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SPECIAL ARTICLE

Recommendations for participation in competitive sports of athletes with arterial hypertension: a position statement from the sports cardiology section of the European Association of Preventive Cardiology (EAPC)

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Current guidelines of the European Society of Cardiology advocate regular physical activity as a Class IA recommendation for the prevention and treatment of cardiovascular disease. Despite its undisputed multitude of beneficial effects, competitive athletes with arterial hypertension may be exposed to an increased risk of cardiovascular events. This document is an update of the 2005 recommendations and will give guidance to physicians who have to decide on the risk of an athlete during sport participation.

Keywords Leisure time • Physical activity • Exercise training • Competition

Introduction

Arterial hypertension is the most relevant risk factor for cardiovascular disease worldwide and one of the most common abnormalities identified during clinical evaluation of athletes.[1] The European Society of Cardiology (ESC) guidelines advocate regular physical activity as a Class IA recommendation for the prevention and treatment of cardiovascular disease,[2] which is contributing to the growing number of hypertensive individuals who train regularly and wish to engage in competitive sport.[3]

Arterial hypertension has been recognized as a risk factor to coronary artery disease progression and left ventricular (LV) hypertrophy, which represent substrates for myocardial infarction and ventricular arrhythmias.[4] Moreover, arterial hypertension induces structural changes in end-organs including the retina, kidneys, and brain that can lead to injury and increase the risk of spontaneous haemorrhage.[5] Furthermore, an acute increase in blood pressure (BP) during effort may trigger atherosclerotic plaque rupture[6–9] leading to ischaemic myocardial or cerebrovascular events.[4,6–9] Therefore, timely identification of hypertensive individuals is paramount in the setting of pre-participation screening, in order to implement a healthier lifestyle, appropriate management and follow-up.[10–13]

For the purpose of the present position statement, our panel of experts was to propose recommendations, which represent the best possible balance between risks and benefits inherent with competitive sports participation, based on scientific evidence, when available, and consensus of experts. Detailed information on the classification, prevalence, evaluation, and recommendation for patients with arterial hypertension can be found in the current European Society of Hypertension (ESH)/ESC guidelines.[5]

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In this document, competitive athletes are defined as individuals of all ages, who engage in exercise training on a regular basis and participate in official sports competition, be it as amateurs or professionals.[14,15]

Classification

Hypertension is defined as systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg (*Table 1*), repeatedly measured in the office.[16] Importantly, children and adolescents have lower BP levels with normal values <120/80 mmHg.[17,18] In adults, the threshold for an elevated 24 h ambulatory blood pressure monitoring (ABPM) is ≥130/80 mmHg (daytime: ≥135/85 mmHg; night-time: ≥120/70 mm Hg).[5,16,19] The cuff size should be chosen according to the circumference of the athlete's arm, and in case of asymmetric exercises (e.g. shot put, tennis, etc.) BP can be measured in the non-dominant arm.

Isolated systolic hypertension and isolated diastolic hypertension, both not rare in young men, correspond to an elevated systolic BP with normal diastolic BP or an elevated diastolic BP with normal systolic BP, respectively.

Subjects with elevated BP in the clinic and normal home blood pressure monitoring (HBPM) and/or ABPM have white-coat or isolated clinic hypertension, those with normal office BP but elevated HBPM and/or ABPM have masked hypertension.[20,21] Also in these conditions, thresholds given above for ABPM and HBPM apply.

During exercise, physiologically systolic BP increases and diastolic BP remains stable or mildly decreases. Even though the association between an exaggerated BP response during exercise testing and cardiovascular events is not well established, it has been related to incident hypertension.[22] Also, 200 mmHg at 100 W has been demonstrated to independently predict long-term mortality in healthy middle-aged men.[23] In Olympic, athletes systolic BP of 220 mmHg in males and 200 mmHg in females measured during cycle ergometry are beyond the 95th percentile[23] and thus warrant further follow-up evaluation including ABPM.[24]

Table 1 Classification of blood pressure: ESH/ESC guidelines[5]

