



# Arterijska hipertenzija i sportska aktivnost

## Hypertension and sports activity

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**SAŽETAK:** Ovaj pregledni rad analizira složen odnos između arterijske hipertenzije i sporta, obuhvaćajući ključne aspekte zastupljenosti, rizičnih čimbenika i strategija liječenja. Hipertenzija je vodeći uzrok kardiovaskularnih (KV) bolesti i smrtnosti, a, iako redovita tjelesna aktivnost najčešće ima kardioprotektivni učinak, određene sportske discipline i životne navike mogu dovesti do povišenja vrijednosti arterijskoga tlaka (AT) u sportaša. U ovom ćemo radu istaknuti ulogu izometrijskoga treninga, povišene tjelesne mase te primjene sredstava za poboljšanje sportskih performansi kao čimbenika koji pridonose povećanom riziku. Nadalje, razmotrit ćemo posljedice povišenog AT-a na sportske aktivnosti i uspješnost u sportu te na dugoročno KV zdravlje tjelesno aktivnih osoba. Raspraviti ćemo i o dijagnostičkim izazovima, uz naglasak na ograničenja rutinskih mjerenja i potrebu za primjenom naprednih dijagnostičkih metoda, poput 24-satnog ambulantnog mjerenja arterijskoga tlaka. Predstaviti ćemo najnovije europske smjernice kao okvir za pravilnu dijagnozu i procjenu rizika od hipertenzije u sportaša. Terapijski pristup uključuje prije svega intervencije u životnom stilu i navikama, kao što su promjene prehranbenih navika, smanjenje stresa i individualno prilagođeni programi tjelesne aktivnosti. Kada je nužno, farmakološko se liječenje preporučuje uz pažljivo uzimanje u obzir postojećih antidopinških propisa i mogućih učinaka na sportsku uspješnost. U ovom radu naglašavamo i važnost individualiziranoga pristupa u zbrinjavanju hipertenzije u sportaša te zago- varamo multidisciplinarni model skrbi koji integrira stručnost u područjima medicine, nutricionizma i sportskog treniranja. Sažimajući trenutačne podatke i znanje, cilj je rada pružiti praktične smjernice kliničarima koji se skrbe o sportašima i osobama koje se redovito bave tjelesnom aktivnošću da bi im se omogućilo bolje razumijevanje i učinkovitije liječenje hipertenzije u ovoj populaciji.

**SUMMARY:** This summary article reviews the complex relationship between hypertension and sports, addressing key aspects of prevalence, risk factors, and management strategies. Hypertension is a leading cause of cardiovascular disease and mortality, and while regular exercise generally provides cardioprotective effects, certain sports disciplines and lifestyle choices may elevate blood pressure (BP) levels in athletes. The article highlights the role of isometric training, high body mass, and the use of performance-enhancing substances as contributors to increased risk. Additionally, it explores the implications of high BP on both athletic performance and long-term cardiovascular health in physically active patients. Diagnostic challenges are discussed, emphasizing the limitations of routine measurements and the need for advanced tools such as ambulatory BP monitoring. Updated European guidelines are presented as a framework for accurate hypertension diagnosis and risk assessment among athletes. Management approaches prioritize lifestyle interventions, including dietary changes, stress reduction, and tailored exercise programs. When necessary, pharmacological treatments are recommended with careful consideration of doping regulations and potential impacts on athletic performance. This article underscores the importance of individualized care in addressing hypertension in athletes, advocating for a multidisciplinary approach that integrates medical, nutritional, and training expertise. By consolidating current evidence, the article aims to provide practical guidance for clinicians, treating athletes and patients with regular physical activities, to better understand and manage hypertension in this population.

**KLJUČNE RIJEČI:** hipertenzija u sportaša, kardiovaskularni rizik, intervencije u životnom stilu, probir za hipertenziju, hipertenzija uzrokovana tjelovježbom.

