- Hypertension is defined as office systolic BP (SBP) values >_140 mmHg and/or diastolic BP (DBP) values >_90 mmHg.

Classification of office blood pressure and definitions of hypertension grade

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

Hypertansion is associated with risk of several CV events

- haemorrhagic stroke,
- ischaemic stroke,
- myocardial infarction,
- sudden death,
- heart failure,
- peripheral artery disease (PAD),
- end-stage renal disease.
- developing atrial fibrillation (AF),
- early elevations of BP leads to increased risk of cognitive decline and dementia.

Risk assessment

- Hypertension rarely occurs in isolation, and often clusters with other CV risk factors such as:
  - dyslipidaemia
  - glucose intolerance.
- This metabolic risk factor clustering has a multiplicative effect on CV risk.
- Since 2003, the European Guidelines on CVD prevention have recommended use of the Systematic COronary Risk Evaluation (SCORE) system because it is based on large, representative European cohort data sets
- https://www.escardio.org/static_file/Escardio/Subspecialty/EACPR/Documents/score-charts.pdf

SCORE - European High Risk Chart

10 year risk of fatal CVD in high risk regions of Europe by gender, age, systolic blood pressure, total cholesterol and smoking status

EAPC
European Association of Preventive Cardiology
European Society of Cardiology

How do I use the SCORE charts to assess CVD risk in asymptomatic persons?

- **1.** Use the **low risk charts** in Andorra, Austria, Belgium*, Cyprus, Denmark, Finland, France, Germany, Greece*, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, The Netherlands*, Norway, Portugal, San Marino, Slovenia, Spain*, Sweden*, Switzerland and the United Kingdom.
- Use the **high risk charts** in other European countries. Of these, some are **at very high risk** and the charts may underestimate risk in these. These include Albania, Algeria, Armenia, Azerbaijan, Belarus, Bulgaria, Egypt, Georgia, Kazakhstan, Kyrgyzstan, Latvia, FYR Macedonia, Moldova, Russian Federation, Syrian Arab Republic, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.
- *Updated, re-calibrated charts are now available for Belgium, Germany, Greece, The Netherlands, Spain, Sweden and Poland.
- **2.** Find the cell nearest to the person's age, cholesterol and BP values, bearing in mind that risk will be higher as the person approaches the next age, cholesterol or BP category.
- **3.** Check the qualifiers
  4. Establish the total 10 year risk for fatal CVD.

Relative Risk Charts

- Note that a low total cardiovascular risk in a young person may conceal a high relative risk; this may be explained to the person by using the relative risk chart. As the person ages, a high relative risk will translate into a high total risk. More intensive lifestyle advice will be needed in such persons. This chart refers to relative risk, not percentage risk, so that a person in the top right corner is at 12 times higher risk than a person in the bottom left corner.
- Another approach to explaining risk to younger persons is to use cardiovascular **risk age**. For example, in the high risk chart, a 40 year old male hypertensive smoker has a risk of 4%, which is the same as a 65 year old with no risk factors, so that his risk age is 65. This can be reduced by reducing his risk factors.

Risk estimation using SCORE: Qualifiers

- • The charts should be used in the light of the clinician’s knowledge and judgement, especially with regard to local conditions.
- • As with all risk estimation systems, risk will be over-estimated in countries with a falling CVD mortality rate, and under estimated if it is rising.
- • At any given age, risk appears lower for women than men. However, inspection of the charts shows that their risk is merely deferred by 10 years, with a 60 year old woman resembling a 50 year old man in terms of risk.

Risk estimation using SCORE: Qualifiers

Risk may be higher than indicated in the chart in:
- Sedentary or obese subjects, especially those with central obesity
- Those with a strong family history of premature CVD

- Socially deprived individuals and those from some ethnic minorities

- Individuals with diabetes- the SCORE charts should only be used in those with type 1 diabetes without target-organ damage; Other diabetic subjects are already at high to very high risk.

