Hypertension in teenagers

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Guidelines

2016 European Society of Hypertension guidelines for the management of high blood pressure in children and adolescents

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J Hypertens 2016, 34:1887–1920

Hypertension in teenagers

13 – 19 yrs

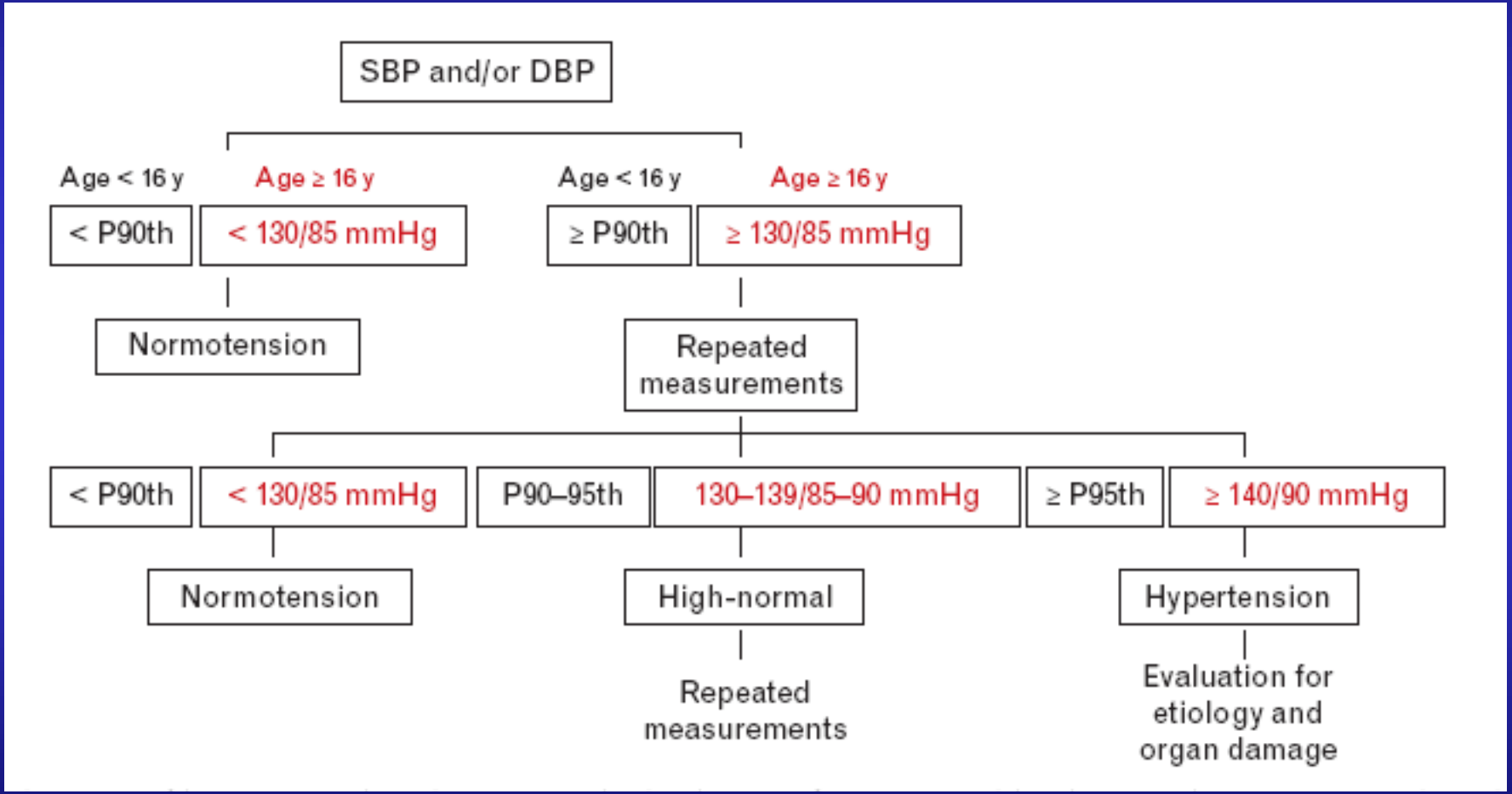
	13 – 15 yrs	16 – 19 yrs
Definition	**≥ 95th percentile**	**≥ 140/90 mmHg**

