



# CLINICAL AND CERTIFICATION DILEMMAS IN AVIATION MEDICINE IN THE CONTEXT OF THE DIAGNOSIS AND TREATMENT OF ARTERIAL HYPERTENSION

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**Abstract:** Arterial hypertension constitutes one of the greatest public health challenges of the 21st century. Its role in the etiology of cardiovascular diseases (CVD), such as myocardial infarction, stroke, and heart failure, has been repeatedly confirmed in epidemiological and clinical studies. In recent years, changes have been observed in both the definition and classification of hypertension, as well as in approaches to pharmacological and non-pharmacological treatment, as reflected in the new ESC 2024 guidelines. This paper reviews current blood pressure classification criteria, compares European and American guidelines, summarizes therapeutic changes, and discusses population-specific determinants—including those concerning military pilots—in the context of pathophysiology and aviation medicine.

**Keywords:** hypertension, military pilots, ESC Guidelines

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## INTRODUCTION

In aviation medical certification, blood pressure (BP) values in pilots are considered primarily as limits for flight eligibility rather than as thresholds for initiating treatment according to the current version of ESC 2024 guidelines. This applies particularly to pilots of high-maneuverability aircraft that generate substantial +Gz accelerations. BP measured at the head/eyes level is a key determinant of a pilot's tolerance to these conditions. Methods to improve acceleration tolerance include the use of anti-G suits and breathing/straining techniques and maneuvers aimed at maintaining adequate cerebral blood flow. Therefore, baseline BP prior to exposure to +Gz acceleration is particularly important. This creates a dilemma for aviation physicians and examiners, who must balance adherence to clinical guidelines against the potential benefits of maintaining higher BP values in pilots in exchange for improved tolerance of +Gz acceleration.

Arterial hypertension (HT) is a complex disease with a multifaceted pathophysiology involving interactions among the vascular, nervous, and hormonal systems, as well as the kidneys. The pathomechanism is primarily driven by a sustained increase in peripheral arterial resistance, often accompanied by dysregulation of cardiac output and renal dysfunction, particularly with respect to water–electrolyte (sodium) homeostasis [17]. The sympathetic nervous system and the renin–angiotensin–aldosterone system (RAAS) play key roles in the development of HT; endothelial dysfunction, immune mechanism, and gut dysbiosis have also been implicated [12,17]. Genetic factors must also be considered. High concordance rates of hypertension in monozygotic twins indicate a strong hereditary component [19]. Increasing attention is being directed towards the phenotypic heterogeneity of hypertension, including, inter alia, early-onset disease, a reno-vascular phenotype (characterized by concomitant impairment of renal and vascular function), and disturbances of the circadian blood pressure rhythm (such as the absence of nocturnal decline—non-dipping). Identifying these phenotypes may be important both for individualizing therapy and for precise assessment of cardiovascular risk [11,14].

Regardless of underlying pathomechanism, arterial hypertension is a major cardiovascular risk factor contributing to accelerated atherosclerosis, left ventricular hypertrophy, heart failure, and stroke. Studies such as the Framingham Heart Study have demonstrated a direct relationship between the degree of BP elevation and the risk of

cardiovascular events [10]. Long-term maintenance of elevated BP values also leads to kidney damage and hypertensive retinopathy. Particularly dangerous is so-called silent organ damage, which may remain asymptomatic for many years and result in sudden cardiovascular events [17,1]. Accordingly, global CVD risk assessment in individuals with HT should take into account coexisting factors such as tobacco use, dyslipidemia, diabetes, and a family history of cardiovascular disease.

## Epidemiology and blood pressure classifications

The epidemiology of arterial hypertension indicates its rising global prevalence, currently exceeding 1.28 billion adults, a substantial proportion of whom are unaware of their hypertensive status [29,30]. In low- and middle-income countries, the burden of this condition is greatest, particularly due to limited access to treatment [29,30]. The PURE study demonstrated that modifiable risk factors, including hypertension, account for the majority of cardiovascular disease cases and deaths worldwide [31].

Guidelines defining both BP thresholds and therapeutic strategies vary across geographic regions and scientific societies. Beyond their educational and managerial roles, clinical guidelines constitute an important tool supporting decision-making at the system level and often form the basis for legal regulations and institutional recommendations in health care. In clinical practice, however, physicians are confronted with multiple recommendation documents addressing the same issue, authored by various national and international scientific societies. In the field of arterial hypertension, available documents include European and Polish [11,14,20], North American [28], Asian [24,27], and global [25] guidelines.