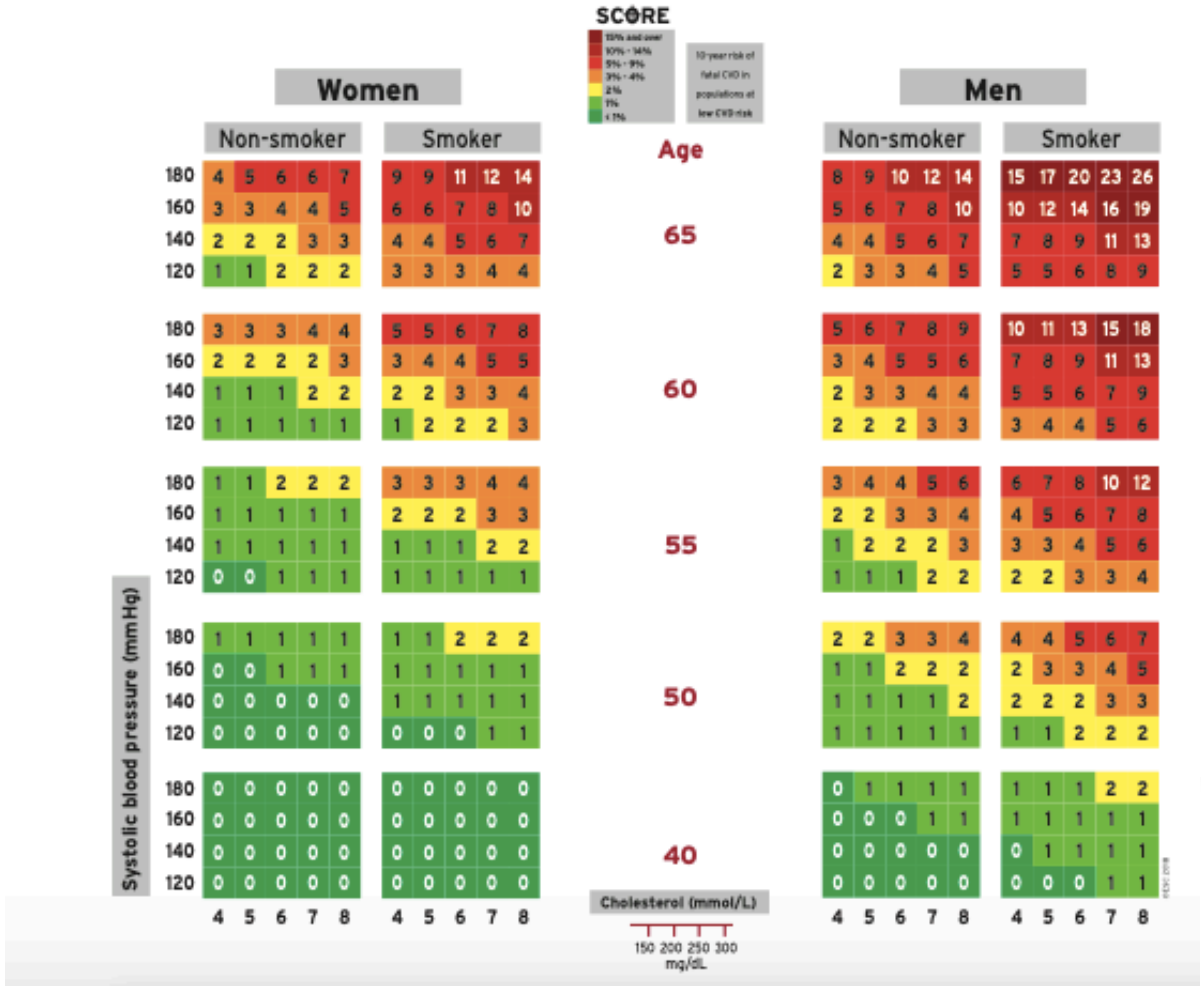
- Those with low HDL cholesterol* or increased triglyceride, fibrinogen, apoB, Lp(a) levels and perhaps increased high-sensitivity CRP.