BP for boys by age and height percentiles

Age (years)	BP percentile	SBP (mmHg) percentile of height							DBP (mmHg) percentile of height						
		5th	10th	25th	50th	75th	90th	95th	5th	10th	25th	50th	75th	90th	95th
1	90th	94	95	97	99	100	102	103	49	50	51	52	53	53	54
	95th	98	99	101	103	104	106	106	54	54	55	56	57	58	58
	99th	105	106	108	110	112	113	114	61	62	63	64	65	66	66
2	90th	97	99	100	102	104	105	106	54	55	56	57	58	58	59
	95th	101	102	104	106	108	109	110	59	59	60	61	62	63	63
	99th	109	110	111	113	115	117	117	66	67	68	69	70	71	71
3	90th	100	101	103	105	107	108	109	59	59	60	61	62	63	63
	95th	104	105	107	109	110	112	113	63	63	64	65	66	67	67
	99th	111	112	114	116	118	119	120	71	71	72	73	74	75	75
4	90th	102	103	105	107	109	110	111	62	63	64	65	66	66	67
	95th	106	107	109	111	112	114	115	66	67	68	69	70	71	71
	99th	113	114	116	118	120	121	122	74	75	76	77	78	78	79
5	90th	104	105	106	108	110	111	112	65	66	67	68	69	69	70
	95th	108	109	110	112	114	115	116	69	70	71	72	73	74	74
	99th	115	116	118	120	121	123	123	77	78	79	80	81	81	82
6	90th	105	106	108	110	111	113	113	68	68	69	70	71	72	72
	95th	109	110	112	114	115	117	117	72	72	73	74	75	76	76
	99th	116	117	119	121	123	124	125	80	80	81	82	83	84	84
7	90th	106	107	109	111	113	114	115	70	70	71	72	73	74	74
	95th	110	111	113	115	117	118	119	74	74	75	76	77	78	78
	99th	117	118	120	122	124	125	126	82	82	83	84	85	86	86
8	90th	107	109	110	112	114	115	116	71	72	72	73	74	75	76
	95th	111	112	114	116	118	119	120	75	76	77	78	79	79	80
	99th	119	120	122	123	125	127	127	83	84	85	86	87	87	88
9	90th	109	110	112	114	115	117	118	72	73	74	75	76	76	77
	95th	113	114	116	118	119	121	121	76	77	78	79	80	81	81
	99th	120	121	123	125	127	128	129	84	85	86	87	88	88	89
10	90th	111	112	114	115	117	119	119	73	73	74	75	76	77	78
	95th	115	116	117	119	121	122	123	77	78	79	80	81	81	82
	99th	122	123	125	127	128	130	130	85	86	86	88	88	89	90
11	90th	113	114	115	117	119	120	121	74	74	75	76	77	78	78
	95th	117	118	119	121	123	124	125	78	78	79	80	81	82	82
	99th	124	125	127	129	130	132	132	86	86	87	88	89	90	90
12	90th	115	116	118	120	121	123	123	74	75	75	76	77	78	79
	95th	119	120	122	123	125	127	127	78	79	80	81	82	82	83
	99th	126	127	129	131	133	134	135	86	87	88	89	90	90	91
13	90th	117	118	120	122	124	125	126	75	75	76	77	78	79	79
	95th	121	122	124	126	128	129	130	79	79	80	81	82	83	83
	99th	128	130	131	133	135	136	137	87	87	88	89	90	91	91
14	90th	120	121	123	125	126	128	128	75	76	77	78	79	79	80
	95th	124	125	127	128	130	132	132	80	80	81	82	83	84	84
	99th	131	132	134	136	138	139	140	87	88	89	90	91	92	92
15	90th	122	124	125	127	129	130	131	76	77	78	79	80	80	81
	95th	126	127	129	131	133	134	135	81	81	82	83	84	85	85
	99th	134	135	136	138	140	142	142	88	89	90	91	92	93	93
16	90th	125	126	128	130	131	133	134	78	78	79	80	81	82	82
	95th	129	130	132	134	135	137	137	82	83	83	84	85	86	87
	99th	136	137	139	141	143	144	145	90	90	91	92	93	94	94
17	90th	127	128	130	132	134	135	136	80	80	81	82	83	84	84
	95th	131	132	134	136	138	139	140	84	85	86	87	87	88	89
	99th	139	140	141	143	145	146	147	92	93	93	94	95	96	97

reference values for adults are recommended.

Diagnosis of hypertension



J Hypertens 2016, 34:1887–1920

Classification of hypertension in children up to 15 years

Category	SBP and/or DBP percentile
Normal	< 90th
High-normal	≥ 90th to < 95th percentile
Hypertension	≥ 95th percentile
Stage 1 hypertension	95th percentile to the 99th percentile and 5mmHg
Stage 2 hypertension	> 99th percentile plus 5mmHg
ISH	SBP ≥ 95th percentile and DBP < 90th percentile

J Hypertens 2016, 34:1887–1920

Classification of hypertension in adolescents (>16 yrs)

Category	SBP and/or DBP (mmHg)
Normal	< 130/85
High-normal	130–139/85–89
Hypertension	≥ 140/90
Stage 1 hypertension	140–159/90–99
Stage 2 hypertension	160–179/100–109
ISH	≥ 140/<90

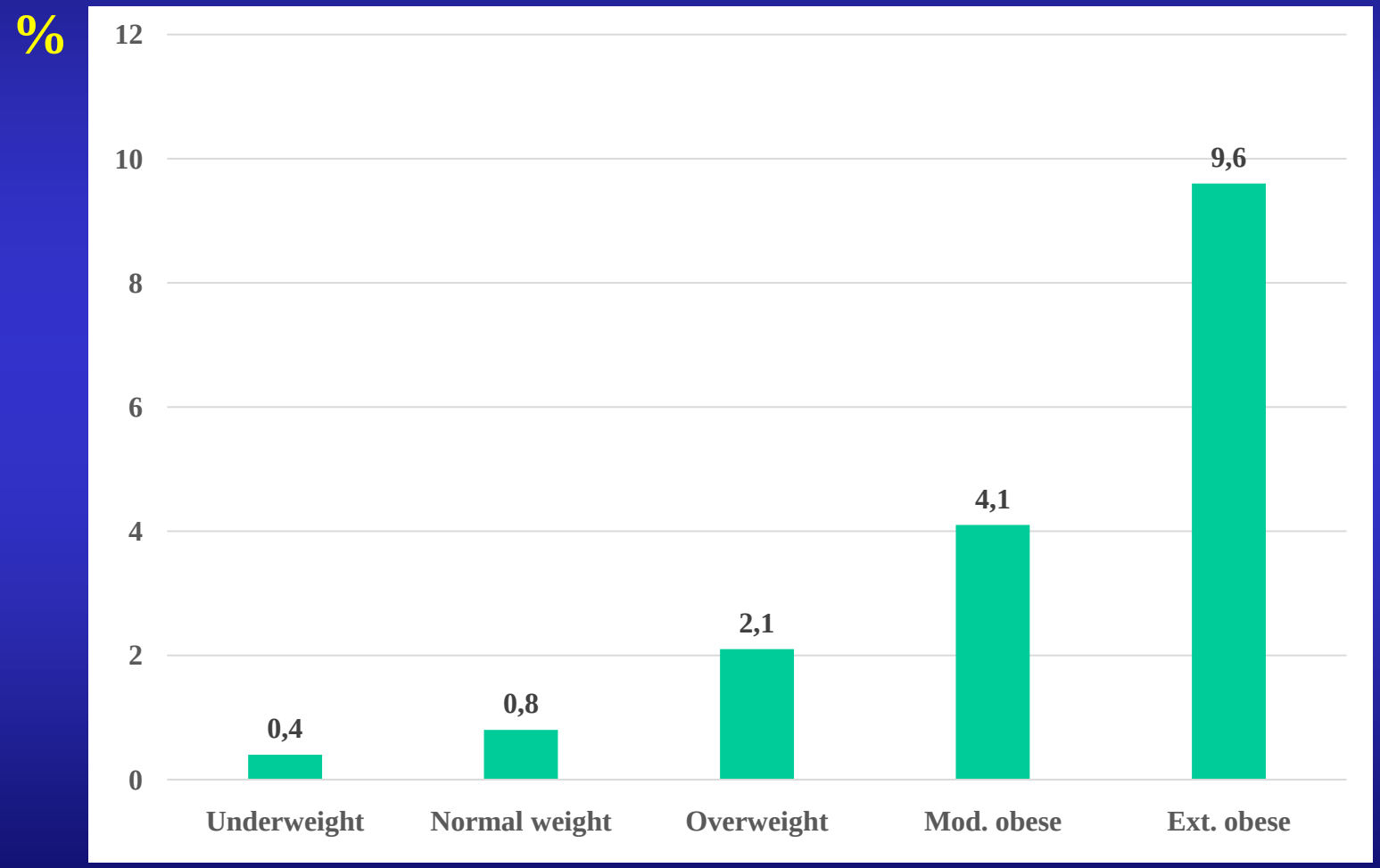
J Hypertens 2016, 34:1887–1920

BP measurement

- Auscultatory method; conventional device
- Cuff size!!
- Caution: cuff overblowing
- At least 2 measurements during each visit
- Repeated visits
- DBP – Korotkoff V