Significant discrepancies in BP classification and nomenclature existed for several years between the American recommendations (2017 ACC/AHA classification) and the ESC/ESH 2018 guidelines [28,29]. According to the ACC/AHA guidelines, BP was classified as follows:

Normal	< 120 and < 80 mmHg
Elevated	120–129 and < 80 mmHg
Hypertension, Stage 1	130–139 or 80–89 mmHg
Hypertension, Stage 2	≥ 140 or ≥ 90 mmHg
Hypertensive crisis	≥ 180 and/or ≥ 120 mmHg

According to ESC/ESH, BP ranges were defined as:

Optimal	< 120 and < 80 mmHg
Normal	120–129 and/or 80–84 mmHg
High normal	130–139 and/or 85–89 mmHg
Grade 1 hypertension	140–159 and/or 90–99 mmHg
Grade 2 hypertension	160–179 and/or 100–109 mmHg
Grade 3 hypertension	≥ 180 and/or ≥ 110 mmHg
Isolated systolic hypertension	≥ 140 and < 90 mmHg

### A new approach to defining hypertension and to therapeutic decision-making

Advances in research and clinical trial evidence lead to frequent updates of clinical guidelines. While these updates allow practitioners to rely on current evidence, they may also cause confusion and difficulties in selecting the most appropriate recommendations for a specific patient. Differences in definitions, therapeutic targets, and intervention strategies among documents hinder a uniform therapeutic approach and may hinder guideline implementation in daily clinical practice.

The ESC 2024 guidelines introduce important changes in the classification and treatment of arterial hypertension [14]. BP values are defined as follows: non-elevated BP: systolic <120 mmHg and diastolic <70 mmHg; elevated BP: systolic 120–139 mmHg or diastolic 70–89 mmHg; and arterial hypertension: systolic ≥140 mmHg and/or diastolic ≥90 mmHg.

These guidelines propose a simplified and more transparent approach not only to classification but also to therapeutic decision-making in hypertension management. This approach results from a revised categorization of BP values and cardiovascular risk assessment. A key change is a shift away from rigid thresholds in favor of greater consideration of the individual patient profile, including treatment tolerance and comorbidities. In contrast to the American approach (ACC/AHA), which lowered the diagnostic threshold for hypertension, the ESC maintained the classical definition, indicating that above this level, clear benefits from treatment have been demonstrated in most adults. At the same time, the concept of “elevated” BP was introduced, which does not yet denote hypertension but necessitates cardiovascular risk assessment and consideration of intervention.

These recommendations are based on robust clinical evidence demonstrating that lower BP is associated with a reduced risk of cardiovascular events, with the greatest therapeutic benefits

observed in patients with high baseline risk. In this group, antihypertensive therapy may be initiated already at moderately elevated BP values, before reaching 140/90 mmHg which is the traditional European threshold for hypertension.

ESC experts also emphasize that the risk of cardiovascular complications increases gradually even at lower BP values, rendering arbitrary diagnostic thresholds only approximate guides [14]. For this reason, terms implying an ideal health status, such as “optimal” or “normal,” were removed from the nomenclature so as not to diminish the importance of healthy lifestyle behaviors even at low BP levels.

The update of target systolic BP values is based on recent clinical trial data demonstrating that BP reduction leads to a significant decrease in cardiovascular risk. Consequently, in most patients receiving antihypertensive therapy, the newly recommended target systolic BP range is 120–129 mmHg across broad populations eligible for treatment. Therapy should be individualized, and BP should be lowered to these only if well tolerated. For older adults (≥85 years), patients with symptomatic orthostatic hypotension, frailty, or limited life expectancy, less stringent targets (the “lowest level reasonably achievable”) may be appropriate.

This represents a significant departure from previous European recommendations, which were based on a two-step strategy, initially recommending a target of below 140/90 mmHg and subsequently aiming for values below 130/80 mmHg once initial control had been achieved.

Another new element of the ESC 2024 guidelines is the category of “sufficiently high-risk cardiovascular patients,” which justifies initiation of treatment even in cases of high-normal BP [14].