**KEYWORDS:** hypertension in athletes, cardiovascular risk, lifestyle intervention, blood pressure screening, exercise-induced hypertension.

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## Uvod

Arterijska je hipertenzija nedvojbeno jedan od vodećih uzroka kardiovaskularnog (KV) pobola i smrtnosti<sup>1</sup>. Međutim, postavljanje dijagnoze hipertenzije u sportaša osobit je izazov jer zdrave mlade ili odrasle osobe rijetko dolaze u kontakt sa zdravstvenim djelatnicima koji bi ih suočili s mogućim bolestima i rizicima koji su s njima povezani. Unatoč tomu, hipertenzija pogađa i sportaše, pokatkad već u mlađoj životnoj dobi<sup>2</sup>. Povišene vrijednosti arterijskoga tlaka (AT) često se otkrivaju tijekom rutinskih sistematskih pregleda sportaša<sup>3</sup>. Dugotrajna hipertenzija dovodi do razvoja supkliničkih patoloških promjena koje znatno povećavaju KV rizik te time potiču razvoj klinički vidljivih KV bolesti kasnije u životu<sup>4</sup>. U osoba koje sudjeluju u natjecateljskim sportovima, osnovni je cilj sportskomedicinskog pregleda otkrivanje supkliničkih odstupanja uzrokovanih asimptomatskim bolestima. U Mađarskoj se obvezni liječnički pregled za sportaše natjecateljskih sportova provodi jednom godišnje u dobi od 16 do 65 godina, dok se osobe mlađe od 16 i starije od 65 godina pregledavaju svakih šest mjeseci<sup>5</sup>. Međutim, jednokratno mjerenje vrijednosti brahijalnog AT-a tijekom pregleda obično nije dostatno za postavljanje dijagnoze hipertenzije. Takav nalaz može pobuditi kliničku sumnju, koju je potom potrebno dodatno istražiti daljnjim dijagnostičkim koracima. Prije svega, za utvrđivanje vrijednosti AT-a u mirovanju potrebno je provesti kućno mjerenje ili 24-satno ambulantno mjerenje arterijskoga tlaka jer jednokratno mjerenje tijekom sportskomedicinskog pregleda može precijeniti vrijednosti AT-a zbog povišenja uzrokovana stresom.

## Definicija i interpretacija arterijskoga tlaka

Istraživanja usmjerena na hipertenziju u sportaša ne pružaju ujednačenu sliku, ponajprije zbog promjenjive definicije same hipertenzije. Većina je istraživanja provedena u odraslih osoba ili adolescenata, pri čemu se povišena vrijednost AT-a najčešće definirala kao sistolički tlak >140 mmHg i dijastolički tlak >90 mmHg. Godine 2024. Europsko kardiološko društvo objavilo je nove smjernice koje, uz definiranje graničnih vrijednosti AT-a u odraslih, jasno propisuju ispravan postupak mjerenja AT-a i dijagnostičke korake u postavljanju dijagnoze hipertenzije<sup>6</sup>.

Prema novim europskim smjernicama, normalne (nepovišene) vrijednosti AT-a u odraslih osoba u mirovanju definiraju se kao sistolički tlak <120 mmHg i dijastolički tlak <70 mmHg<sup>6</sup>. Povišeni AT izmjeren u kućnim uvjetima definira se kao sistolički tlak od 120 do 134 mmHg i dijastolički tlak od 70 do 84 mmHg, dok se dijagnoza hipertenzije postavlja kada dnevne kućne vrijednosti dosegnu ili prelaze 135 mmHg sistoličkoga tlaka i 85 mmHg dijastoličkoga tlaka<sup>6</sup>.