- Asymptomatic subjects with evidence of pre-clinical atherosclerosis, for example plaque on ultrasonography.

- Those with moderate to severe chronic kidney disease (GFR <60 mL/min/1.73 m2)

SCORE - European Low Risk Chart

10 year risk of fatal CVD in low risk regions of Europe by gender, age, systolic blood pressure, total cholesterol and smoking status



EAPC
European Association of Preventive Cardiology
European Society of Cardiology

How do I use the SCORE charts to assess CVD risk in asymptomatic persons?

- **1.** Use the **low risk charts** in Andorra, Austria, Belgium*, Cyprus, Denmark, Finland, France, Germany, Greece*, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, The Netherlands*, Norway, Portugal, San Marino, Slovenia, Spain*, Sweden*, Switzerland and the United Kingdom.
- Use the **high risk charts** in other European countries. Of these, some are **at very high risk** and the charts may underestimate risk in these. These include Albania, Algeria, Armenia, Azerbaijan, Belarus, Bulgaria, Egypt, Georgia, Kazakhstan, Kyrgyzstan, Latvia, FYR Macedonia, Moldova, Russian Federation, Syrian Arab Republic, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.
- *Updated, re-calibrated charts are now available for Belgium, Germany, Greece, The Netherlands, Spain, Sweden and Poland.
- **2.** Find the cell nearest to the person's age, cholesterol and BP values, bearing in mind that risk will be higher as the person approaches the next age, cholesterol or BP category.
- **3.** Check the qualifiers
  4. Establish the total 10 year risk for fatal CVD.

Relative Risk Charts

- Note that a low total cardiovascular risk in a young person may conceal a high relative risk; this may be explained to the person by using the relative risk chart. As the person ages, a high relative risk will translate into a high total risk. More intensive lifestyle advice will be needed in such persons. This chart refers to relative risk, not percentage risk, so that a person in the top right corner is at 12 times higher risk than a person in the bottom left corner.
- Another approach to explaining risk to younger persons is to use cardiovascular **risk age**. For example, in the high risk chart, a 40 year old male hypertensive smoker has a risk of 4%, which is the same as a 65 year old with no risk factors, so that his risk age is 65. This can be reduced by reducing his risk factors.

Risk estimation using SCORE: Qualifiers

- The charts should be used in the light of the clinician’s knowledge and judgement, especially with regard to local conditions.
- • As with all risk estimation systems, risk will be over-estimated in countries with a falling CVD mortality rate, and under estimated if it is rising.
- • At any given age, risk appears lower for women than men. However, inspection of the charts shows that their risk is merely deferred by 10 years, with a 60 year old woman resembling a 50 year old man in terms of risk.

Risk estimation using SCORE: Qualifiers

- Risk may be higher than indicated in the chart in:
  - Sedentary or obese subjects, especially those with central obesity
  - Those with a strong family history of premature CVD
  - Socially deprived individuals and those from some ethnic minorities
- - Individuals with diabetes- the SCORE charts should only be used in
- those with type 1 diabetes without target-organ damage; Other diabetic
- subjects are already at high to very high risk
- - Those with low HDL cholesterol* or increased triglyceride, fibrinogen,
- apoB, Lp(a) levels and perhaps increased high-sensitivity CRP.
- - Asymptomatic subjects with evidence of pre-clinical atherosclerosis, for
- example plaque on ultrasonography.
- - Those with moderate to severe chronic kidney disease
- (GFR <60 mL/min/1.73 m2)

Factors influencing cardiovascular risk in patients with hypertension. **Demographic characteristics and laboratory parameters**