### Treatment of arterial hypertension

The treatment of arterial hypertension includes both non-pharmacological and pharmacological interventions. The ESC 2024 guidelines place strong emphasis on lifestyle modification, including weight reduction, salt restriction, increased physical activity, and smoking cessation [14]. Such interventions are recommended for all patients, regardless of BP level, and should be undertaken in parallel with pharmacotherapy.

Pharmacotherapy should be applied in patients with BP ≥140/90 mmHg and, in some cases, already at 130–139/85–89 mmHg if high cardiovascular risk is present. Treatment usually begins with single-pill combination therapy containing two or three agents—typically an angiotensin-converting

enzyme inhibitor (ACE-I) or an angiotensin receptor blocker (ARB) in combination with a thiazide-like diuretic and/or a calcium-channel blocker [14].

Another novelty in ESC 2024 guidelines is the emphasis on treatment targeting vascular stiffness and blood pressure control during the night and early morning hours, especially in high-risk groups [14]. In patients resistant to treatment, spironolactone, other diuretics, centrally acting agents, or interventions such as renal denervation should be considered [2,3].

### Importance of treatment personalization

The ESC 2024 guidelines emphasize the importance of personalized treatment, taking into account age, risk of complications, therapy tolerance, and patient preferences. In the population of military pilots, it is crucial to avoid medications that may affect psychomotor function, circadian rhythm, level of alertness, or the ability to respond under high-stress conditions. Calcium-channel blockers and beta-blockers may have limitations that should be considered in close cooperation with aviation physicians.

It should be emphasized, however, that progress in the treatment of arterial hypertension encompasses not only refinement of classical antihypertensive drugs but also the development of interventional and targeted methods. One of the most promising strategies is renal denervation (RDN), a percutaneous endovascular catheter-based neuromodulation approach that enables ablation of renal sympathetic nerve fibers within the adventitial layer of the renal arteries using radiofrequency, ultrasound, or neurolytic agents. RDN has shown efficacy in lowering BP, particularly in patients with treatment-resistant hypertension [2].

Research is also ongoing on gene therapy and biologic agents that modulate the RAAS (renin-angiotensin-aldosterone system), and on the role of the gut microbiome in BP regulation. The introduction of devices for continuous BP monitoring (e.g., subcutaneous implants) may also revolutionize approaches to assessing treatment effectiveness and personalizing therapy [12].

### Arterial hypertension in pilots

Military pilots are a unique population in whom arterial hypertension may have serious consequences for both flight safety and crew health. Due to the nature of their work, pilots are exposed to numerous factors affecting the cardiovascular system, such as G-force accelerations, noise, vibration, hypoxia, and chronic stress [9,15]. These factors may lead to increases in blood pressure

and contribute to the accelerated development of hypertension and its progression or resistance to treatment.

+Gz accelerations lead to the redistribution of a substantial volume of blood to the lower half of the body, particularly the lower limbs, and to reduced cerebral perfusion. Reflex sympathetic activation results in a rapid rise in BP, which, in the case of repeated exposures, may become persistent [9].

Continuous exposure to high-intensity noise, especially at low frequencies, leads to activation of the hypothalamic-pituitary-adrenal (HPA) axis, increased concentrations of cortisol and catecholamines, and an increase in peripheral resistance and sodium retention [15].

Vibration exposure, common during helicopter operations and in armored vehicles, affects proprioceptive receptors and the autonomic nervous system, adversely influencing BP regulation [9].

Hypoxia activates arterial chemoreceptors, oxidative stress, and endothelial dysfunction, intensifying vasoconstriction and vascular remodeling [18].

Chronic psychological stress also plays an important role in the development and progression of arterial hypertension [13]. HPA axis activation in response to stressors increases cortisol, adrenaline, and noradrenaline, elevating BP via enhanced sympathetic activity, sodium retention, and vascular changes [22].

Long-term exposure to stress also contributes to chronic overload of the systems regulating blood pressure. Studies have shown a correlation between high levels of occupational or social stress and higher systolic and diastolic BP, independent of other risk factors [13,22]. Chronic stress is also associated with impaired heart-rate variability (HRV), indicating an imbalance in the autonomic nervous system, with reduced vagal activity and sympathetic predominance [8]. Reduced HRV is a prognostic marker of increased cardiovascular risk and of hypertension progression, especially in young individuals and in occupational groups exposed to strong stressors, such as military jet pilots [8].