Uz točno mjerenje, u procjeni dugoročnog KV rizika povezanog s vrijednostima AT-a presudnu ulogu imaju i drugi čimbenici rizika, poput umjerenog do teškog kroničnog bubrežnog zatajenja, potvrđene prisutnosti vaskularne bolesti, srčanog zatajivanja, dijabetesa te obiteljske hiperkolesterolemije<sup>6</sup>. Dugoročnu stratifikaciju KV rizika dodatno potkrepljuje primjena algoritama SCORE2 i SCORE2-OP<sup>7,8</sup>.

Pri procjeni povišenog AT-a u sportaša ključno je paziti da osoba nije konzumirala kofein niti provodila tjelesnu aktivnost najmanje 30 minuta prije mjerenja<sup>6</sup>. U djece i sportaša mlađih od 18 godina AT se mora procjenjivati prema tablicama vrijednosti u percentilima koji su prilagođeni dobi, visini

## Introduction

Arterial hypertension is unequivocally one of the primary causes of cardiovascular (CV) morbidity and mortality<sup>1</sup>. However, establishing the diagnosis of hypertension in athletes poses a particular challenge, as otherwise healthy young individuals or adults rarely come into contact with healthcare professionals who would confront them with the potential disease and its associated risks. Nonetheless, hypertension does affect athletes as well, sometimes even at a young age<sup>2</sup>. Elevated blood pressure (BP) is frequently detected during routine screening examinations in athletes<sup>3</sup>. Long-standing hypertension leads to the development of subclinical pathological alterations, which substantially increase CV risk and thereby promote the development of overt CV disease later in life<sup>4</sup>. In competitive athletes, the principal aim of the sports medicine examination is to detect subclinical abnormalities in asymptomatic individuals. In Hungary, compulsory medical screening is conducted once a year for competitive athletes between the ages of 16 and 65, while those under 16 or over 65 are examined every six months<sup>5</sup>. However, brachial BP measured once during the examination is usually insufficient to establish the diagnosis of hypertension. It may raise clinical suspicion, which must be further investigated in additional steps. First and foremost, to determine resting BP, home or ambulatory 24-hour BP monitoring is required, as a single measurement during the sports medical examination may overestimate BP due to stress-induced elevation.

## Definition and interpretation of blood pressure

Studies focusing on hypertension in athletes do not present a uniform picture, primarily due to the evolving definition of hypertension itself. Most investigations have been conducted in adults or adolescents, with elevated BP commonly defined as systolic >140 mmHg and diastolic >90 mmHg. In 2024, the European Society of Cardiology introduced a new guideline that, in addition to defining BP thresholds in adults, clearly outlines the correct procedure for BP measurement and the diagnostic steps for hypertension<sup>6</sup>.

According to the new European guideline, normal (non-elevated) BP in adults at rest is defined as systolic <120 mmHg and diastolic <70 mmHg<sup>6</sup>. Home-measured elevated BP is defined as systolic between 120–134 mmHg and diastolic between 70–84 mmHg, while hypertension is diagnosed when daytime home BP readings reach or exceed 135 mmHg systolic and 85 mmHg diastolic<sup>6</sup>.

In assessing the long-term CV risk associated with a patient's BP, in addition to accurate measurement, other risk factors play a decisive role—such as moderate-to-severe chronic kidney disease, confirmed vascular disease, heart failure, diabetes mellitus, and familial hypercholesterolemia<sup>6</sup>. The long-term CV risk stratification is further supported by the SCORE2 and SCORE2-OP algorithms<sup>7,8</sup>.

When evaluating elevated BP in athletes, it is essential that no caffeine be consumed and no physical activity performed for at least 30 minutes prior to measurement<sup>6</sup>. In children and athletes under 18 years of age, BP must be assessed based on percentile tables adjusted for age, height, and sex. This is particularly important in this age group, as the majority of com-

i spolu. To je osobito važno u ovoj dobnoj skupini jer se većina dozvola za natjecateljske sportove izdaje upravo u toj populaciji. U djece se hipertenzijom smatra AT jednak ili viši od 95. percentile za odgovarajuću dob, spol i visinu<sup>9</sup>.