Prevalence of hypertension in adolescents

aged 12 – 19 yrs by weight class



J Clin Hypertens (Greenwich) 2013;15:793–805

Adj. prevalence of hypertension in adolescents aged 12 – 19 yrs by weight class

Weight categories	
Underweight	**0.56** (0.32 – 0.99)
Normal weight	**1.0**
Overweight	**2.68** (2.39 – 3.00)
Moderate obesity	**5.29** (4.76 – 5.87)
Extreme obesity	**12.44** (11.27 – 13.74)

J Clin Hypertens (Greenwich) 2013;15:793–805

ORIGINAL PAPER

High Blood Pressure in Overweight and Obese Youth: Implications for Screening

Corinna Koebnick, PhD;[1] Mary Helen Black, PhD;[1] Jun Wu, MD, MS;[1] Mayra P. Martinez, MPH;[1] Ning Smith, PhD;[1,2] Beatriz Kuizon, MD;[3] David Cuan, MD;[4] Deborah Rohm Young, PhD;[1] Jean M. Lawrence, ScD, MPH, MSSA;[1] Steven J. Jacobsen, PhD, MD[1]

From the Department of Research and Evaluation, Kaiser Permanente Southern California, Pasadena, CA;[1] Center for Health Research, Kaiser Permanente Northwest, Portland, OR;[2] Pediatric Nephrology, Kaiser Permanente Los Angeles Medical Center, Los Angeles, CA;[3] and Department of Pediatrics, Kaiser Permanente Riverside Medical Center, Riverside, CA[4]

- **n=237,248, aged 6 – 17 years**

The prevalence of hypertension was best predicted by a BMI-for-age ≥94th percentile.

These results suggest that all obese youth should be screened for hypertension.

J Clin Hypertens (Greenwich) 2013;15:793–805

Hypertension in teenagers

- Less frequent than in adults
- Prevalence increases with age and BMI
- BP ≥ 95th percentile by age, gender, and height up to the age of 15 yrs
- BP ≥ 140/90 mmHg from 16 yrs
- EH is the most common form of hypertension
- Secondary HT is more common than in adults

Recommendations for 24-h ABPM

During the process of diagnosis

- Confirm hypertension before starting antihypertensive drug treatment to avoid treatment of white-coat hypertension
- Target organ damage (LVH and microalbuminuria) and office BP normal (masked hypertension)
- DM1 and DM2
- CKD
- Renal, liver or heart transplant
- Severe obesity with or without sleep-disordered breathing
- Hypertensive response during the treadmill test
- Discrepancy between office BP and home BP

During antihypertensive drug treatment

- Evaluate for apparent drug-resistant hypertension
- Assessment of BP control in children with target organ damage
- Symptoms of hypotension

Clinical trials

Other clinical conditions

- Autonomic dysfunction
- Suspicion of catecholamine-secreting tumors

J Hypertens 2016, 34:1887–1920

Ambulatory BP by age

boys

Boys												
	24-h				Day				Night			
Age (years)	50th	75th	90th	95th	50th	75th	90th	95th	50th	75th	90th	95th
5	105/65	109/69	113/72	116/74	111/72	116/76	120/79	123/81	95/55	99/59	103/62	106/65
6	106/66	110/69	115/73	118/75	112/72	116/76	121/79	124/81	96/55	100/59	105/63	108/66
7	106/66	111/70	116/73	119/75	112/73	117/76	122/80	125/82	96/56	101/60	106/64	110/67
8	107/66	112/70	117/73	120/75	112/73	117/76	122/80	125/82	97/56	102/60	108/64	111/67
9	108/67	113/70	118/73	121/75	113/72	118/76	123/80	126/82	97/56	103/60	109/64	112/67
10	109/67	114/70	119/73	123/75	113/72	119/76	124/80	127/82	98/56	104/60	110/64	113/67
11	110/67	116/71	121/74	125/76	115/72	121/76	126/80	129/82	99/56	105/60	111/64	115/67
12	113/67	118/71	124/74	127/76	117/72	123/76	128/80	132/82	101/56	107/60	113/64	116/67
13	115/67	121/71	126/74	130/76	120/72	126/76	131/80	135/82	103/56	109/60	115/64	119/67
14	118/68	124/71	129/75	133/77	122/73	129/77	134/80	138/82	106/57	112/61	118/64	121/67
15	121/68	127/72	132/75	136/77	125/73	132/77	137/81	141/83	108/57	114/61	120/64	123/66
16	123/69	129/72	135/76	138/78	128/74	135/78	140/81	144/84	111/57	117/61	123/64	126/66

J Hypertens 2016, 34:1887–1920

Home BPM

Methodological aspects

- Measured daily on at least 3–4 days, preferably on 7 consecutive days in the mornings as well as in the evenings
- Measured in **a quiet room**, with the patient in the seated position, back and arm supported, **after 5min of rest**
- Two measurements per occasion taken 1–2min apart
- Home blood pressure is the average of these readings, with exclusion of the first monitoring day

Clinical indications for use

- All patients receiving antihypertensive medication
- Suspicion of white-coat hypertension
- Conditions where strict blood pressure control is mandatory (high-risk patients)
- Clinical trials

J Hypertens 2016, 34:1887–1920

Systolic and diastolic home blood pressure values by height

Height (cm)	Percentiles for boys ($n = 347$)		Percentiles for girls ($n = 420$)	
	50th	95th	50th	95th
120–129	105/64	119/76	101/64	119/74
130–139	108/64	121/77	103/64	120/76
140–149	110/65	125/77	105/65	122/77
150–159	112/65	126/78	108/66	123/77
160–169	115/65	128/78	110/66	124/78
170–179	117/66	132/78	112/66	125/79
180–189	121/67	134/79	114/67	128/80