	Systolic		Diastolic
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

Table 2 Relevant clinical characteristics for risk stratification of patients with hypertension[5]

Risk factors	• Men >55 years; woman >65 years • Diabetes mellitus • Smoking • Dyslipidaemia • Abdominal obesity • Premature cardiovascular disease in family (men <55 years; women <65 years)
Target organ damage	• LV hypertrophy induced by hypertension • Diastolic dysfunction • Ultrasound evidence of arterial wall thickening or atherosclerotic plaque • Hypertensive eye fundus • Increase in serum creatinine (men 1.3–1.5 mg/dL, women 1.2–1.4 mg/dL) • Microalbuminuria
Associated clinical conditions	• Atrial fibrillation • Cerebrovascular disease • Ischaemic heart disease • Heart failure • Peripheral vascular disease • Renal impairment, proteinuria • Advanced retinopathy

Prevalence

The largest study on arterial hypertension in athletes in Europe (n = 2000; age 25 ± 6 years; 64% males) reported a prevalence of 3% with only a small minority (0.2%) with secondary hypertension.[25]

Evaluation

Assessment of hypertension has to be carried out in the context of other cardiovascular risk factors and resulting target organ damage like cardiovascular and/or renal complications (*Table 2*).[16] Testing for microalbuminuria after 24 h rest[26] and tissue Doppler imaging for plaque detection of carotid arteries may be considered in high-risk subjects. Also, clinical history, assessment of cardiovascular risk, physical examination, and subsequent diagnostic tests should be performed in order to exclude secondary causes, which may account for 5–10%, as they may be reversed with appropriate management.[27] Indeed, widely used supplements, energy drinks, medications (including anti-inflammatory drugs or thyroid hormones for weight reduction), or performance enhancing substances (e.g. erythropoietin, anabolic steroids) are an underestimated cause of secondary hypertension.[28,29] Secondary causes of hypertension should be sought in individuals if:

(1) Age at onset <30 years,
(2) Absence of risk factors including family history of hypertension,
(3) Grade 3 hypertension (≥180/110 mmHg) or hypertensive emergencies, and
(4) Sudden increase in BP in a previously normotensive individual or resistant hypertension despite medical treatment.[27]

In case of border line office measurements or in athletes with white-coat or masked hypertension, HBPM and ABPM also during training sessions should be performed.

Echocardiography has its place to assess LV hypertrophy [increased relative wall thickness (RWT) of >0.42 (RWT =

Table 3 Stratification of total cardiovascular risk to quantify prognosis in patients with hypertension[5]

Other RFs, asymptomatic OD, or disease	Blood pressure (mmHg)			
	High normal SBP 130–139 or DBP 85–89	Grade 1 HT SBP 140–159 or DBP 90–99	Grade 2 HT SBP 160–179 or DBP 100–109	Grade 3 HT SBP ≥180 or DBP ≥110
No other RF		Low risk	Moderate risk	High risk
1–2 RF	Low risk	Moderate risk	Moderate to high risk	High risk
≥3 RF	Low to moderate risk	Moderate to high risk	High risk	High risk
OD, CKD Stage 3, or diabetes	Moderate to high risk	High risk	High risk	High to very high risk
CVD, CKD stage ≥4, or diabetes with OD/RFs	Very high risk	Very high risk	Very high risk	Very high risk

RF: blood pressure (high normal BP; Grades 1–3); gender, age (men ≥55 years; women ≥65 years); smoking; dyslipidaemia (total cholesterol >190 mg/dL and/or LDL >115 mg/dL and/or HDL <40 mg/dL in men and <46 mg/dL in women); fasting plasma glucose 102–125 mg/dL; abnormal glucose tolerance test; body mass index ≥30 kg/m^2; abdominal obesity (men ≥102 cm; women ≥88 cm); 1st degree family history of premature cardiovascular disease (men <55 years; women <65 years). OD: hypertension-induced LV hypertrophy; carotid wall thickening or plaque; carotid-femoral pulse wave velocity >10 m/s; ankle-brachial index <0.9; CKD with eGFR 30–60 mL/min/1.73 m^2; presence of micro-albuminuria. Established cardiovascular or renal disease: cerebrovascular disease; coronary heart disease; heart failure; symptomatic peripheral artery disease; CKD: eGFR <30 mL/min/1.73 m^2; proteinuria; and advanced retinopathy (haemorrhages; exudates; papilloedema).
CKD, chronic kidney disease; CVD, cardiovascular disease; DBP, diastolic blood pressure; HT, hypertension; OD, organ damage; RF, risk factor; SBP, systolic blood pressure.

