

Systemic Hypertension: Definition, Classification, Risk Factors, Blood Pressure Assessment, and Hypertension-Mediated Organ Damage

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Abstract:

Hypertension (HTN) is a highly prevalent chronic condition and one of the major modifiable risk factors for cardiovascular disease, stroke, and renal impairment. It is commonly diagnosed when office systolic blood pressure is ≥ 140 mmHg and/or diastolic blood pressure is ≥ 90 mmHg, with home and ambulatory blood pressure monitoring providing additional diagnostic information. Its prevalence increases with age and is frequently associated with other cardiovascular risk factors, including obesity, diabetes mellitus, dyslipidemia, and metabolic syndrome. Persistent elevation of blood pressure can lead to hypertension-mediated organ damage involving the heart, brain, kidneys, blood vessels, and eyes, thereby increasing cardiovascular morbidity and mortality. Accurate blood pressure measurement, appropriate classification, and comprehensive cardiovascular risk assessment are essential for early diagnosis and effective management. Furthermore, distinguishing primary from secondary hypertension is important for identifying potentially treatable underlying causes. This review aims to summarize the definition, classification, epidemiology, and major risk factors of hypertension, with particular emphasis on blood pressure measurement, cardiovascular risk stratification, and hypertension-mediated organ damage. It also highlights the clinical importance of early detection, assessment of associated comorbidities, and appropriate management strategies to minimize long-term cardiovascular and renal complications.

Keywords: Hypertension; Blood pressure; Cardiovascular risk factors; Hypertension-mediated organ damage; Ambulatory blood pressure monitoring; Primary hypertension; Secondary hypertension.

Introduction:

Hypertension is defined as the level of blood pressure (BP) at which the benefits of treatment (either with lifestyle interventions or drugs) outweigh the risks of treatment. In most guidelines hypertension is diagnosed with office SBP values > 140 mmHg and/or diastolic BP (DBP) values > 90 mmHg as in table 1& 2. (1).

Table 1: Blood pressure categories (1).

Blood Pressure Categories 			
BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)		DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 – 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

Table 2: Ambulatory BP and home BP values used to define hypertension; these definitions apply to all adults (>18-year-old) (1).

	SBP/DBP, mm Hg
Office BP	≥ 140 and/or ≥ 90
<u>Ambulatory blood pressure monitoring (ABPM).</u>	
24-h average	≥ 130 and/or ≥ 80
Day time (or awake) average	≥ 135 and/or ≥ 85
Night time (or asleep) average	≥ 120 and/or ≥ 70
Home blood pressure monitoring (HBPM)	≥ 135 and/or ≥ 85

High-normal BP is intended to identify individuals who could benefit from lifestyle interventions and who would receive pharmacological treatment if compelling indications are present. (2).

Isolated systolic hypertension defined as elevated SBP (≥ 140 mmHg) and low DBP (< 90 mmHg) is common in young and in elderly people. In young individuals, including children, adolescents and young adults, isolated systolic hypertension is the most common form of essential hypertension. However, it is also particularly common in the elderly, in whom it reflects stiffening of the large arteries with an increase in pulse pressure (difference between SBP and DBP) (3).

Prevalence of hypertension:

There is a high prevalence of hypertension which is consistent across the world, irrespective of income status. Hypertension becomes progressively more common with advancing age, with a prevalence of $> 60\%$ in people aged > 60 years. As populations age, the number of people with hypertension will increase by 15–20% by 2025, reaching close to 1.5 billion (4).

Data from the Egyptian National hypertension Project (NHP) showed that hypertension is the most common non-communicable diseases among Egyptians. The most recent WHO report on non-communicable diseases in Egypt indicated that the prevalence of HTN rose to 40%. More than 50% of individuals older than 60 years suffered from hypertension. That means if an Egyptian population of more than 80 million, there will be 15 million with HTN and 7 millions in need of pharmacological treatment and regular follow up. The problem is complicated by the low awareness rates, only 38% of hypertensive Egyptians were aware of having high blood pressure, only 24% were receiving treatment, whereas control rates ($< 140/90$ mmHg) were 8%. Other cardiovascular risk factors namely hypercholesterolemia, increased LDL-cholesterol, low HDL-cholesterol, hypertriglyceridemia, diabetes, impaired glucose tolerance and obesity were present in 60% of hypertensive patients (5).