J Hypertens 2016, 34:1887–1920

The most common types of hypertension in teenagers

- EH
- Secondary causes
  - Renal parenchymal disease
    - Chronic pyelonephritis
    - Focal segmental glomerulosclerosis
    - Chronic glomerulosclerosis
  - Cocaine abuse, amphetamine
  - Anorectics

When to screen for fibromuscular dysplasia

1. Age < 30 yrs, especially women
2. Stage 3 hypertension (≥ 180/110 mmHg) or worsening of hypertension
3. Resistant hypertension
4. Small kidney without a history of renal or urological disease
5. Abdominal bruit without manifest atherosclerosis
6. FMD in another vascular bed

History

Family history:

in parents and grandparents

- **Hypertension, CVD, diabetes, dyslipidemia, obesity**
- **Hereditary kidney disease (polycystic kidney disease)**
- **Hereditary endocrine diseases (pheo, fam hyperaldosteronism, Type-2 MEN)**
- **Hypertension-associated syndromes (neurofibromatosis)**

History

Perinatal history:

- **Birth weight**
- **Gestational age, oligohydramnios, anoxia and umbilical artery catheterization**

History

Personal history:

- **Hypertension**
- **Urinary tract infection, renal or urological disease**
- **Cardiac or endocrine (including diabetes mellitus), or neurological diseases**
- **Growth retardation**

Symptoms suggestive of secondary hypertension

- Dysuria
- Thirst/polyuria
- Nycturia, hematuria
- Edema, weight loss, failure to thrive
- Palpitations, sweating, fever, pallor, flushing
- Cold hands and feet, intermittent claudication
- Virilization, primary amenorrhea, and male pseudohermaphroditism

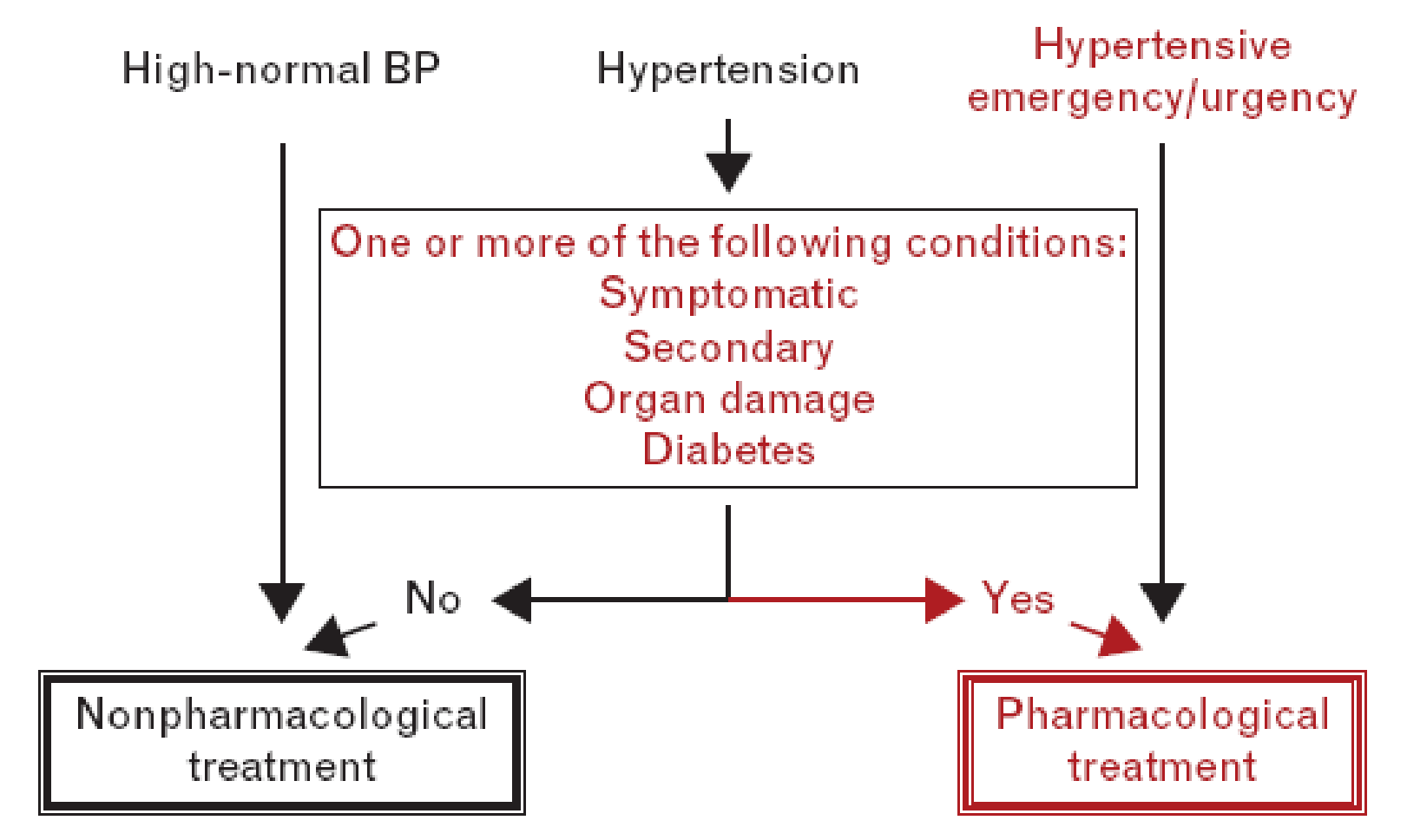
Symptoms suggestive of organ damage

- Headache, epistaxis, vertigo, impaired vision
- Facial palsy, stroke
- Dyspnoe

Medication

- Antihypertensive drugs
- Steroids, CyA, tacrolimus
- Tricyclic antidepressants, atypical antipsychotics
- Decongestants
- Oral contraceptives
- Illegal substance

When to initiate antihypertensive treatment



J Hypertens 2016, 34:1887–1920

Non-pharmacological treatment

- Weight reduction in the obese and overweight
- Physical activity
  - Aerobic exercise
  - Strength exercise, weight lifting
- Dietary measures
  - Salt

Pharmacological treatment

- Failure of lifestyle measures
- Symptoms
- Secondary hypertension
- Organ damage
- Severe hypertension
- Diabetes

