg in white participants with normotension. However, in white participants with hypertension, this reduction increased to 5.5 mmHg. The effect in black and Asian populations seems to be even greater, though further research is needed. Further, increasing dietary potassium intake may reduce the risk of hypertension as shown in some observational research, though higher-quality evidence is warranted. Still, the ratio of sodium-to-potassium may be more important in the prevention of hypertension than manipulating either nutrient in isolation.

NICE guidelines for management of hypertension advise health professionals to ‘discourage excessive consumption of coffee and other caffeine-rich products.’ Experimental studies have shown that caffeine can raise levels of adrenaline, noradrenaline, and cortisol, all of which can lead to an increase in blood pressure. However, recent literature reviews suggest an unpredicted protective effect of habitual coffee consumption toward the occurrence of cardiovascular

events. There is currently no general consensus on the effect of caffeine on blood pressure, with the effects of caffeine dependent on several variables such as the daily dose, coffee-drinking habits, and patients' pre-existing blood pressure.

A 2018 systematic review and dose-response meta-analysis of 10 cohort studies (243,869 participants) reported that the risk of hypertension was reduced by 2% with each one cup/day increment of coffee consumption with up to a 10% reduced risk with 8 cups/day, relative to non-coffee drinkers. Possible mechanisms include the diuretic and natriuretic activity of caffeine. Although, it is possible that it is not caffeine but other active compounds either in coffee or associated in diets of those with high coffee intake that may explain the dose-dependent inverse association of coffee consumption and risk of hypertension. Other ingredients in coffee, such as potassium, magnesium, and antioxidants may contribute to the beneficial effect. In addition, Chlorogenic acid (a polyphenol found in coffee) exhibits anti-inflammatory activity via inhibition of TNF-α and IL-6 pathways. Further research is required to attempt to determine a causal relationship and rule out the possibility of residual confounding.

A large number of dietary flavonoids have been shown to elicit vascular protection, including antioxidant and anti-inflammatory effects as well as improving nitric oxide bioavailability and endothelial function. A Cochrane meta-analysis of 40 treatment comparisons (1,804 participants) revealed a small but statistically significant blood pressure-reducing effect (-1.8 mmHg) of flavanol-rich cocoa products compared with control. Subgroup analyses demonstrated larger reductions in hypertensive patients (mean effect -4 mmHg systolic blood pressure).

In addition to a Mediterranean diet, the promotion of leafy vegetables, and even following a vegetarian diet, a number of individual food groups and nutrients may have a positive impact on blood pressure either in isolation or combined with other active ingredients and pharmacology. Thus, diet seems to be a powerful tool for the primary and secondary prevention of hypertension. Nevertheless, a number of variables appear to impact the magnitude of blood pressure reduction when investigating the impact of nutrition. These include but are not limited to study design and blinding, 'active' versus 'inactive' control groups, study duration, and participant characteristics (age, ethnicity, health status, sex etc.). Such caveats need to be

considered when determing the impact of an intervention, especially something as complex as diet.

Table 13.3. Quality of evidence for nutritional components and the impact on blood pressure reduction

Strong evidence for	Some evidence for	Not scientifically supported
Mediterranean-style diet	Vitamin C	Potassium
Dietary nitrates	Cocoa flavonoids	Pycnogenol
Reducing dietary salt (sodium)	Proteins, peptides, and amino acids	Taurine
Moderate coffee consumption	Coenzyme Q10	Smoking cessation
Moderate tea consumption	Melatonin	Alcohol reduction
Omega-3 polyunsaturated fatty acids	Aged garlic extract	
Dietary magnesium	Probiotics	
Calcium supplementation		

Strong evidence refers to an evidence class of I or IIa and an evidence level of A or B
Some evidence refers to an evidence class of IIa or IIb and an evidence level of B
Not scientifically supported refers to an evidence class of III and an evidence level of C

Evidence Class
Class I - Evidence and/or general agreement that a given treatment or procedure is beneficial, useful, effective
Class IIa - Weight of evidence/opinion is in favour of usefulness/efficacy
Class IIb - Usefulness/efficacy is less well established by evidence/opinion
Class III - Evidence or general agreement that the given treatment or procedure is not useful/effective and in some cases may be harmful