- Sex (men >women)
- Age
- Smoking (current or past history)
- Total cholesterol and HDL-C
- Uric acid
- Diabetes
- Overweight or obesity
- Family history of premature CVD (men aged <55 years and women aged <65 years)
- Family or parental history of early-onset hypertension
- Early-onset menopause
- Sedentary lifestyle
- Psychosocial and socioeconomic factors
- Heart rate (resting values >80 beats/min)

Factors influencing cardiovascular risk in patients with hypertension. Asymptomatic HMOD

•Arterial stiffening: Pulse pressure (in older people) ≥60 mmHg
•Carotid–femoral PWV >10 m/s

ECG LVH (Sokolow–Lyon index >35 mm, or R in aVL ≥11 mm; Cornell voltage duration product >2440 mm.ms, or Cornell voltage >28 mm in men or >20 mm in women)

Echocardiographic LVH [LV mass index: men >50 g/$m^{2.7}$; women >47 g/$m^{2.7}$ (height in $m^{2.7}$); indexation for BSA may be used in normal-weight patients; LV mass/BSA g/m^2 >115 (men) and >95 (women)]

Microalbuminuria (30–300 mg/24 h), or elevated albumin–creatinine ratio (30–300 mg/g; 3.4–34 mg/mmol) (preferentially on morning spot urine)[b]

Moderate CKD with eGFR >30–59 mL/min/1.73 m^2 (BSA) or severe CKD eGFR <30 mL/min/1.73 m^2 [b]

Ankle−brachial index <0.9

Advanced retinopathy: haemorrhages or exudates, papilloedema

Factors influencing cardiovascular risk in patients with hypertension.

Established CV or renal disease

- Cerebrovascular disease: ischaemic stroke, cerebral haemorrhage, TIA
- CAD: myocardial infarction, angina, myocardial revascularization
- Presence of atheromatous plaque on imaging
- Heart failure, including HFpEF
- Peripheral artery disease
- Atrial fibrillation

- BSA = body surface area;
- CAD = coronary artery disease;
- CKD = chronic kidney disease;
- CV = cardiovascular;
- CVD = cardiovascular disease;
- ECG = electrocardiogram;
- eGFR = estimated glomerular filtration rate;
- HDL-C = HDL cholesterol;
- HFpEF = heart failure with preserved ejection fraction;
- HMOD = hypertension-mediated organ damage;
- LV = left ventricular; LVH = left ventricular hypertrophy;
- PWV = pulse wave velocity;
- SCORE = Systematic COronary Risk Evaluation;
- TIA = transient ischaemic attack.

Ten year cardiovascular risk categories (Systematic COronary Risk Evaluation system)

Very high risk	**People with any of the following:**
	Documented CVD, either clinical or unequivocal on imaging. • **Clinical CVD** includes acute myocardial infarction, acute coronary syndror rization, stroke, TIA, aortic aneurysm, and PAD • **Unequivocal documented CVD on imaging** includes significant plaque ultrasound; it does not include increase in carotid intima-media thickness • **Diabetes mellitus with target organ damage**, e.g. proteinuria or a with hypertension or hypercholesterolaemia • **Severe CKD** (eGFR <30 mL/min/1.73 m^2) • **A calculated 10 year SCORE of ≥10%**
High risk	**People with any of the following:** • **Marked elevation of a single risk factor**, particularly cholesterol >8 mm cholesterolaemia or grade 3 hypertension (BP ≥180/110 mmHg) • **Most other people with diabetes mellitus** (except some young people out major risk factors, who may be at moderate-risk)
	Hypertensive LVH
	Moderate CKD eGFR 30-59 mL/min/1.73 m^2)
	A calculated 10 year SCORE of 5-10%
Moderate risk	**People with:** • **A calculated 10 year SCORE of ≥1 to <5%** • **Grade 2 hypertension** • **Many middle-aged people belong to this category**
Low risk	**People with:** • **A calculated 10 year SCORE of <1%**

Risk modifiers increasing cardiovascular risk estimated by the Systemic COronary Risk Evaluation (SCORE) system