Based on office BP, the global prevalence of hypertension was estimated to be 1.13 billion in 2015 with a prevalence of over 150 million in central and Eastern Europe. The overall prevalence of hypertension in adults is around 30–45% with a global age standardized prevalence of 24 and 20% in men and women, respectively, in 2015 (6).

HTN is the most common modifiable risk factor for cardiovascular disease which is the leading cause of death. The predicted global prevalence of HTN in women at 2025 is 29.5% with 13% predicted increase in worldwide prevalence of HTN in women from 2000 to 2025 versus 11% in male. In general, women showed better awareness, treatment, and control rate of HTN than men both in economically developed and developing countries. (7).

Severity of HTN was defined as mild if BP = 140–159/ 90–99 mmHg, moderate if BP = 160–179/ 100–109 mmHg, and severe if BP $\geq 180/110$ mmHg (5).

A cardiovascular global risk was assessed based on the Egyptian guidelines risk scoring system for hypertensive patients. Patients with established cardiovascular diseases (coronary artery disease, cerebrovascular disease, peripheral arterial disease) as well as patients with renal failure were considered at a very high risk for future cardiovascular events. Patients with diabetes mellitus, target organ damage and patients with more than 3 cardiovascular risk factors (male gender, female age > 55 or male age > 45, current smokers, dyslipidemia, obesity) were categorized as a high-risk group, while patients with 1-3 cardiovascular risk factors were considered as an intermediate-risk group. Patients with no additional risk factors and no target organ damage presented the low-risk group. (7).

Target organ damage was present in patients with more than stage I hypertension ($\geq 160/100$ mmHg), e.g. ECG-LVH in 20%, coronary artery disease (CAD) 16%, systolic heart failure in 5% and renal failure in 3.2%. Egyptians have one of the highest mortality rates secondary to CAD worldwide. Hypertension is an established major risk factor for CAD. (5).

Blood pressure relationship with risk of cardiovascular and renal events

Elevated BP was the leading global contributor to premature death, accounting for almost 10 million deaths and over 200 million disability-adjusted life years. Importantly, despite advances in diagnosis and treatment over the past 30 years, the disability-adjusted life years attributable to hypertension have increased by 40% since 1990. SBP > 140 mmHg accounts for most of the mortality and morbidity (70%), and the largest number of SBP-related deaths per year are due to ischemic heart disease (4.9 million), hemorrhagic stroke (2.0million), and ischemic stroke (1.5million)(8).

Diabetes mellitus (DM) was defined as a hemoglobin A1c (HbA1c) level of 6.5% or higher, fasting plasma glucose (FPG) level of 126 mg/ dl or higher; or a 2-hour plasma glucose level of 200 mg/dl or higher; and/or a random plasma glucose of 200 mg/dl or higher. All measurements were taken at least twice. Patients were also considered diabetics if they were previously diagnosed and are receiving anti-diabetic agents (9).

Dyslipidemia was considered when low density lipoprotein (LDL) cholesterol was ≥ 130 mg/dl, or high-density lipoprotein (HDL) cholesterol ≤ 50 mg/dl in women and ≤ 40 mg/dl in men, increased triglycerides (TG) ≥ 150 mg/dl, or if the patient is currently receiving a lipid lowering agent (10).

Metabolic syndrome is an accumulation of several disorders, which together raise the risk of an individual developing atherosclerotic cardiovascular disease, insulin resistance, and diabetes mellitus, and vascular and neurological complications such as a cerebrovascular accident. Metabolic disarrangement becomes a syndrome if the patient has any three of the following:

- Waist circumference more than 40 inches in men and 35 inches in women.
- Elevated triglycerides 150 milligrams per deciliter of blood (mg/dL) or greater.
- Reduced (HDL) less than 40 mg/dL in men or less than 50 mg/dL in women.
- Elevated fasting glucose of 100 mg/dL or greater.
- Blood pressure values of systolic 130 mmHg or higher and/or diastolic 85 mmHg or higher (11).