U djece i mlađih odraslih osoba (<35 godina) sekundarna je hipertenzija relativno česta (15–30 % bolesnika s hipertenzijom) te je stoga uvijek potrebno provesti odgovarajuću dijagnostičku obradu<sup>10</sup>. U dijagnostičkom postupku može biti nužno provesti ultrazvuk abdomena, osobito ultrazvuk bubrega, procjenu opstruktivne apneje u snu, laboratorijsku procjenu funkcije štitnjače te isključivanje hiperaldosteronizma<sup>11</sup>.

U Mađarskoj sportskomedicinski pregledi uključuju ne samo mjerenje AT-a već i 12-kanalni EKG, auskultaciju srca i pluća te, u starijih sportaša (>35 godina), dodatne laboratorijske pretrage koje upućuju na KV rizik (npr. lipidogram, glukoza u krvi), sa svrhom točnije stratifikacije rizika<sup>5</sup>. U sportaša s hipertenzijom opravdana je i primjena transtorakalne ehokardiografije kao najdostupnije metode oslikavanja<sup>12</sup>.

## Zastupljenost hipertenzije u sportaša

Procjena zastupljenosti arterijske hipertenzije među sportašima temelji prije svega na rezultatima sistematskih probirnih pregleda. Ranija su istraživanja pokazala da se, zbog metodoloških razlika među pojedinim istraživanjima, zastupljenost hipertenzije u sportaša znatno razlikuje među studijama, s rezultatima u rasponu od 0 do 83 %<sup>13</sup>. Ipak, većinom je prihvaćeno da je zastupljenost hipertenzije u sportaša niža nego u nesportaškoj populaciji<sup>3,13</sup>, premda se ta razlika može smanjivati s dobi i pojavom komorbiditeta.

Međutim, analiza velike baze podataka sportaša provedena 2019. godine (na temelju granične vrijednosti od 140/90 mmHg) pokazala je da je trećina elitnih sportaša imala hipertenziju<sup>2</sup>, što je stopa koja je očito viša od one zabilježene u općoj populaciji<sup>14</sup>. Taj bi udio vjerojatno bio i veći da se ispitanike s vrijednostima unutar raspona za visoki-normalni AT (120–134/70–84 mmHg), prema novoj definiciji Europskog kardiolškog društva, također klasificiralo kao hipertenzivne<sup>6</sup>.

Tumačenje očitavanja AT-a dobivenih tijekom sportskih pregleda u skladu s ovim novim smjernicama od osobite je važnosti, jer povišeni AT u mlađoj životnoj dobi znatno povećava rizik od razvoja teških KV bolesti te ukupnu smrtnost kasnije u životu<sup>15,16</sup>.

## Čimbenici koji pridonose povišenju arterijskoga tlaka u sportaša

U razvoju arterijske hipertenzije u sportaša važnu ulogu imaju čimbenici rizika čiji je utjecaj dobro poznat i u općoj populaciji. Međutim, sportaši često konzumiraju dodatke prehrani za koje se smatra da poboljšavaju sportski uspjeh. Povremeno se koriste i tvarima o čijim su učincima informirani isključivo preko oglašavanja ili neformalnih izvora. U takvim je slučajevima od ključne važnosti izbjegavati pripravke koji mogu nositi zdravstveni rizik te pripravke koji su potencijalno zabranjeni s antidopinškog aspekta.

Klasični KV čimbenici rizika osobito su važni u sportaša koji se bave vrlo intenzivnim anaerobnim treninzima, posebice u disciplinama koje zahtijevaju veću tjelesnu masu za optimalnu uspješnost – najčešće u izometrijskim sportskim disciplinama. U tih sportaša smanjenje tjelesne mase često nije prihvatljiva mogućnost za liječenje hipertenzije. Naprotiv,

petitive sports licenses are issued within this demographic. In children, BP at or above the 95th percentile corresponding to age, sex, and height is considered hypertensive<sup>9</sup>.