- Social deprivation, the origin of many causes of CVD
- Obesity (measured by BMI) and central obesity (measured by waist circumference)
- Physical inactivity
- Psychosocial stress, including vital exhaustion
- Family history of premature CVD (occurring at age <55 years in men and <60 years in women)
- Autoimmune and other inflammatory disorders
- Major psychiatric disorders
- Treatment for infection with human immunodeficiency virus
- Atrial fibrillation
- LV hypertrophy
- CKD
- Obstructive sleep apnoea syndrome

HMOD hypertension-mediated organ damage

previously was termed ‘target organ damage’,

HMOD more accurately describes hypertension-induced structural and/or functional changes in major organs:

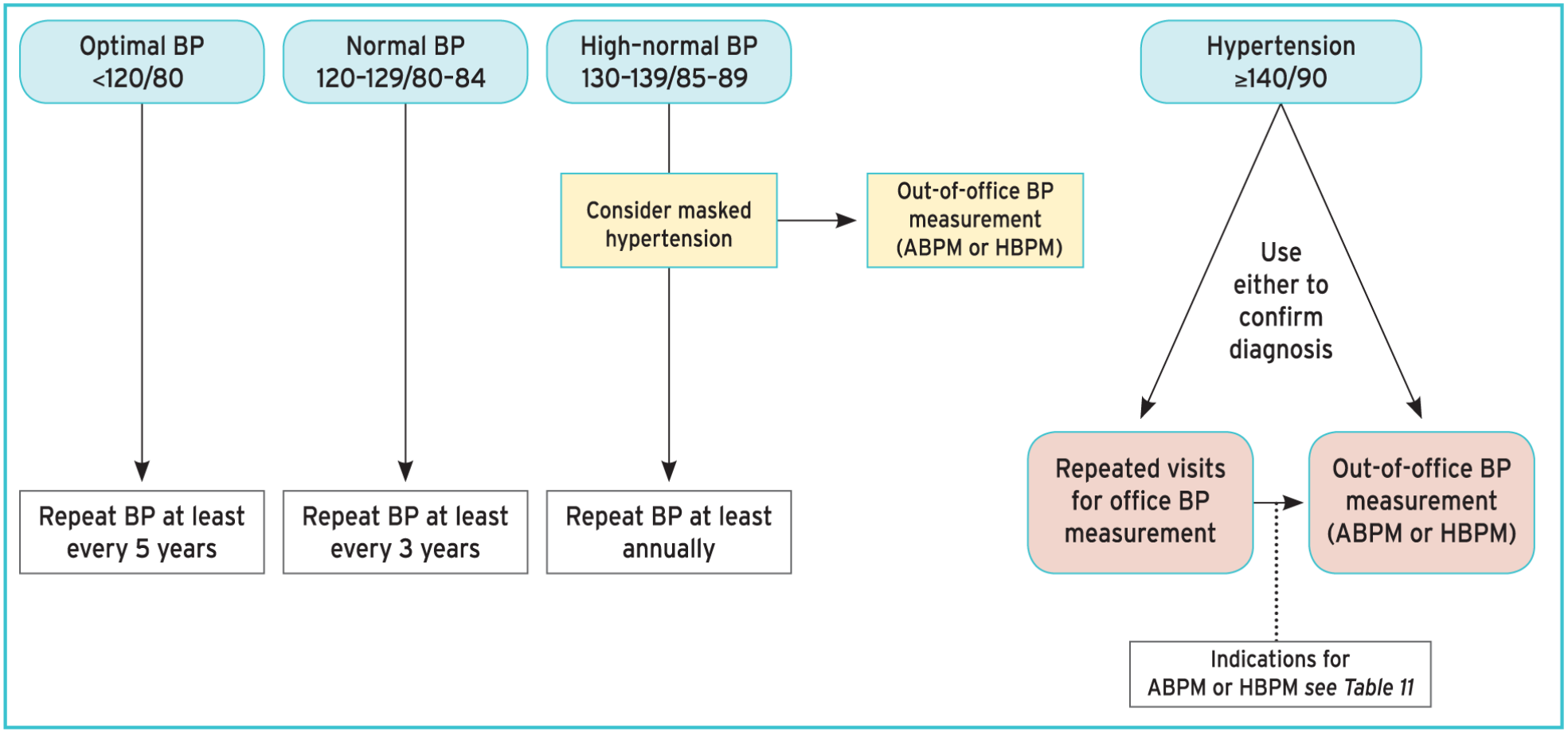
- heart,
- brain,
- retina,
- kidney,
- vasculature