Stress also affects molecular mechanisms through epigenetic changes. Chronic stress activation has been shown to lead to methylation of genes encoding glucocorticoid receptors, RAAS enzymes, and sodium-transport proteins, resulting in permanent changes in the genetic expression of blood pressure regulation systems [5,7,23].

From the perspective of aviation medicine, chronic stress should be regarded as a key independent risk factor for the development of hypertension.

Long-standing BP elevation results in target-organ damage. Typical changes include left ventricular hypertrophy, microalbuminuria, retinal vascular changes, and brain injury (including leukoaraiosis and microbleeds) [17]. Importantly, these changes may develop subclinically, which makes early detection and appropriate intervention crucial—even when BP only slightly exceeds the normal range [17].

### **Implications of the 2024 ESC guidelines for the treatment of arterial hypertension in military pilots**

Requirements in aviation medicine differ depending on the country. NATO STANAG 3526 and EASA guidelines emphasize the necessity of maintaining BP <140/90 mmHg and good tolerability of antihypertensive medications, particularly with regard to psychomotor functions and G-tolerance [4,16]. Ambulatory blood pressure monitoring (ABPM) is recommended, along with assessment of cardiac, renal, and neurological status in pilots with diagnosed hypertension. Treatment should be carried out by specialists, with consideration given to minimizing side effects [4].

In Poland, qualification for flying duty additionally takes into account requirements arising from the Ministry of National Defence regulations and national guidelines. According to these regulations, a diagnosis of hypertension treated pharmacologically may result in temporary disqualification from flying, and in the absence of BP control, even permanent loss of fitness for flying duties. The new ESC 2024 guidelines promote a more intensive therapeutic approach. This may lead to more frequent identification of individuals who meet criteria for intervention, including those previously classified as high-normal BP. In particular, the category of “elevated blood pressure” (120–139/70–89 mmHg) is considered clinically relevant. Although it does not constitute a diagnosis of hypertension, the coexistence of additional cardiovascular risk factors may indicate the need to initiate treatment, including pharmacotherapy. In military pilots, such decisions may influence aeromedical certification decisions and medical board determinations.

In complex cases, temporary disqualification or clearance to fly with restrictions may be considered. Early identification of a pre-hypertensive state and modification of risk factors are crucial for maintaining full operational capability [14].

The ESC 2024 guidelines recommend a lower therapeutic target for systolic BP—120–129 mmHg—in most pharmacologically treated

patients, provided it is well tolerated. This represents a significant change from the previous two-step treatment regimen and aims to reduce the risk of cardiovascular events in the general population. However, from the perspective of aviation medicine, this target may be controversial. Lowering systolic BP to such low levels in individuals flying high-maneuverability aircraft (e.g., fighter pilots) carries a risk of impaired cerebral perfusion and transient neurological deficits (including G-LOC) and therefore requires cautious individual adjustment.

### **Dilemma: treatment of hypertension vs. fitness to fly**

Establishing precise therapeutic goals, such as achieving BP values of 120/80 mmHg, may lead to situations in which a pilot with hypertension undergoing pharmacological treatment is declared temporarily unfit to fly or reassigned to other duties. This creates dissonance between the principles of primary and secondary prevention, guidelines and therapeutic targets that are appropriate from a clinical perspective, and operational requirements and combat readiness. Therefore, it is necessary to develop specific decision algorithms that take into account both cardiovascular risk and the specific demands of military aviation service.

## **CONCLUSIONS FOR AVIATION MEDICINE**

In the context of aviation medicine, arterial hypertension remains a significant risk factor that directly affects fitness-for-duty decisions. In accordance with EASA guidelines [4] and NATO STANAG 3526 [16], detection of hypertension or the need to initiate drug therapy may result in unfavorable certification decisions if health status is not adequately controlled. Studies conducted in the Polish Air Force [6] and the German Bundeswehr [21] indicate that regular BP monitoring and implementation of preventive measures are crucial for maintaining pilots’ operational capability. U.S. Air Force guidance [26] likewise emphasizes the necessity of individualized risk assessment and the application of treatment in accordance with the most recent ESC and ACC/AHA recommendations.

The new ESC 2024 guidelines pose a challenge to the medical services of the armed forces but also open the way to redefining cardiovascular prevention among flight personnel. The key conclusions are as follows:

- 1) Update national aviation medical regulations to reflect the latest ESC recommendations.