Among children and young adults (<35 years), secondary hypertension is relatively common (15–30% of hypertensive patients), and must therefore always be investigated<sup>10</sup>. Abdominal ultrasound, particularly renal ultrasonography, evaluation for sleep apnea, thyroid function tests, and the exclusion of hyperaldosteronism may all be necessary in the diagnostic work-up<sup>11</sup>.

In Hungary, sports medicine screening includes not only BP measurement but also a 12-lead ECG, chest auscultation, and in senior athletes (>35 years), supplementary laboratory tests indicating CV risk (e.g., lipid profile, blood glucose), all aimed at more accurate risk stratification<sup>5</sup>. In hypertensive athletes, the most accessible imaging modality, transthoracic echocardiography, is also warranted<sup>12</sup>.

## Prevalence of hypertension in athletes

The prevalence of hypertension among athletes is primarily derived from the findings of screening examinations. Earlier studies have demonstrated that due to methodological differences across various investigations, the reported prevalence of hypertension in athletes varies widely—ranging from 0% to 83%<sup>13</sup>. Nevertheless, it has generally been accepted that the prevalence of hypertension in athletes is lower than in the non-athlete population<sup>3,13</sup>, although this may change with advancing age and the appearance of comorbidities.

However, an analysis of a large-scale athlete database conducted in 2019 (using a cutoff value of 140/90 mmHg) found that one-third of elite athletes were hypertensive<sup>2</sup>, a rate clearly higher than that observed in the general population<sup>14</sup>. This proportion would likely have been even greater if the study had also classified individuals within the newly defined European guideline range for high-normal BP (120–134/70–84 mmHg) as hypertensive<sup>6</sup>.

Interpreting BP readings obtained during athletic examinations in light of these new guidelines is of particular importance, as elevated BP at a young age significantly increases the risk of developing severe CV disease and elevates all-cause mortality in later life<sup>15,16</sup>.

## Substances contributing to elevated blood pressure in athletes

In the development of hypertension in athletes, the risk factors well known in the general population also play a significant role. However, athletes often consume dietary supplements that are known to enhance performance. Occasionally, they use substances whose effects they have only heard about through advertising or informal sources. In such cases, primary considerations include avoiding preparations that may pose health risks and those that are potentially prohibited from an anti-doping perspective.

Classical CV risk factors are particularly relevant among athletes engaged in high-intensity anaerobic training, especially those requiring greater body mass for optimal performance—typically in isometric disciplines. In these athletes, weight loss is often not a viable option for managing hypertension. On the contrary, to maintain their body mass and

ti sportaši radi održavanja tjelesne mase i idealnog sastava tijela namjerno konzumiraju visokokaloričnu prehranu s niskim udjelom vlakana<sup>17</sup>.