Table 4 General recommendations for competitive sport participation in athletes with systemic hypertension

Criteria for eligibility	Recommendations	Evaluation	Follow-up
BP: well controlled Further RF: none TOD: none ACC: none	All sports	History, PE, ECG, ET; echo[a]	Yearly
BP: well controlled Further RF: well controlled TOD: none ACC: none	All sports	History, PE, ECG, ET; echo	6–12 months
BP: well controlled Further RF: well controlled TOD: present ACC: none	All sports, except power sports known to severely increase BP	History, PE, ECG, ET; echo	6 months
BP: well controlled Further RF: well controlled TOD: none or present ACC: present	All sports, except power sports known to severely increase BP[b]	History, PE, ECG, ET; echo	6 months

Individual recommendations need to also consider cardiovascular risk profile, target organ damage and associated clinical conditions.
ACC, associated clinical condition; BP, blood pressure; ET, exercise testing; LVH, left ventricular hypertrophy; PE, physical examination, including BP measurements[5]; RF, risk factors; TOD, target organ damage.
[a]Echocardiography according to clinical condition, but once every 1–2 years.
[b]Eligibility depending on type and severity of ACC and/or TOD.

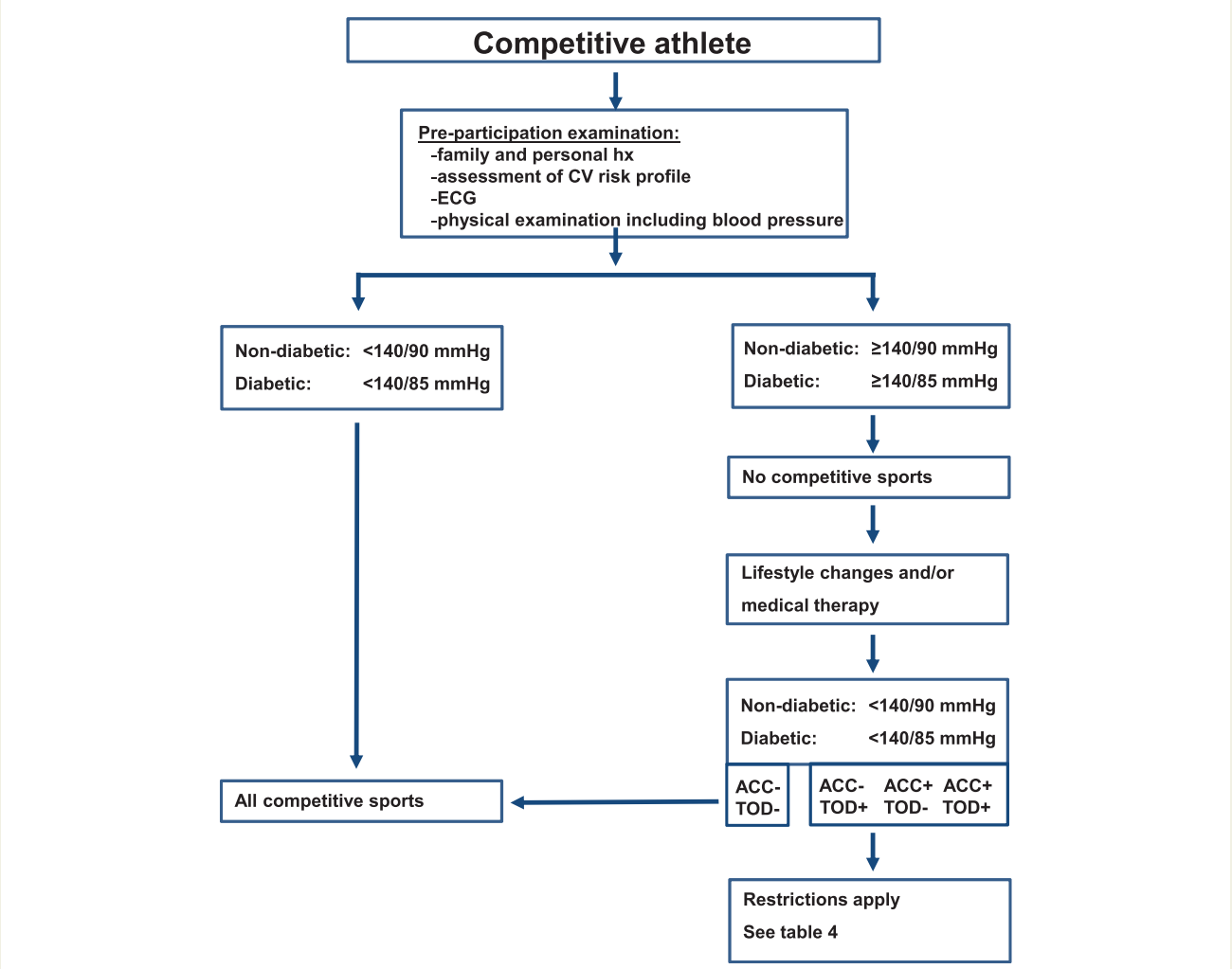


Figure 1 Pre-participation examination in competitive athletes with arterial hypertension. Evaluation includes family and personal history, cardiovascular risk profile, physical examination, blood pressure, and resting 12-lead ECG. Additional tests according to current guidelines. If blood pressure is <140/90 mmHg (<140/85 mmHg in diabetic), all competitive sports are allowed. Otherwise, no competitive sports until normalization of values. Depending on associated clinical conditions and/or target organ damage restrictions may apply (*Table 4*).