Evidence Level
Level A - Data derived from multiple randomized clinical trials or their meta-analysis
Level B - Data derived from single randomized clinical trial or large non-randomized studies
Level C - Consensus or opinion of the experts and/or small studies, retrospectives studies, registries

13.4 Smoking

Smoking is a considerable risk to public health, responsible for over 6 million deaths worldwide. It is a major risk factor for several diseases, including lung cancer, coronary heart disease and stroke. NICE guidelines for the management of hypertension support smoking cessation, given the broad benefits on cardiovascular risk reduction. However, the specific association between smoking and blood pressure is more complicated.

Epidemiological studies have generally reported lower blood pressures among current smokers compared with non-smokers. A recent meta-analysis of 141,317 individuals from 23 population-based studies reported current as compared with never smoking was associated with lower systolic and diastolic blood pressures (-2.4 and -1.93 mmHg, respectively). Current smoking was even associated with a lower risk of hypertension and severe hypertension. Short-term smoking cessation has been suggested to produce reductions in blood pressure, heart rate and sympathetic activity. A randomized crossover study investigated the effects of 1 week of smoking cessation on blood pressure and heart rate in 39 normotensive male habitual smokers. 24-hour ambulatory blood pressure was significantly lower in the non-smoking period compared with the smoking period (by 3.5 mmHg systole and 1.9 mmHg diastole), as was 24-hour heart rate (by 7.3 beats/min). However, a 4-year observational follow-up study found that sustained smoking cessation resulted in increased blood pressure and incidence of hypertension. The adjusted relative risks of hypertension in those who had quit smoking for <1, 1 to 3, and ≥3 years were 0.6 (95% CI 0.2 to 1.9), 1.5 (95% CI 0.8 to 2.8), and 3.5 (95% CI 1.7 to 7.4), respectively, compared with current smokers.

Various confounding factors could explain this association of smoking cessation and hypertension. For example, weight gain is often reported in those who successfully quit smoking (i.e., smokers tend to have a lower BMI than non-smokers). However, the previously discussed findings demonstrated similar results among those who lost weight, gained weight, and maintained weight. Thus, data supports a short-term reduction in blood pressure but a longer-term increase for those who stop smoking. The mechanisms for this are deserving of future investigation.

In conclusion, more research is required to elucidate the complex relationship between smoking and blood pressure. Current smokers have been observed to have lower blood pressures than non-smokers, but have higher resting heart rates, supporting the notion that smoking may exert

its detrimental effects on cardiovascular disease, at least partially, by increasing resting heart rate. Sustained smoking cessation may counterintuitively result in an increase in blood pressure. However, given current evidence suggests that smoking exerts its negative effects on the cardiovascular system via mechanisms separate to elevated blood pressure, smoking cessation is still one of the best things a smoker can do to improve their health.

13.5 Alcohol

The abuse of alcohol is a major public health problem and is one of the biggest avoidable risks for disease and death. It also carries a substantial economic burden, costing the NHS around £3.5 billion per year. NICE guidelines advise men and women to drink no more than 14 units of alcohol per week, with emphasis on spreading drinking over 3 or more days, and highlight the importance of alcohol-free days. However, the question of what constitutes safe alcohol consumption remains debated.

Epidemiological and clinical studies have demonstrated that chronic alcohol consumption (>3 drinks/day; 30g ethanol) is associated with an increased incidence of hypertension and an increased risk of cardiovascular diseases. The magnitude of increased blood pressure in heavy drinkers' averages ~5-10 mmHg. In the Framingham cohort, there was an increase of 7 mmHg in mean arterial pressure when heavy alcohol users were compared with all others. The extensive risks of harmful alcohol intake on other aspects of health also need to be considered.