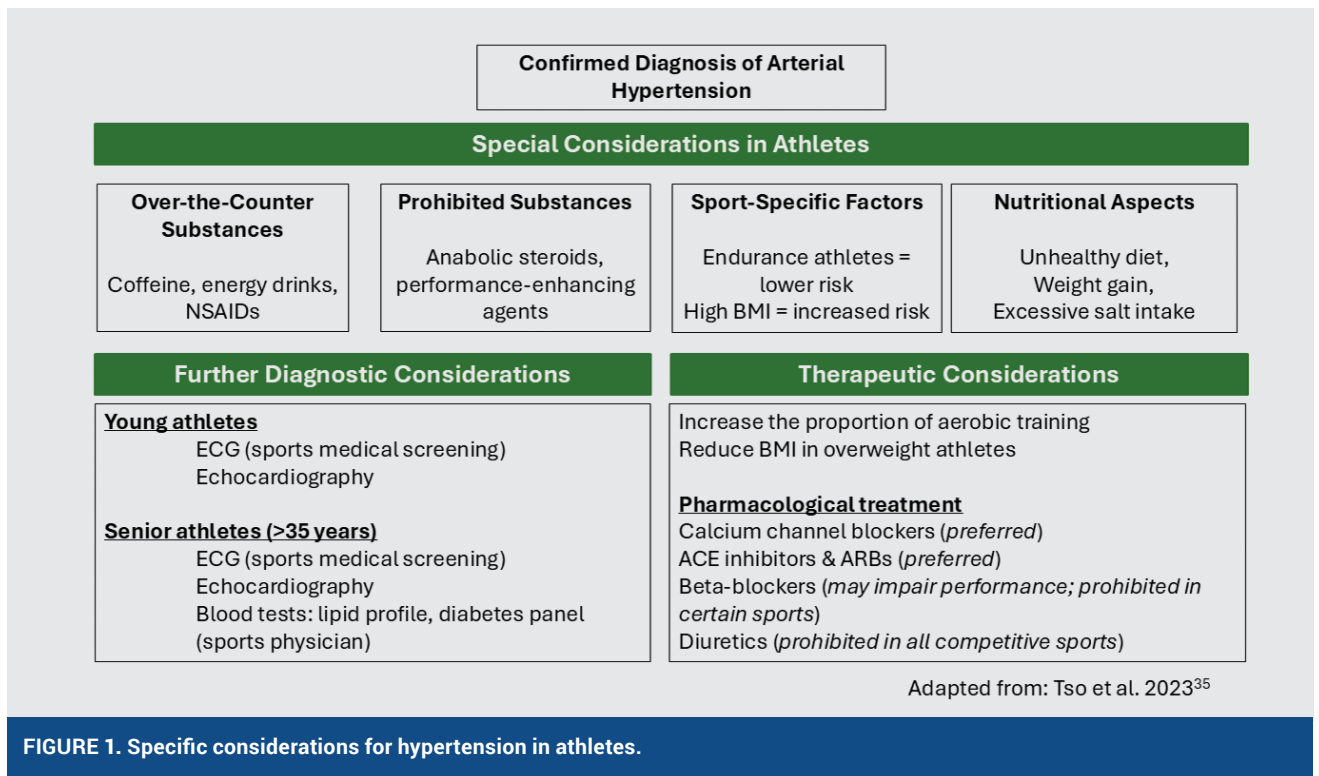
U sportaša koji se bave disciplinama u kojima je najbitnija snaga – bilo da se sportom bave natjecateljski ili rekreativno, ali predano – primjena sredstava za poboljšanje uspješnosti, uključujući tvari navedene na antidopinškim popisima, uvijek se mora uzeti u obzir kao mogući etiološki čimbenik hipertenzije. Anabolički steroidi povisuju AT te pridonose razvoju aterosklerotskih vaskularnih bolesti te patološke hipertrofije lijeve klijetke<sup>18</sup>. Iako neki smatraju da je uporaba anaboličkih steroida ograničena na usku skupinu „entuzijasta mišićavosti“, istraživanja pokazuju da se zastupljenost njihove uporabe i dalje kreće oko 10–20% čak i među rekreativnim i elitnim sportašima<sup>19</sup>.

U sportovima izdržljivosti sportaši često primjenjuju povećan unos soli radi poboljšanja uspješnosti i sprječavanja grčeva povezanih s tjelesnim naporom. Međutim, takva praksa povećava rizik od hipertenzije, a ergogeni učinak unosa povećanih količina soli i dalje je vrlo upitan<sup>20</sup> (slika 1).

ideal body composition, they intentionally consume high-calorie, low-fiber diets<sup>17</sup>.

Among strength athletes—either competitive or recreational but highly committed—the use of performance-enhancing agents, including substances listed on anti-doping registers, must always be considered as a possible etiological factor in hypertension. Anabolic steroids increase BP and contribute to the development of atherosclerotic vascular disease and pathological left ventricular hypertrophy<sup>18</sup>. While some may assume that the use of anabolic steroids is limited to a fringe group of “muscle enthusiasts,” studies indicate that their prevalence remains approximately 10–20% even among both recreational and elite athletes<sup>19</sup>.