Classification of hypertension stages according to blood pressure levels, presence of cardiovascular risk ...

Hypertension disease staging	Other risk factors, HMOD, or disease	BP (mmHg) grading			
		High normal SBP 130-139 DBP 85-89	Grade 1 SBP 140-159 DBP 90-99	Grade 2 SBP 160-179 DBP 100-109	Grade 3 SBP ≥180 or DBP ≥110
Stage 1 (uncomplicated)	No other risk factors	Low risk	Low risk	Moderate risk	High risk
	1 or 2 risk factors	Low risk	Moderate risk	Moderate to high risk	High risk
	≥3 risk factors	Low to Moderate risk	Moderate to high risk	High Risk	High risk
Stage 2 (asymptomatic disease)	HMOD, CKD grade 3, or diabetes mellitus without organ damage	Moderate to high risk	High risk	High risk	High to very high risk
Stage 3 (established disease)	Established CVD, CKD grade ≥4, or diabetes mellitus with organ damage	Very high risk	Very high risk	Very high risk	Very high risk

European Heart Journal, Volume 39, Issue 33, 01 September 2018, Pages 3021–3104, https://doi.org/10.1093/eurheartj/ehy339

Screening and diagnosis of hypertension. ABPM = ambulatory blood pressure monitoring; BP = blood pressure; …



European Heart Journal, Volume 39, Issue 33, 01 September 2018, Pages 3021–3104, https://doi.org/10.1093/eurheartj/ehy339

Office blood pressure measurement

- Patients should be seated comfortably in a quiet environment for 5 min before beginning BP measurements.
- 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 AF, in whom manual auscultatory methods should be used as most automated devices have not been validated for BP measurement in patients with AF.[a]

Office blood pressure measurement

- 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.
- 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.
- Record heart rate and use pulse palpation to exclude arrhythmia.

Key information to be collected in personal and family medical history

- **Risk factors**
- Family and personal history of hypertension, CVD, stroke, or renal disease
- Family and personal history of associated risk factors (e.g. familial hypercholesterolaemia)
- Smoking history
- Dietary history and salt intake
- Alcohol consumption
- Lack of physical exercise/sedentary lifestyle
- History of erectile dysfunction
- Sleep history, snoring, sleep apnoea (information also from partner)
- Previous hypertension in pregnancy/pre-eclampsia

Key information to be collected in personal and family medical history

- **History and symptoms of HMOD, CVD, stroke, and renal disease**
- Brain and eyes: headache, vertigo, syncope, impaired vision, TIA, sensory or motor deficit, stroke, carotid revascularization, cognitive impairment, dementia (in the elderly)
- Heart: chest pain, shortness of breath, oedema, myocardial infarction, coronary revascularization, syncope, history of palpitations, arrhythmias (especially AF), heart failure
- Kidney: thirst, polyuria, nocturia, haematuria, urinary tract infections
- Peripheral arteries: cold extremities, intermittent claudication, pain-free walking distance, pain at rest, peripheral revascularization
- Patient or family history of CKD (e.g. polycystic kidney disease)