interventricular septum + posterior wall/end-diastolic diameter)] and mass (>110 g/m^2 in men, >95 g/m^2 in women),[30] impaired relaxation (measured by tissue Doppler echocardiography) or systolic dysfunction (assessed by longitudinal strain analysis),[31–34] valves, and the ascending aorta.

Long-term, high-volume, and high-intensity endurance sport itself may induce enlargement of all cardiac cavities and mild LV hypertrophy, better known as athlete's heart. Whereas these physiological adaptations are reversible by detraining,[35] remodelling caused by hypertension is not, but is amenable to effective BP lowering therapy.

Exercise testing (with ECG and BP monitoring)[25] should be routinely performed to assess exercise capacity and to rule out exercise-induced hypertension. As stated above, BP values obtained during exercise should not be used for a definitive diagnosis of hypertension,[36] since it is uncertain whether it is a reliable predictor of overt arterial hypertension later in life.[24,37–39] Nonetheless, at least annual follow-up preferably with ABPM and particular attention to cardiovascular risk factors is warranted, but without restriction from any competitive sport.[23]

Risk stratification

The terms low-, moderate-, high-, and very high-risk correspond to approximate absolute 10-year risks of cardiovascular mortality of <1%, 1–4%, 5–10%, and >10%, respectively, according to the European SCORE system as defined by the 2016 ESC prevention guidelines.[2]

Recommendations

General recommendations

Athletes with hypertension should be treated according to general guidelines.[27] Appropriate non-pharmacological measures should be considered as the first step: salt restriction, weight reduction when obesity is present, alcohol restriction, increased consumption of vegetables and fruits, smoking cessation, discontinuation of supplements, ergogenic, and/or anti-inflammatory drugs. Aerobic-exercise