Hypertension in teenagers

1. Isolated systolic hypertension
2. Systolic-diastolic hypertension

Isolated systolic hypertension in young individuals

Hypotheses of pathogenesis

1. **ISH in young individuals is abnormal**

   ↑SV and/or ↑aortic stiffness

2. **ISH in young individuals is a „spurious condition“**

   ↑PP due to pulse wave amplification and back reflection; ↑ arterial elasticity

CONTROVERSIES IN HYPERTENSION

Isolated Systolic Hypertension in Young People Is Not Spurious and Should Be Treated

Pro Side of the Argument

Carmel M. McEniery, Stanley S. Franklin, John R. Cockcroft, Ian B. Wilkinson

Essential hypertension is a common condition, affecting ≈ 25% of the population[1,2] and is the leading cause of death and disability worldwide.[3] No longer viewed as a single disorder, essential hypertension has many different forms, including isolated systolic hypertension (ISH), the most common form of hypertension in older adults, affecting ≈50% of those aged ≥60 years.[4] Historically, ISH in older individuals was viewed as benign and merely part of the natural ageing process. However, evidence from epidemiological and intervention studies now demonstrates that older individuals subject of continued debate.[17,18] Indeed, the terms spurious and pseudo have been applied to ISH in young subjects. We think that ISH in young people is associated with increased future risk and requires careful evaluation and treatment. As such, the terms spurious and pseudo hypertension are unjustified.

Origins of the Term Spurious ISH in Young People

The terms spurious or pseudo hypertension are usually

Hypertension 2016; 68: 269-275

CONTROVERSIES IN HYPERTENSION

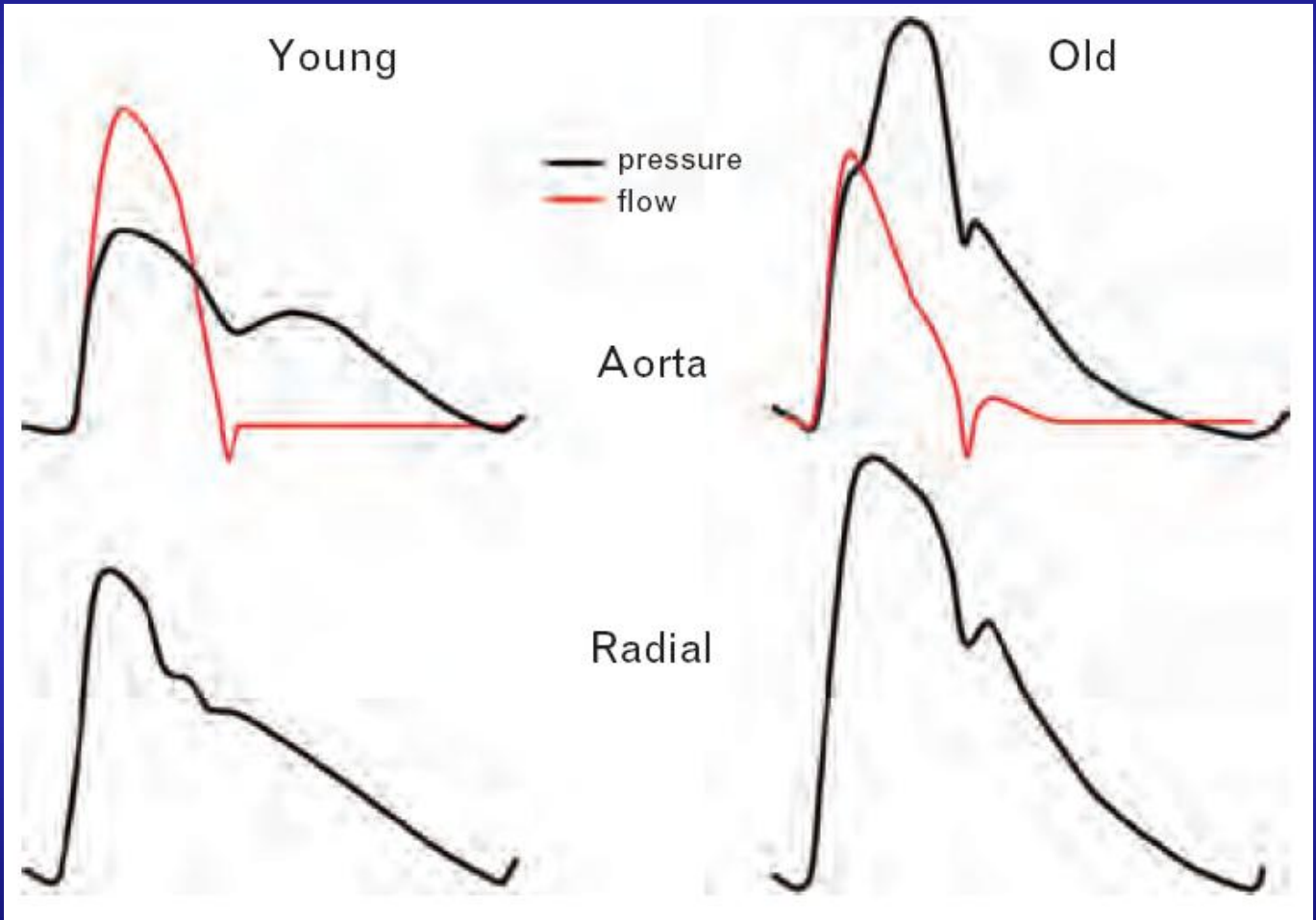
Isolated Systolic Hypertension in Young People Is Not Spurious and Should Be Treated