- 2) Implement screening procedures to identify pilots with “elevated BP” and high cardiovascular risk before overt hypertension develops.
- 3) Develop non-pharmacological strategies (lifestyle, environmental interventions) as first-line measures in young pilots.
- 4) Establish an expert group to define safety limits for pharmacotherapy in the context of certification regulations.

## AUTHORS’ DECLARATION

**Study Design:** Ewelina Zawadzka-Bartczak, Lech Kopka. **Statistical analysis:** Ewelina Zawadzka-Bartczak, Lech Kopka. **Data Collection:** Ewelina Zawadzka-Bartczak, Lech Kopka. **Manuscript Preparation:** Ewelina Zawadzka-Bartczak, Lech Kopka. The Authors declare that there is no conflict of interest.

## REFERENCES

1. Abba MS, Nduka CU, Anjorin S, Zanna FH, Uthman OA. Socioeconomic macro-level determinants of hypertension: ecological analysis of 138 low- and middle-income countries. *J Cardiovasc Dev Dis.* 2023;10(2):57. doi: 10.3390/jcdd10020057.
2. Bhatt DL, Kandzari DE, O’Neill WW, et al.; SYMPPLICITY HTN-3 Investigators. A controlled trial of renal denervation for resistant hypertension. *N Engl J Med.* 2014;370(15):1393–1401. doi: 10.1056/NEJMoa1402670.
3. Böhm M, Kario K, Kandzari DE, et al. Efficacy of catheter-based renal denervation in the absence of antihypertensive medications (SPYRAL HTN-OFF MED Pivotal): a multicentre, randomised, sham-controlled trial. *Lancet.* 2020;395(10234):1444–1451. doi: 10.1016/S0140-6736(20)30554-7.
4. European Union Aviation Safety Agency (EASA). Easy Access Rules: Part-MED (Medical). 2023 update. Available at: <https://www.easa.europa.eu>. Accessed 6 Oct 2025.
5. Fujita T. Recent advances in hypertension: epigenetic mechanisms involved in development of salt-sensitive hypertension. *Hypertension.* 2023;80(4):711–718. doi: 10.1161/HYPERTENSIONAHA.122.20588.
6. Gielerak G, Krzesiński P, Piotrowicz K, et al. The prevalence of cardiovascular risk factors among Polish soldiers: results from the MIL-SCORE program. *Cardiol Res Pract.* 2020;2020:3973526. doi: 10.1155/2020/3973526.
7. Karabaeva RZ, Vochshenkova TA, Mussin NM, Albayev RK, Kaliyev AA, Tamadon A. Epigenetics of hypertension as a risk factor for the development of coronary artery disease in type 2 diabetes mellitus. *Front Endocrinol (Lausanne).* 2024;15:1365738. doi: 10.3389/fendo.2024.1365738.
8. Liao D, Cai J, Barnes RW, Tyroler HA, Rautaharju P, Holme I, Heiss G. Association of cardiac autonomic function and the development of hypertension: the ARIC study. *Am J Hypertens.* 1996;9(12 Pt 1):1147–1156. doi: 10.1093/aje/145.8.696
9. Maculewicz E, Pabin A, Dziuda Ł, Białek M, Białek A. Selected exogenous (occupational and environmental) risk factors for cardiovascular diseases in military and aviation. *J Clin Med.* 2023;12(23):7492. doi: 10.3390/jcm12237492.
10. Mahmood SS, Levy D, Vasan RS, Wang TJ. The Framingham Heart Study and the epidemiology of cardiovascular disease: a historical perspective. *Lancet.* 2014;383:999–1008. doi: 10.1016/S0140-6736(13)61752-3.
11. Mancia G, Kreutz R, Brunström M, et al. 2023 ESH guidelines for the management of arterial hypertension: endorsed by the International Society of Hypertension and the European Renal Association. *J Hypertens.* 2023;41(12):1874–2071. doi: 10.1097/HJH.0000000000003480.
12. Marques FZ, Mackay CR, Kaye DM. Beyond gut feelings: how the gut microbiota regulates blood pressure. *Nat Rev Cardiol.* 2018;15(1):20–32. doi: 10.1038/nrcardio.2017.120.
13. Matthews KA, Katholi CR, McCreath H, et al. Blood pressure reactivity to psychological stress predicts hypertension in the CARDIA study. *Circulation.* 2004;110(1):74–78. doi: 10.1161/01.CIR.0000133415.37578.E4.
14. McEvoy JW, McCarthy CP, Bruno RM, et al. 2024 ESC guidelines for the management of elevated blood pressure and hypertension. *Eur Heart J.* 2024;45(38):3912–4018. doi: 10.1093/eurheartj/ehae178.
15. Münzel T, Schmidt FP, Steven S, et al. Environmental noise and the cardiovascular system. *J Am Coll Cardiol.* 2018;71(6):688–697. doi: 10.1016/j.jacc.2017.12.015.
16. NATO. AAMedP-1.10 (STANAG 3526): Interchangeability of NATO Aircrew Medical Categories. 2021. Available at: <https://www.nato.int/structur/AC/135/main/stanags.htm>. Accessed 6 Oct 2025.
17. Oparil S, Acelajado MC, Bakris GL, et al. Hypertension. *Nat Rev Dis Primers.* 2018;4:18014. doi: 10.1038/nrdp.2018.14.
18. Parati G, Agostoni P, Basnyat B, et al. Clinical recommendations for high-altitude exposure in cardiovascular patients. *Eur Heart J.* 2018;39(17):1546–1554. doi: 10.1093/eurheartj/ehx720.