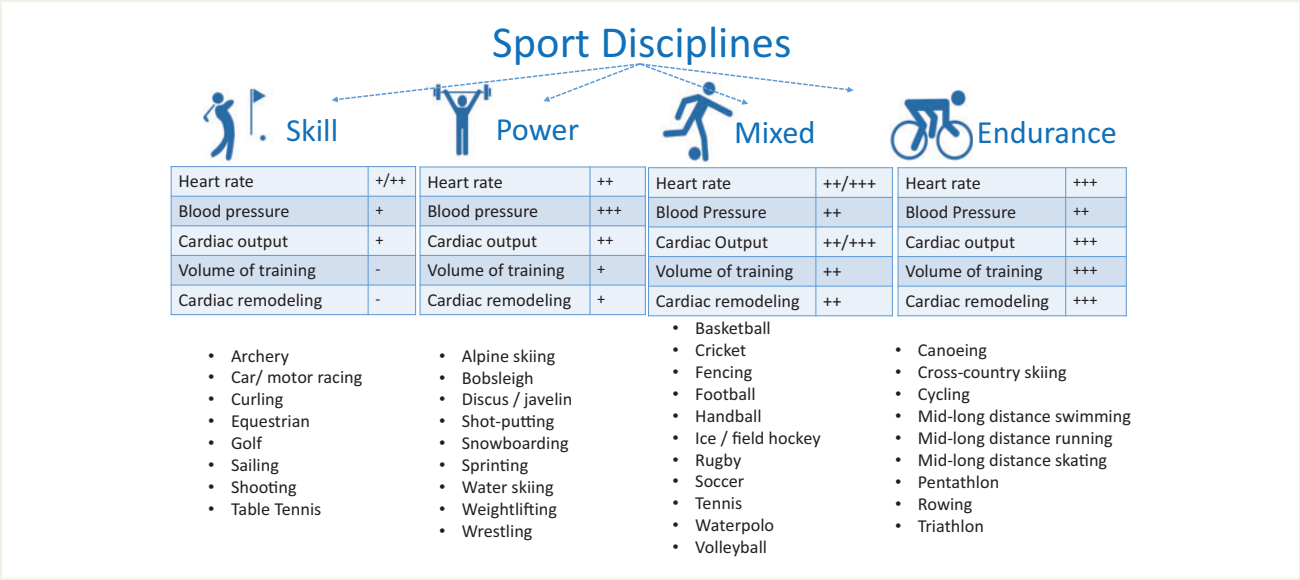


Figure 2 Classification of different sports disciplines. Sport disciplines are divided according to acute physiologic responses (i.e. heart rate and blood pressure) and long-term impact on cardiac output and remodelling.[45,46] Skill sports: achievement depends on technical or bodily skill. Increase in heart rate is accompanied by modest increase in blood pressure and cardiac output. No cardiac remodelling. Power sports: achievement depends on explosive muscle power (i.e. high-static exercise). Substantial increase in heart rate and blood pressure during repeated bursts. Cardiac remodelling with increase in left ventricular wall thickness and modest increase in left ventricular cavity size and function occurs. Mixed sports: alternating phases of dynamic and/or static work and recovery (e.g. ball and team sports). Duration and exercise intensity vary largely according to type of sport and the role the athlete plays. Phasic increases in heart rate and blood pressure may reach near-maximum values, alternating with recovery phases. There is cardiac remodelling with increase in left ventricular cavity size and modest change in left ventricular wall thickness. Endurance sports: prolonged and intensive high dynamic, often associated with high-static exercise at near maximal cardiac output, through increase in heart rate, and blood pressure over several hours. Cardiac remodelling with significant increase in left ventricular cavity size and wall thickness is present. -/+: no, +: weak, ++: moderate, and +++: strong effect.

programmes should complement athletes' training schedules. (*Level of evidence: IB*).

Athletes should be periodically reassessed and in case of low or moderate risk, drug treatment is initiated when hypertension persists, e.g. 3 months after appropriate lifestyle changes have been implemented or when out-of-office BP remains elevated. It is not recommended to initiate antihypertensive therapy at high normal BP, however, lifestyle changes are encouraged. Antihypertensive drug therapy should be started promptly in athletes with Grade 3 hypertension and/or high- or very high risk for cardiovascular complications (*Table 3*). (*Level of evidence: IB*).