Con Side of the Argument

Empar Lurbe, Josep Redon

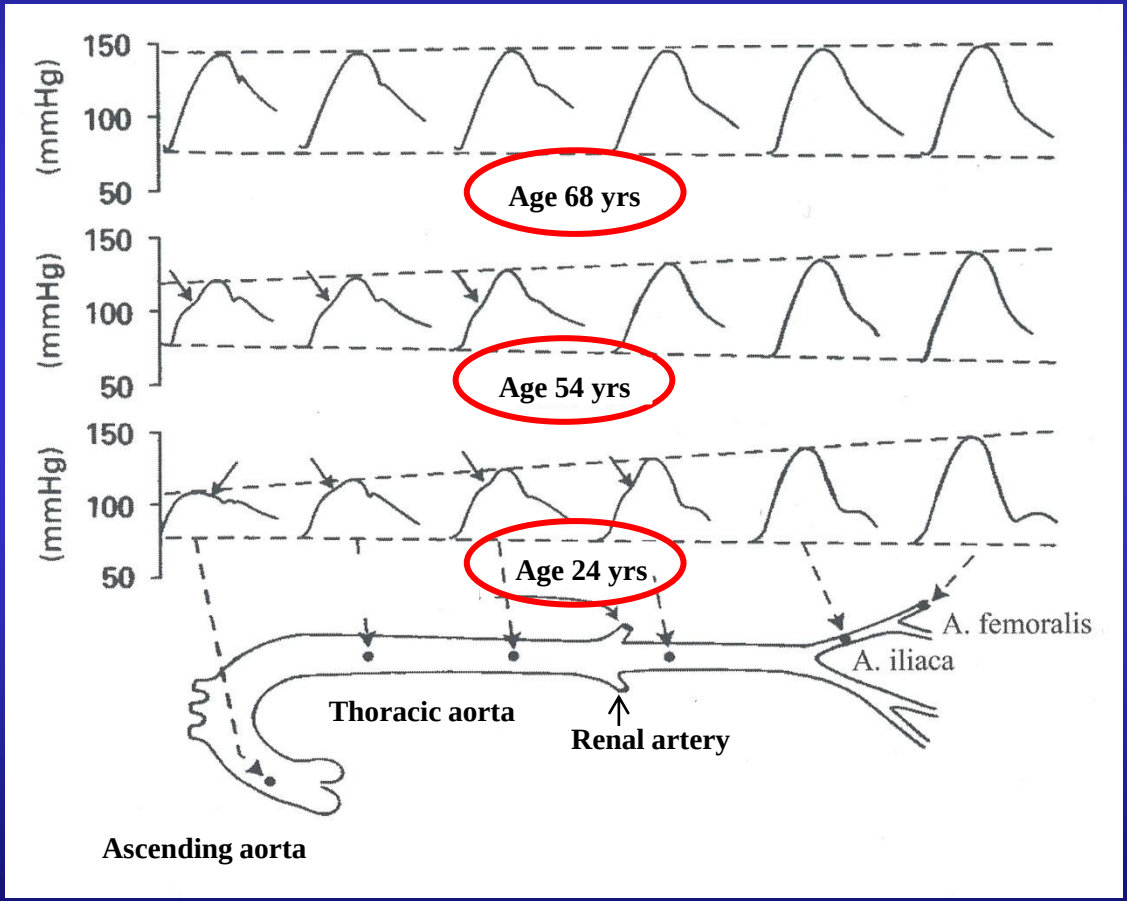
Isolated systolic hypertension (ISH) in young people, defined on the basis of brachial blood pressure (BP) as a systolic BP (SBP) of at least 140 mm Hg with a diastolic BP (DBP) of <90 mm Hg, is not an unusual condition and is increasing in prevalence.[1–3] To date, this concept has been confronted with challenges in the mechanisms, clinical relevance, and consequences. Parameters other than brachial BP, such as noninvasive central hemodynamics, have introduced new insights to a United States pediatric population of 12- to 16-year olds, the most prevalent hypertensive subtype was ISH.[5] Similarly, in Spanish obese youths, the overall prevalence of ISH was 4%, outnumbering systo-diastolic hypertension (SDH) by a ratio of 2:1.[6] Along with age, ethnicity, and obesity, the number of BP measurements at the time of establishing the diagnosis is a factor which affects the prevalence, the lower the number of measurements the higher the prevalence.[5]