19. Polderman TJC, Benyamin B, de Leeuw CA, et al. Meta-analysis of the heritability of human traits based on fifty years of twin studies. *Nat Genet.* 2015;47(7):702–709. doi: 10.1038/ng.3285.
20. Prejbisz A, Dobrowolski P, Doroszko A, et al. Guidelines for the management of hypertension in Poland 2024—the position of the Polish Society of Hypertension/Polish Cardiac Society experts. *Arterial Hypertens.* 2024;28:91–146. doi: 10.5603/ah.103916.
21. Sammito S, Güttler N. Cardiovascular risk profiles in German Air Force pilots. *BMJ Mil Health.* 2023;169(2):176–180. doi: 10.1136/bmjilitary-2020-001608.
22. Steptoe A, Kivimäki M. Stress and cardiovascular disease. *Nat Rev Cardiol.* 2012;9:360–370. doi: 10.1038/nrcardio.2012.45.
23. Takeda Y, Demura M, Yoneda T, Takeda Y. Epigenetic regulation of the renin–angiotensin–aldosterone system in hypertension. *Int J Mol Sci.* 2024;25(15):8099. doi: 10.3390/ijms25158099.
24. Umemura S, Arima H, Arima S, et al. The Japanese Society of Hypertension guidelines for the management of hypertension (JSH 2019). *Hypertens Res.* 2019;42:1235–1481. doi: 10.1038/s41440-019-0284-9.
25. Unger T, Borghi C, Charchar F, et al. 2020 International Society of Hypertension global hypertension practice guidelines. *Hypertension.* 2020;75:1334–1357. doi: 10.1161/HYPERTENSIONAHA.120.15026.
26. United States Air Force. Aerospace Medicine Waiver Guide—Compendium. 2025. Available at: <https://www.afms.af.mil/>. Accessed 6 Oct 2025.
27. Wang TD, Chiang CE, Chao TH, et al. 2022 guidelines of the Taiwan Society of Cardiology and the Taiwan Hypertension Society for the management of hypertension. *Acta Cardiol Sin.* 2022;38(3):225–325. doi: 10.6515/ACS.202205\_38(3).20220321A.
28. Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA guideline for high blood pressure in adults. *Circulation.* 2018;138(17):e484–e594. doi: 10.1161/CIR.0000000000000596.
29. Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH guidelines for the management of arterial hypertension. *Eur Heart J.* 2018;39(33):3021–3104. doi: 10.1093/eurheartj/ehy339. Erratum in: *Eur Heart J.* 2019;40(5):475. doi: 10.1093/eurheartj/ehy686.
30. World Health Organization. Hypertension: fact sheet. Available at: <https://www.who.int/news-room/fact-sheets/detail/hypertension>. Accessed 6 Oct 2025.
31. Yusuf S, Joseph P, Rangarajan S, et al. Modifiable risk factors, cardiovascular disease, and mortality in 155,722 individuals from 21 countries (PURE): a prospective cohort study. *Lancet.* 2020;395(10226):795–808. doi: 10.1016/S0140-6736(19)32008-2. Erratum in: *Lancet.* 2020;395(10226):784. doi: 10.1016/S0140-6736(19)32282-2.