More than 50% of hypertensive patients have additional cardiovascular risk factors. The most common additional risk factors are diabetes (15%–20%), lipid disorders (elevated [LDL] and triglycerides [30%]), overweight-obesity (40%), hyperuricemia (25%) and metabolic syndrome (40%), as well as unhealthy lifestyle habits (e.g., smoking, high alcohol intake, sedentary lifestyle). The presence of one or more additional cardiovascular risk factors proportionally increases the risk of coronary, cerebrovascular, and renal diseases in hypertensive patients. The therapeutic strategy must include lifestyle changes, BP control to target and the effective treatment of the other risk factors to reduce the residual cardiovascular risk. The combined treatment of hypertension and additional cardiovascular risk factors reduces the rate of cardiovascular diseases (CVD) beyond BP control. (12).

Hypertension-Mediated Organ Damage (HMOD):

Hypertension-mediated organ damage (HMOD) is defined as the structural or functional alteration of the arterial vasculature and/or the organs it supplies that is caused by elevated BP (table.3). End organs include the brain, the heart, the kidneys, central and peripheral arteries, and the eyes. While assessment of overall cardiovascular risk is important for the management of hypertension, additional detection of HMOD is unlikely to change the management of those patients already identified as high risk (i.e., those with established CVD, stroke, diabetes, chronic kidney diseases (CKD), or familial hypercholesterolemia). However, it can provide important therapeutic guidance on management for hypertensive patients with low or moderate overall risk through reclassification due to presence of HMOD, and preferential selection of drug treatment based on the specific impact on HMOD. (3).

Target organ damage was present in patients with more than stage I HTN e.g. left ventricular hypertrophy (LVH) in 20%, coronary artery diseases (CAD) in 16%, systolic heart failure in 5% and renal failure in 3%. Egyptians have one of the highest mortality rates secondary to CAD worldwide and HTN is the established major risk factor for CAD. (5).

Table 3: Simplified Classification of Hypertension Risk according to additional Risk Factors, Hypertension-Mediated Organ Damage (HMOD), and Previous Disease. (3).

Other Risk Factors, HMOD, or Disease	High-Normal SBP 130–139, DBP 85–89		Grade 1 SBP 140–159, DBP 90–99	Grade 2 SBP $\geq$ 160, DBP $\geq$ 100
No other risk factors	low		Low	Moderate
1 or 2 risk factors	low		Moderate	High
$\geq$ 3 risk factors	low	moderate	High	High
HMOD, CKD grade 3, diabetes mellitus, CVD	High		High	High

Blood pressure measurement

Auscultatory or automatic sphygmomanometers are the preferred method for measuring BP in the doctor's office. Mercury BP-measuring devices should be calibrated at regular intervals and failure to calibrate these devices may lead to error in blood pressure measurements. Blood pressure should initially be measured in both upper arms, using an appropriate cuff size for the arm circumference. Ideally established by simultaneous measurement, the arm with the higher BP values should be used for all subsequent measurements (13).

The standing blood pressure should be taken in the following situations: first visit evaluation, elderly patients (above 60 years), diabetic patients of any age, patients with postural symptoms; dizziness, light headedness or faintness and intake of drugs that can produce postural hypotension. BP should also be measured 1 min and 3 min after standing. In the standing position, the arm should rest supported on either a high table, the shoulder of the examiner or in the armpit of the examiner, depending on the relative height of the patient and the examiner. Orthostatic hypotension is defined as a reduction in SBP of $\geq$ 20 mmHg or in DBP of $\geq$ 10 mmHg within 3 min of standing, and is associated with an increased risk of mortality and CV events or fatal events. (13).