According to existing evidence, not all levels of alcohol are bad; *the dose makes the poison… or the therapy*. For example, research suggests that moderate consumption of alcohol can be beneficial to the cardiovascular system and even reduce blood pressure. Moderate drinking is generally considered to be: two drinks a day for men aged <65, one drink a day for men aged >65, and one drink a day for women of any age. A drink is 355 mL of beer, 148 mL of wine or 44 mL of 80-proof distilled spirits. It also seems that reducing alcohol consumption is only beneficial for those that drink an excessive amount. A recent systematic review and meta-analysis including 36 trials with 2,865 participants investigated the effect of a reduction in alcohol consumption on blood pressure. In people who drank two or fewer drinks per day, a reduction in alcohol was not associated with a significant reduction in blood pressure. However, in people who drank more than two drinks per day, a reduction in alcohol intake was associated with increased blood pressure reduction. Reduction in systolic blood pressure (−5.50

mmHg) and diastolic blood pressure (–3.97 mmHg) was strongest in participants who drank six or more drinks per day if they reduced their intake by ~50%.

Therefore, excessive alcohol is associated with increased cardiovascular disease risk and increased incidence of hypertension, particularly for heavy drinkers. Alcohol seems to have a biphasic effect on blood pressure; with a decreased blood pressure up to 12 hours after consumption and increased blood pressure >13 hours after consumption. This may explain the reduction in blood pressure with regular, but moderate consumption. The reduction of alcohol consumption seems to be increasingly beneficial with heavier drinkers, thus, heavy drinkers have the most to gain by reducing their alcohol intake.

13.6 Conclusion

Non-pharmacological interventions are an integral part of preventing and managing not only hypertension but also in reducing cardiovascular mortality and morbidity. The importance of physical activity, exercise, and diet need to be consistently emphasised as powerful primary and secondary preventive tools. Therefore, all treating physicians must allow time with patients to discuss patient goals related to non-pharmacological, lifestyle modifications. Finally, although the biggest effects are seen in the most at-risk patients, it is important to remember the concept: "*an ounce of prevention is worth a pound of cure*".

Key References

Andriani H, Kosasih RI, Putri S, Kuo HW. Effects of changes in smoking status on blood pressure among adult males and females in Indonesia: a 15-year population-based cohort study. BMJ Open. 2020 Apr 30;10(4):e038021. doi: 10.1136/bmjopen-2020-038021. PMID: 32354782; PMCID: PMC7213843.

Bowman TS, Gaziano JM, Buring JE, Sesso HD. A prospective study of cigarette smoking and risk of incident hypertension in women. J Am Coll Cardiol. 2007 Nov 20;50(21):2085-92. doi: 10.1016/j.jacc.2007.08.017. Epub 2007 Nov 5. PMID: 18021879.

Buckley BJR, Thijssen D, and Lip GYH. Relative skeletal muscle mass and incident hypertension: associations, caveats, and future perspectives. *J Hypertens* 38: 2020.

Carpio-Rivera E, Moncada-Jiménez J, Salazar-Rojas W, and Solera-Herrera A. Acute Effects of Exercise on Blood Pressure: A Meta-Analytic Investigation. *Arq Bras Cardiol* 106: 422-433, 2016.

Cicero AFG, Grassi D, Tocci G, Galletti F, Borghi C, Ferri C. Nutrients and Nutraceuticals for the Management of High Normal Blood Pressure: An Evidence-Based Consensus Document. High Blood Press Cardiovasc Prev. 2019 Feb;26(1):9-25. doi: 10.1007/s40292-018-0296-6. Epub 2019 Jan 22. PMID: 30671873.

Cowell OR, Mistry N, Deighton K, Matu J, Griffiths A, Minihane AM, Mathers JC, Shannon OM, Siervo M. Effects of a Mediterranean diet on blood pressure: a systematic review and meta-analysis of randomized controlled trials and observational studies. J Hypertens. 2020 Oct 14. doi: 10.1097/HJH.0000000000002667. Epub ahead of print. PMID: 33060448.

D'Elia L, La Fata E, Galletti F, Scalfi L, Strazzullo P. Coffee consumption and risk of hypertension: a dose-response meta-analysis of prospective studies. Eur J Nutr. 2019 Feb;58(1):271-280. doi: 10.1007/s00394-017-1591-z. Epub 2017 Dec 8. PMID: 29222637.