Blood pressure amplification



J Hypertens 2013, 31:649–654

Pressure waves in large arteries in individuals of different age

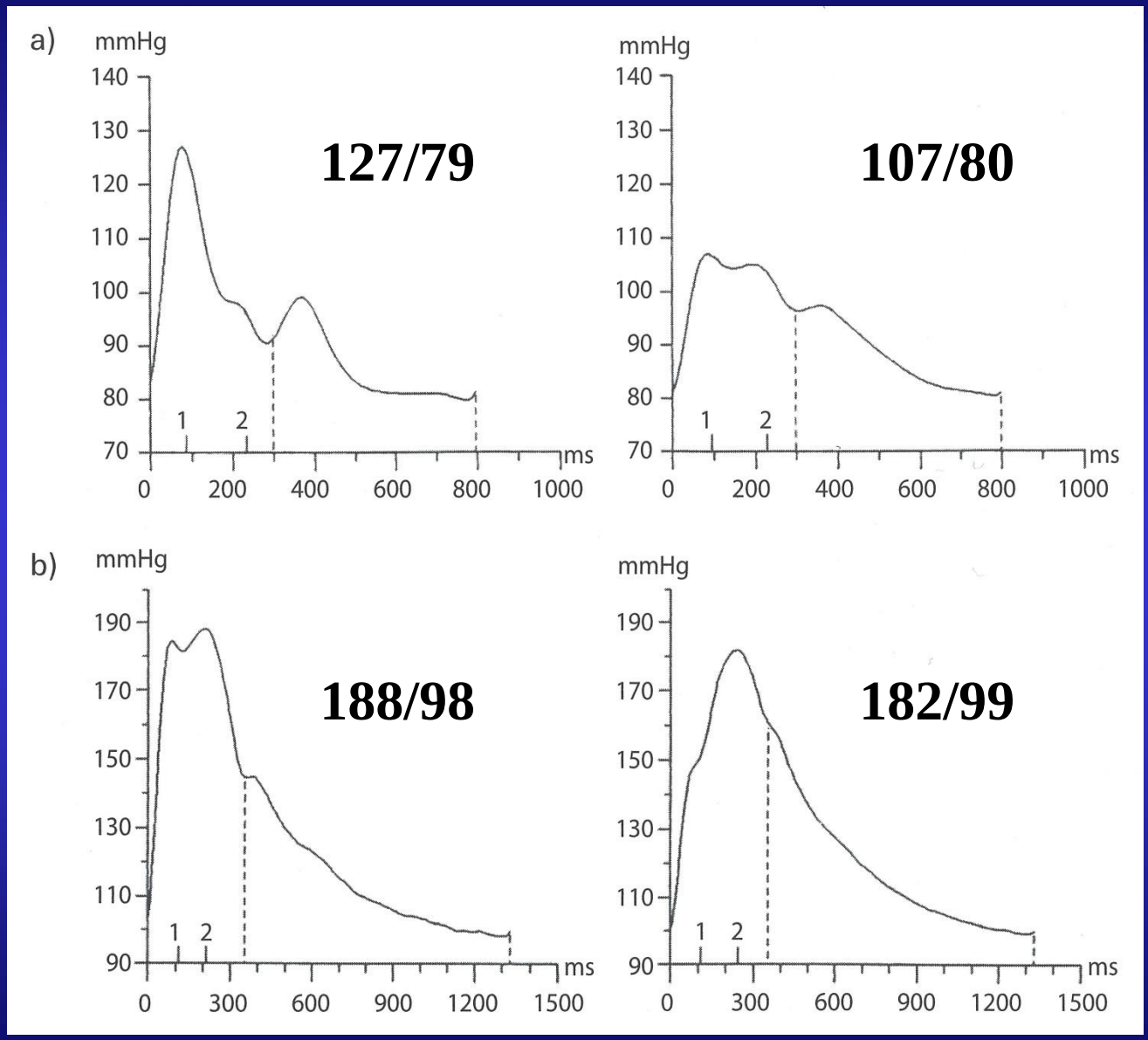


Nichols WW, 1998

a. radialis aorta

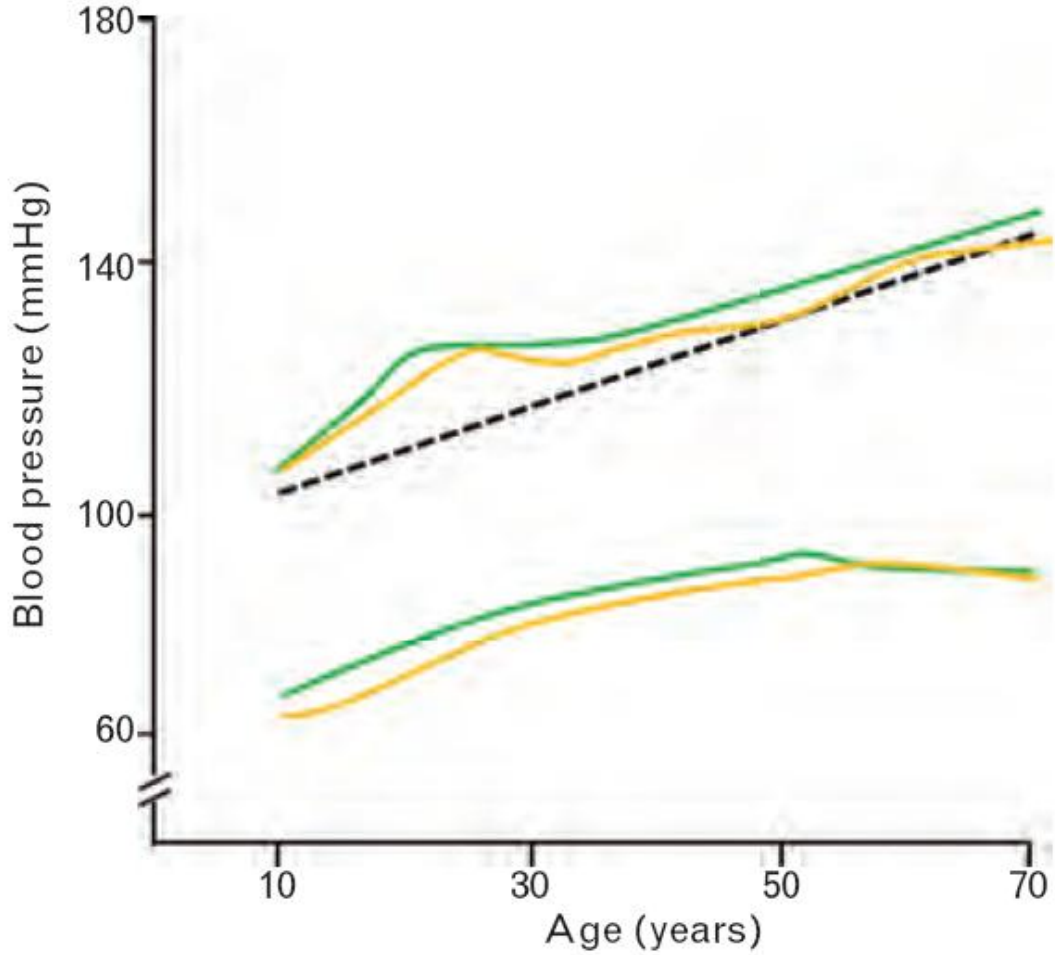
♂ 22 yrs

♀ 78 yrs



Filipovsky J, 2014

Brachial BP and SBP in aorta



Brachial BP, US NHS

Brachial BP, Austral.

Aortic SBP, cath.

Nichols WW et al., 2011

BMJ

RESEARCH

Association of blood pressure in late adolescence with subsequent mortality: cohort study of Swedish male conscripts

Johan Sundström, associate professor,[1] Martin Neovius, associate professor,[2] Per Tynelius, statistician,[3] Finn Rasmussen, professor[3]

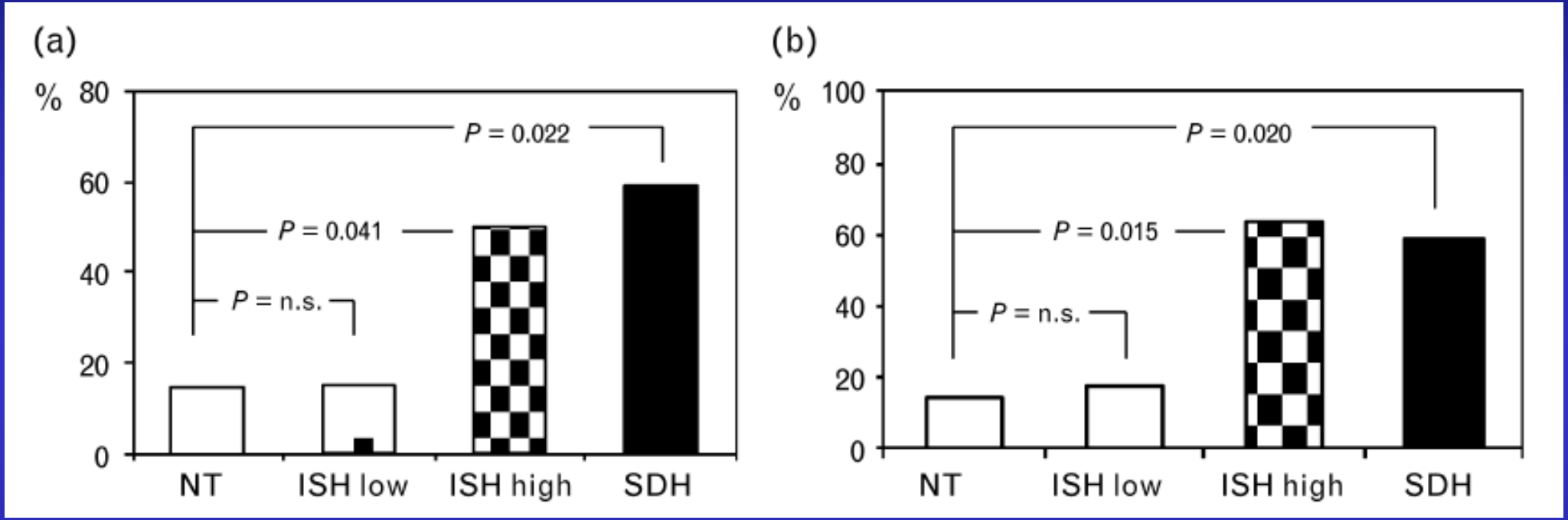
1 207 141 men, mean age 18.4 yrs, FU median 24 yrs