The goal of antihypertensive therapy is to reduce BP to <140/90 mmHg and to <140/85 mmHg in diabetic athletes,[5] although the current trend is to adopt lower values, i.e. <130/80, as recently advocated in the ACC/AHA guidelines.[40] (*Level of evidence: IB*).

With regard to white-coat or masked hypertension, ABPM may be particularly useful in assessing BP load. With regard to antihypertensive drugs, current evidence indicates that they are not required. In the absence of randomized trials, it will remain an individual decision to prescribe antihypertensive drugs even in patients with high- or very high cardiovascular risk (*Table 3*). In any case, regular follow-up and non-pharmacological measures are recommended.[27] Also, since it remains uncertain whether isolated systolic or isolated diastolic hypertension progress to overt hypertension or benefit from drug treatment, only lifestyle changes are warranted. (*Level of evidence: IB*).

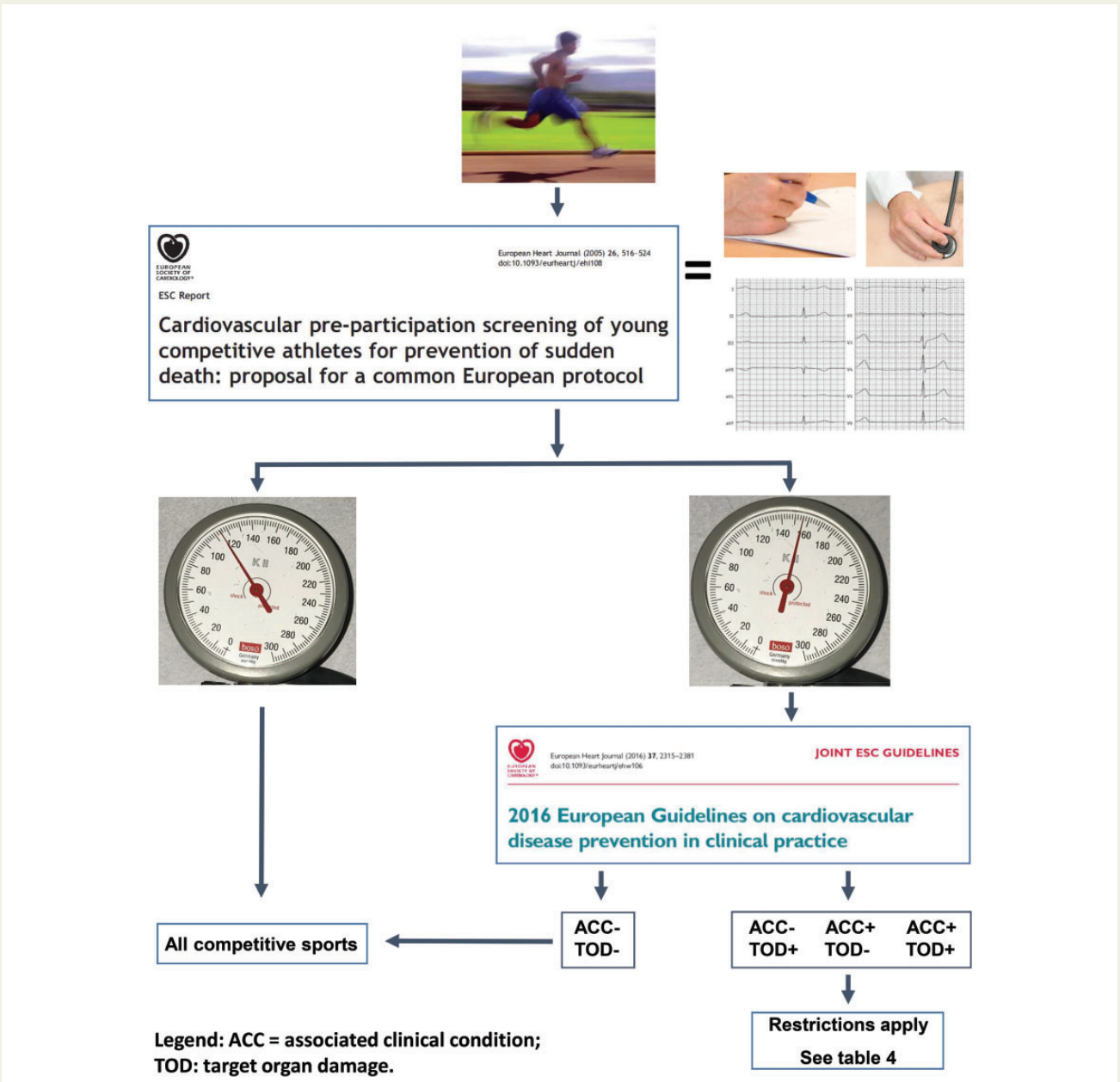
Choice of drugs

Athletes who compete at national and/or international level have to review the current list of prohibited substances and methods of the World Anti-Doping Association[41] before starting drug therapy. If required, a therapeutic use exemption has to be obtained in order to receive the authorization to take the needed medicine.

Angiotensin-converting enzyme inhibitors and angiotensin II receptor blockers are the preferred choice as they do not affect exercise capacity and are not on the doping list. However, they shall not be given to females during reproductive years, because of potential adverse foetal/neonatal effects.

Alternatively or additionally calcium channel blockers are a preferred choice in athletes. If more than one drug is required, combination drugs should be considered as they may improve compliance. Beta blockers are rarely used as second line therapy, as they can generally not be given in athletes with bradycardia <50/min and/or second or third degree AV block. Furthermore, different beta blockers (selective/non selective, older/newer compounds, with/without vasodilatory properties) negatively impact aerobic-exercise performance, which may interfere with compliance. Also, beta blockers are prohibited and considered as doping in some sports like archery and shooting where control of tremor is seeked.[16,42]

Diuretics are banned at all times and in all sports, since they may mask performance-enhancing drugs.[43,44]



Take home figure Work flow and decision tree for competitive athletes during pre-participation examination. [2,49]