Gay HC, Rao SG, Vaccarino V, Ali MK. Effects of Different Dietary Interventions on Blood Pressure: Systematic Review and Meta-Analysis of Randomized Controlled Trials. Hypertension. 2016 Apr;67(4):733-9. doi: 10.1161/HYPERTENSIONAHA.115.06853. Epub 2016 Feb 22. PMID: 26902492.

Graudal NA, Hubeck-Graudal T, Jurgens G. Effects of low sodium diet versus high sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride. Cochrane Database of Systematic Reviews 2017, Issue 4. Art. No.: CD004022. DOI: 10.1002/14651858.CD004022.pub4.

Guthold R, Stevens GA, Riley LM, Bull FC. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1·9 million participants. Lancet Glob Health. 2018 Oct;6(10):e1077-e1086. doi: 10.1016/S2214-109X(18)30357-7. Epub 2018 Sep 4. Erratum in: Lancet Glob Health. 2019 Jan;7(1):e36. PMID: 30193830.

Halperin RO, Gaziano JM, Sesso HD. Smoking and the risk of incident hypertension in middle-aged and older men. Am J Hypertens. 2008 Feb;21(2):148-52. doi: 10.1038/ajh.2007.36. Epub 2008 Jan 3. PMID: 18174885.

Han JM, Lee M-Y, Lee K-B, Kim H, Hyun YY. Low relative skeletal muscle mass predicts incident hypertension in Korean men : A prospective cohort study. *Journal of Hypertension* 2020.

Lee DH, Ha MH, Kim JR, Jacobs DR Jr. Effects of smoking cessation on changes in blood pressure and incidence of hypertension: a 4-year follow-up study. Hypertension. 2001 Feb;37(2):194-8. doi: 10.1161/01.hyp.37.2.194. PMID: 11230270.

Li H, Tong W, Wang A, Lin Z, Zhang Y. Effects of cigarette smoking on blood pressure stratified by BMI in Mongolian population, China. Blood Press. 2010 Apr;19(2):92-7. doi: 10.3109/08037050903516300. PMID: 20070251.

Linneberg A, Jacobsen RK, Skaaby T, Taylor AE, Fluharty ME, Jeppesen JL, Bjorngaard JH, Åsvold BO, Gabrielsen ME, Campbell A, Marioni RE, Kumari M, Marques-Vidal P, Kaakinen M, Cavadino A, Postmus I, Ahluwalia TS, Wannamethee SG, Lahti J, Räikkönen K, Palotie A, Wong A, Dalgård C, Ford I, Ben-Shlomo Y, Christiansen L, Kyvik KO, Kuh D, Eriksson JG, Whincup PH, Mbarek H, de Geus EJ, Vink JM, Boomsma DI, Smith GD, Lawlor DA, Kisialiou A, McConnachie A, Padmanabhan S, Jukema