Conclusions

In adolescent men, the relation of diastolic blood pressure to mortality was more consistent than that of systolic blood pressure.

BMJ 2011;342:d643

Incidence of sustained hypertension

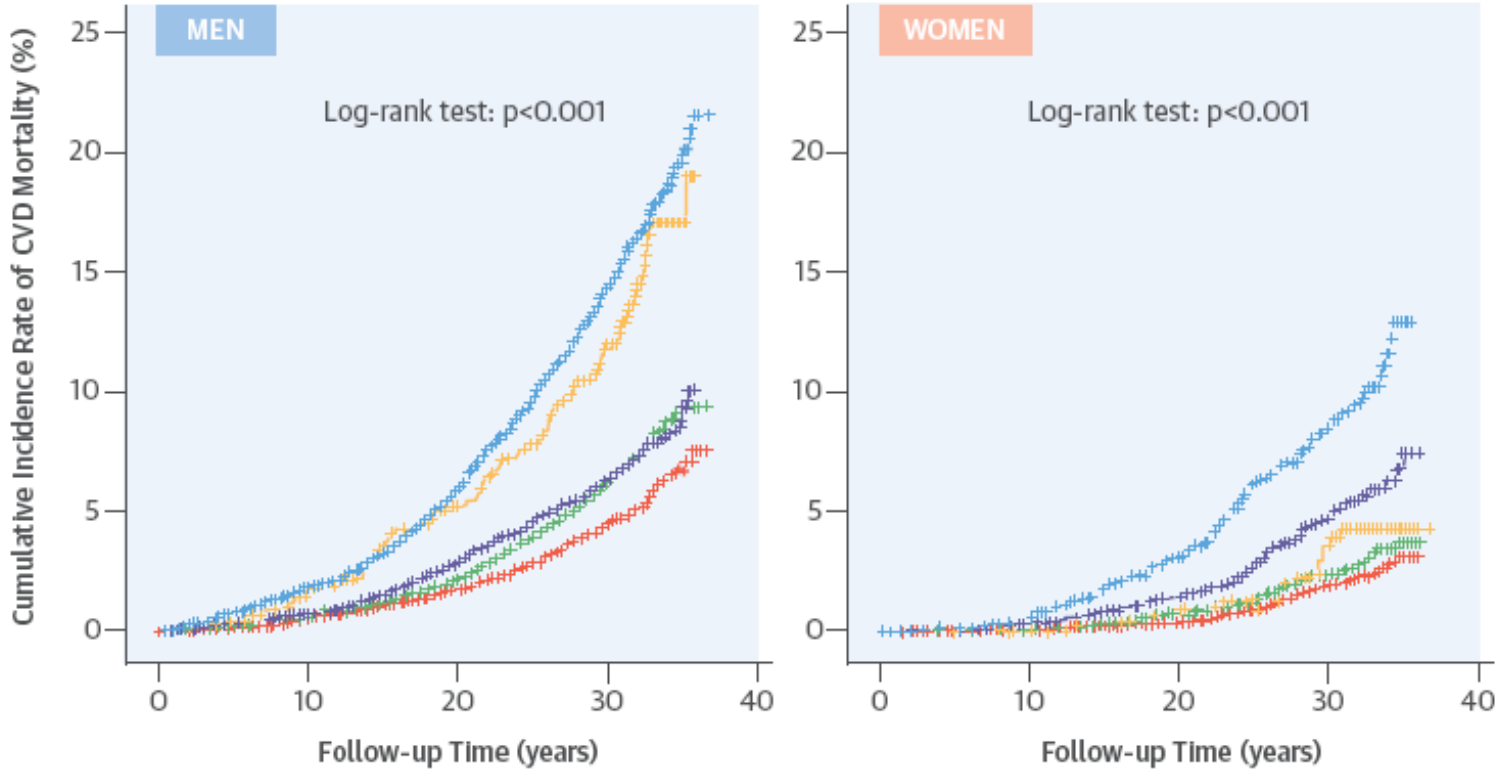


cSBP<120.5 mmHg

cSBP<125 mmHg

J Hypertens 2011; 291:311-1319

Chicago Heart Association Detection Project in Industry



Number at risk								
SDE	3149	3028	2763	930	1085	1062	994	855
IDH	589	569	523	191	328	323	309	283
ISH	4015	3940	3748	1565	1446	1425	1373	1237
High-normal BP	3854	3786	3643	1472	2419	2402	2336	2176
Optimal-normal BP	4261	4202	4067	1565	5935	5890	5747	5416

JACC 2015;65:327-335

Original Article

Central blood pressure and pulse wave amplification across the spectrum of peripheral blood pressure in overweight and obese youth

Empar Lurbe[a,b], María Isabel Torro[a,b], Julio Alvarez-Pitti[a,b], Pau Redon[a,b], and Josep Redon[b,c,d]

Conclusion: In overweight and obese hypertensive patients, ISH is prevalent, posing a challenge for the clinician of whether these may therefore be diagnosed and managed as hypertensive patients. Until prospective studies can give more knowledge, 24-h ABPM can offer information for making clinical decisions.

J Hypertens 2016: 34:1389–1395

Conclusions

Hypertension in teenagers

- Less common than in adults
- Essential hypertension most common
- Non-pharmacological treatment
- Pharmacological treatment: symptoms, secondary hypertension, organ damage, severe hypertension, diabetes
- ISH: higher brachial SBP may be due to back reflection pressure wave in hyperelastic arteries