Young and middle-aged adults with high blood pressure whose systolic blood pressure (top-number) rose more than 6.5mmhg upon standing were more likely to later have a heart attack, stroke or other major heart disease than those with lower systolic blood pressure in response to standing. As a result of that, it is important to measure standing blood pressure in young and middle-aged adults with hypertension and treat those who have elevated blood pressure upon standing (3).

BP can be highly variable, thus the diagnosis of hypertension should not be based on a single set of BP readings at a single office visit, unless the BP is substantially increased (e.g. grade 3 hypertension) and there is clear evidence of HMOD (e.g. hypertensive retinopathy with exudates and hemorrhages, or LVH, or vascular or renal damage). For all others (i.e. almost all patients), repeat BP measurements at repeat office visits have been a long-standing strategy to confirm a persistent elevation in BP, as well as for the classification of the hypertension status(14).

Table 1: Office blood pressure measurement recommendations (3).

Patients should be seated comfortably in a quiet environment for 5 min before beginning BP measurements.
Standing blood pressure measuring is important to discover postural hypotension and patients who develop elevation of blood pressure on standing are reported to develop higher risk of cardiovascular and renal events.
Three BP measurements should be recorded, 1–2 min apart, and additional measurements only if the first two readings differ by >10 mmHg. BP is recorded as the average of the last two BP readings.
Additional measurements may have to be performed in patients with unstable BP values due to arrhythmias, such as in patents with atrial fibrillation (AF), in whom manual auscultatory methods should be used as most automated devices have not been validated for BP measurement in patients with AF.
Use a standard bladder cuff (12–13 cm wide and 35 cm long) for most patients but have larger and smaller cuffs available for larger (arm circumference >32 cm) and thinner arms, respectively.
The cuff should be positioned at the level of the heart, with the back and arm supported to avoid muscle contraction and isometric exercise-dependant increases in BP.
When using auscultatory methods, use phase I and V (sudden reduction/disappearance) Korotkoff sounds to identify SBP and DBP, respectively.
Measure BP in both arms at the first visit to detect possible between-arm differences. Use the arm with the higher value as the reference.
Record heart rate and use pulse palpation to exclude arrhythmia.
Measure BP 1 min and 3 min after standing from a seated position in all patients at the first measurement to exclude orthostatic hypotension. Lying and standing BP measurements should also be considered in subsequent visits in older people, people with diabetes, and people with other conditions in which orthostatic hypotension may frequently occur.

Types of HTN:

1- Primary idiopathic Hypertension:

It is the most common type of hypertension that can be defined as elevated BP of unknown cause. It is one of the most important cardiovascular risk factors, resulting from environmental factors, dietary factors, genetic factors, and interactions among these factors can affect BP (15).

2- Secondary Hypertension:

Is less common type of hypertension that occurs because of a specific condition. Various conditions and medications can lead to secondary hypertension, including:

- Diseases such as adrenal gland tumors, thyroid problems, reno-vascular disease, kidney problems, and obstructive sleep apnea.

- Intoxication as found in acute alcohol abuse or chronic alcohol use, and in illegal drug use, such as cocaine and amphetamines.
- Iatrogenic routes caused by certain medications, such as birth control pills, decongestants, over-the-counter pain relievers, cold remedies, and some prescription drugs.
- Congenital anomalies leading to defects in blood vessels. **(15).**

It can be diagnosed in the following conditions:

- Young onset of grade 2 or 3 hypertension (<40 years), or sudden development of hypertension or rapidly worsening BP in older patients.
- History of renal/urinary tract disease.
- Recreational drug/substance or abuse/concurrent therapies: corticosteroids, nasal vasoconstrictor, chemotherapy, yohimbine, liquorice.
- Repetitive episodes of sweating, headache, anxiety, or palpitations, suggestive of Pheochromocytoma.
- History of spontaneous or diuretic-provoked hypokalaemia, episodes of muscle weakness, and tetany (hyperaldosteronism).
- Symptoms suggestive of thyroid disease or hyperparathyroidism.
- History of or current pregnancy and oral contraceptive use.
- History of sleep apnea. **(3).**

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