JW, Power C, Hyppönen E, Preisig M, Waeber G, Vollenweider P, Korhonen T, Laatikainen T, Salomaa V, Kaprio J, Kivimaki M, Smith BH, Hayward C, Sørensen TI, Thuesen BH, Sattar N, Morris RW, Romundstad PR, Munafò MR, Jarvelin MR, Husemoen LL. Effect of Smoking on Blood Pressure and Resting Heart Rate: A Mendelian Randomization Meta-Analysis in the CARTA Consortium. Circ Cardiovasc Genet. 2015 Dec;8(6):832-41. doi: 10.1161/CIRCGENETICS.115.001225. Epub 2015 Nov 4. PMID: 26538566; PMCID: PMC4684098.
Minami J, Ishimitsu T, Matsuoka H. Effects of smoking cessation on blood pressure and heart rate variability in habitual smokers. Hypertension. 1999 Jan;33(1 Pt 2):586-90. doi: 10.1161/01.hyp.33.1.586. PMID: 9931170.
Naci H, Ioannidis JP. Comparative effectiveness of exercise and drug interventions on mortality outcomes: metaepidemiological study. BMJ. 2013 Oct 1;347:f5577. doi: 10.1136/bmj.f5577. PMID: 24473061; PMCID: PMC3788175.
Naci H, Salcher-Konrad M, Dias S, Blum MR, Sahoo SA, Nunan D, Ioannidis JPA. How does exercise treatment compare with antihypertensive medications? A network meta-analysis of 391 randomised controlled trials assessing exercise and medication effects on systolic blood pressure. Br J Sports Med. 2019 Jul;53(14):859-869. doi: 10.1136/bjsports-2018-099921. Epub 2018 Dec 18. PMID: 30563873.
Noone C, Leahy J, Morrissey EC, Newell J, Newell M, Dwyer CP, Murphy J, Doyle F, Murphy AW, Molloy GJ. Comparative efficacy of exercise and anti-hypertensive pharmacological interventions in reducing blood pressure in people with hypertension: A network meta-analysis. Eur J Prev Cardiol. 2020 Feb;27(3):247-255. doi: 10.1177/2047487319879786. Epub 2019 Oct 15. PMID: 31615283.
Rees K, Takeda A, Martin N, Ellis L, Wijesekara D, Vepa A, Das A, Hartley L, Stranges S. Mediterranean-style diet for the primary and secondary prevention of cardiovascular disease. Cochrane Database of Systematic Reviews 2019, Issue 3. Art. No.: CD009825. DOI: 10.1002/14651858.CD009825.pub3.
Ried K, Fakler P, Stocks NP. Effect of cocoa on blood pressure. Cochrane Database Syst Rev. 2017 Apr 25;4(4):CD008893. doi: 10.1002/14651858.CD008893.pub3. PMID: 28439881; PMCID: PMC6478304.
Roerecke M, Kaczorowski J, Tobe SW, Gmel G, Hasan OSM, Rehm J. The effect of a reduction in alcohol consumption on blood pressure: a systematic review and meta-analysis. Lancet Public Health. 2017 Feb;2(2):e108-e120. doi: 10.1016/S2468-2667(17)30003-8. Epub 2017 Feb 7. PMID: 29253389; PMCID: PMC6118407.
Sacks FM, Svetkey LP, Vollmer WM, et al. Effects on blood pressure of reduced dietary sodium and the dietary approaches to stop hypertension (DASH) diet. DASH Sodium collaborative Research Group. N Engl J Med.2001;344:3–10.
Tasnim S, Tang C, Musini VM, Wright JM. Effect of alcohol on blood pressure. Cochrane Database Syst Rev. 2020 Jul 1;7:CD012787. doi: 10.1002/14651858.CD012787.pub2. PMID: 32609894.
Thuy AB, Blizzard L, Schmidt MD, Luc PH, Granger RH, Dwyer T. The association between smoking and hypertension in a population-based sample of Vietnamese men. J Hypertens. 2010 Feb;28(2):245-50. doi: 10.1097/HJH.0b013e32833310e0. PMID: 19829145.
Unger T, Borghi C, Charchar F, Khan Nadia A, Poulter Neil R, Prabhakaran D, Ramirez A, Schlaich M, Stergiou George S, Tomaszewski M, Wainford Richard D, Williams B, and Schutte Aletta E. 2020 International Society of Hypertension Global Hypertension Practice Guidelines. *Hypertension* 75: 1334-1357, 2020.
Xie C, Cui L, Zhu J, Wang K, Sun N, Sun C. Coffee consumption and risk of hypertension: a systematic review and dose-response meta-analysis of cohort studies. J Hum Hypertens. 2018 Feb;32(2):83-93. doi: 10.1038/s41371-017-0007-0. Epub 2018 Jan 4. PMID: 29302055.
Yokoyama Y, Nishimura K, Barnard ND, et al. Vegetarian diets and blood pressure: a meta-analysis. Jama Intern Med. 2014;174(4):577-87. doi:10.1001/jamainternmed.2013.14547
Zhao Q, Zmuda JM, Kuipers AL, Bunker CH, Patrick AL, Youk AO, and Miljkovic I. Muscle Attenuation Is Associated With Newly Developed Hypertension in Men of African Ancestry. *Hypertens Dallas Tex 1979* 69: 957-963, 2017.