In endurance sports, high sodium intake is often employed with the intent of enhancing performance and preventing exercise-associated muscle cramps. However, this practice increases the risk of hypertension and, furthermore, the ergogenic benefit of sodium loading remains highly questionable<sup>20</sup> (Figure 1).



Stimulansi, poput kofeina i energijskih napitaka, također se često konzumiraju jer mogu privremeno poboljšati sportsku uspješnost. No njihova redovita i prekomjerna uporaba – osobito prije treninga ili natjecanja – može pridonijeti razvoju hipertenzije<sup>21,22</sup>.

Zbog učestalih boli u mišićima i zglobovima sportaši se često koriste nesteroidnim antireumaticima (NSAR), od kojih je većina dostupna bez recepta. Budući da su sportaši često dobro upoznati sa svojim pragom boli tijekom treninga i

Stimulants, such as caffeine and energy drinks, are also frequently consumed, as they may transiently improve performance. However, regular and excessive use—particularly prior to training or competition—may contribute to the development of hypertension<sup>21,22</sup>.

Due to frequent muscle and joint pain, athletes often use non-steroidal anti-inflammatory drugs (NSAIDs), most of which are available over-the-counter. Athletes, being highly aware of

natjecanja, nerijetko uzimaju profilaktički NSAR, što znatno povećava ukupnu količinu unosa lijeka. Pretjerana uporaba NSAR-a – osobito u borilačkim sportovima – povezana je s povećanim rizikom od hipertenzije<sup>23</sup>.

Na razvoj hipertenzije utječu i životni čimbenici koji nisu vezani uz prehranu. Kronični psihološki stres te dugotrajni vrlo intenzivni treninzi – osobito kod elitnih sportaša – također pridonose povećanoj zastupljenosti hipertenzije u ovoj populaciji<sup>13</sup>.

## Čimbenici vezani uz pojedine sportove

Vrsta sporta važna je odrednica u razvoju arterijske hipertenzije u sportaša. Klasifikacija pojedinog sporta ima ključnu ulogu u procjeni rizika od povišenog AT-a<sup>24</sup> jer su sportske discipline koje se temelje na snazi obilježene pretežito izometrijskim treningom te su povezane s višom zastupljenosti hipertenzije u usporedbi sa sportovima temeljenima isključivo na izdržljivosti<sup>13</sup>. I sistolički i dijastolički AT često su niži u sportaša koji se bave sportovima temeljenima na izdržljivosti u usporedbi sa sportašima koji se bave disciplinama koje se temelje na snazi<sup>13</sup>, što se može djelomično pripisati višim indeksom tjelesne mase (BMI) u potonjoj skupini<sup>25</sup>.

Sportašice, u pravilu, imaju niže vrijednosti AT-a u usporedbi s muškarcima; međutim, razlike između sportaša koji se bave sportovima temeljenim na izdržljivosti i onih koji se bave sportovima temeljenim na snazi prisutne su i među ženama<sup>26</sup>. Također je važno naglasiti da vrsta treninga koji se provodi unutar određenog sporta – također ovisno o vodstvu pojedinog trenera ili u određenom klubu – može znatno utjecati na KV ishode. Primjerice, u mladim nogometašima posljednjih je godina, uz tradicionalni trening izdržljivosti i tehničko-taktički trening s loptom, zabilježen porast naglaska na trening snage usmjeren na poboljšanje posturalne stabilnosti<sup>27</sup>.

Povišeni BMI u sportaša koji se bave sportovima temeljenima na snazi povezan je ne samo s višim vrijednostima AT-a nego i s većom učestalošću metaboličkog sindroma i dislipidemije<sup>25</sup>.