Recommendations for competitive sports participation

Recommendations are based on risk stratification and with the understanding that the clinical condition is stable and that general recommendations for the management of hypertension are observed as described above (*Table 4*).

1. In patients with low- or moderate-cardiovascular risk, usually no restrictions apply. If BP values are not normalized, temporary restriction from competitive sport is recommended, with possible exception of skill disciplines (*Figures 1* and *2*).

2. In patients with high-risk or very high-risk in whom control of BP has been achieved, participation in all competitive sports is possible, with the exception of power disciplines (*Figures 1* and *2*). If BP values are not well controlled, temporary restriction from competitive sport is recommended.

Leisure-time and amateur sport activities

Regular exercise training has been shown to reduce morbidity and mortality[47] and is thus a Class IA indication.[2] Patients are advised to perform at least 30 min of moderate-intensity, preferably (but not exclusively) aerobic-exercise training, 5–7 days per week.[5] In patients

with low- or moderate cardiovascular risk high-intensity exercises can be performed,[48] even if common but arbitrary cut-offs, e.g. systolic BP ≥240 mmHg, are exceeded during peak intervals.

Follow-up

Patients need to be followed up regularly by their physicians. In addition, during annual pre-competition medical examination BP needs to be measured at rest and during exercise testing. Furthermore, possible reversal or progression of existing target organ damage has to be assessed by ECG, echocardiography, kidney testing, and/or retinal examination.

An ACC/AHA statement[9] recommends athletes with hypertension who wish to engage in training for competitive sports to undergo prior clinical assessment including BP, which is in keeping with this position statement and our ESC consensus statement.[49]

Summary

The prevalence of arterial hypertension is high overall, increasing with age and unfavourably influenced by western diet and behaviour even in athletes. Therefore, screening should also focus on adolescent athletes. Special considerations have to be given regarding the pharmacological treatment of hypertension in athletes. While eligibility for competitive sports may have to be restricted if target organ damage is present, an athlete with well-controlled BP, having no additional risk factors or target organ damage, is eligible for competition in all sports.

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