Key information to be collected in personal and family medical history

- **History of possible secondary hypertension**
- 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 abuse/concurrent therapies: corticosteroids, nasal vasoconstrictor, chemotherapy, yohimbine, liquorice
- Repetitive episodes of sweating, headache, anxiety, or palpitations, suggestive of Phaeochromocytoma
- 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 apnoea

Key information to be collected in personal and family medical history

- **Antihypertensive Drug Treatment**
- Current/past antihypertensive medication including effectiveness and intolerance to previous medications
- Adherence to therapy

Physical examination

Body habitus

- Weight and height measured on a calibrated scale, with calculation of BMI
- Waist circumference

Physical examination

- **Signs of HMOD**
- Neurological examination and cognitive status
- Fundoscopic examination for hypertensive retinopathy
- Palpation and auscultation of heart and carotid arteries
- Palpation of peripheral arteries
- Comparison of BP in both arms (at least once)

Physical examination

- **Secondary hypertension**
- Skin inspection: cafe-au-lait patches of neurofibromatosis (phaeochromocytoma)
- Kidney palpation for signs of renal enlargement in polycystic kidney disease
- Auscultation of heart and renal arteries for murmurs or bruits indicative of aortic coarctation, or renovascular hypertension
- Comparison of radial with femoral pulse: to detect radio-femoral delay in aortic coarctation
- Signs of Cushing’s disease or acromegaly
- Signs of thyroid disease

Routine workup for evaluation of hypertensive patients

- **Routine laboratory tests**
- Haemoglobin and/or haematocrit
- Fasting blood glucose and glycated HbA_{1c}
- Blood lipids: total cholesterol, LDL cholesterol, HDL cholesterol
- Blood triglycerides
- Blood potassium and sodium
- Blood uric acid
- Blood creatinine and eGFR
- Blood liver function tests
- Urine analysis: microscopic examination; urinary protein by dipstick test or, ideally, albumin:creatinine ratio
- 12-lead ECG

Assessment of hypertension-mediated organ damage

Basic screening tests for HMOD	Indication and interpretation
12-lead ECG	Screen for LVH and other possible cardiac abnormalities, and to document heart rate and cardiac rhythm
Urine albumin:creatinine ratio	To detect elevations in albumin excretion indicative of possible renal disease
Blood creatinine and eGFR	To detect possible renal disease
Fundoscopy	To detect hypertensive retinopathy, especially in patients with grade 2 or 3 hypertension

More detailed screening for HMOD

Echocardiography	To evaluate cardiac structure and function, when this information will influence treatment decisions
Carotid ultrasound	To determine the presence of carotid plaque or stenosis, particularly in patients with cerebrovascular disease or vascular disease elsewhere
Abdominal ultrasound and Doppler studies	•To evaluate renal size and structure (e.g. scarring) and exclude renal tract obstruction as possible underlying causes of CKD and hypertension •Evaluate abdominal aorta for evidence of aneurysmal dilatation and vascular disease •Examine adrenal glands for evidence of adenoma or phaeochromocytoma (CT or MRI preferred for detailed examination); see section 8.2 regarding screening for secondary hypertension •Renal artery Doppler studies to screen for the presence of renovascular disease, especially in the presence of asymmetric renal size
PWV	An index of aortic stiffness and underlying arteriosclerosis
ABI	Screen for evidence of LEAD
Cognitive function testing	To evaluate cognition in patients with symptoms suggestive of cognitive impairment
Brain imaging	To evaluate the presence of ischaemic or haemorrhagic brain injury, especially in patients with a history of cerebrovascular disease or cognitive decline

- The prevalence of ECG LVH increases with the severity of hypertension. The most commonly used criteria to define ECG LVH are

ECG voltage criteria	Criteria for LVH
$S_{V1}+R_{V5}$ (Sokolow–Lyon criterion)	>35 mm
R wave in aVL	≥11 mm
$S_{V3}+R_{aVL}$ (Cornell voltage) Cornell duration product	>28 mm (men)
	>20 mm (women)
	>2440 mm.ms