## Stariji sportaši

Elitni sportaši stariji od 35 godina obično se svrstavaju u kategoriju seniora. U kojoj mjeri stariji sportaši mogu ostati konkurentni uvelike ovisi o vrsti sporta. Primjerice, u elitnom nogometu stariji igrači najčešće prelaze u veteranske ili niže rangirane lige te više nisu dio momčadi najvišeg ranga. Nasuprot tomu, u disciplinama poput maratonskog trčanja uobičajeno je da pripadnici starijih dobnih skupina aktivno sudjeluju i postižu uspjehe u natjecanjima.

Zastupljenost hipertenzije u starijih sportaša niža je nego u nesportaša iste dobne skupine<sup>28</sup>. To se može pripisati nekoличini čimbenika, uključujući niži BMI i veći udio treninga izdržljivosti među starijim sportašima. Bivši elitni sportaši koji ne uzimaju antihipertenzivnu terapiju često imaju niže vrijednosti AT-a u usporedbi s osobama koje se nisu bavile natjecateljskim sportom, neovisno o trenutačnoj razini tjelesne aktivnosti<sup>29</sup>. Ta je razlika najizraženija u bivših sportaša koji su se bavili sportovima temeljenima na izdržljivosti, što upućuje na dugotrajne protektivne učinke intenzivnog treninga izdržljivosti na razvoj hipertenzije, čak i nakon prestanka redovitog treniranja.

their pain thresholds during training and competition, often take NSAIDs prophylactically, which significantly increases overall consumption. Excessive NSAID use—especially in combat sports—is associated with an increased risk of hypertension<sup>23</sup>.

Lifestyle factors beyond nutrition also influence the development of hypertension. Chronic psychological stress and sustained high-intensity physical training—especially among elite athletes—likewise contribute to the elevated prevalence of hypertension in this population<sup>13</sup>.

## Sport-specific considerations

The type of sport is an important determinant in the development of hypertension among athletes. In assessing the risk of elevated BP, the classification of the given sport plays a critical role<sup>24</sup>, as strength-based disciplines characterized by predominantly isometric training are associated with a higher prevalence of hypertension compared to purely endurance-based sports<sup>13</sup>. Among endurance athletes, not only systolic but also diastolic BP tends to be lower than in strength athletes<sup>13</sup>, which is partly attributable to a higher body mass index (BMI) observed in the latter group<sup>25</sup>.

Female athletes typically present with lower BP values compared to males; however, the differences observed between endurance and strength sports are also evident among women<sup>26</sup>. It is also important to emphasize that the nature of training performed within a given sport—particularly under a specific coach or at a particular club—can significantly influence CV outcomes. For example, in youth football players, recent years have seen an increased emphasis on strength training aimed at improving postural stability, alongside traditional endurance and skill-based (ball) training<sup>27</sup>.

The higher BMI observed in strength athletes is associated not only with elevated BP, but also with a greater incidence of metabolic syndrome and dyslipidemia<sup>25</sup>.

## Senior athletes

Elite athletes over the age of 35 are typically referred to as senior athletes. The extent to which older athletes can remain competitive largely depends on the type of sport. In elite-level football, for example, older athletes usually transition to senior leagues and are no longer part of top-division teams. In contrast, in disciplines such as marathon running, it is common to find older age groups actively competing and achieving success.

The prevalence of hypertension in senior athletes is lower than in non-athletic individuals of the same age group<sup>28</sup>. This may be attributed to several factors, including lower BMI and a higher proportion of endurance training among older athletes. Former elite athletes who do not use antihypertensive medication tend to exhibit lower BP levels compared to individuals who did not engage in competitive sports, regardless of current physical activity levels<sup>29</sup>. This difference was most pronounced in former endurance athletes, suggesting that intensive endurance training exerts long-term protective effects against the development of hypertension, even after cessation of regular training.

Ipak, stariji sportaši koji su se bavili sportovima temeljenima na izdržljivosti nisu u svakom pogledu zdraviji od nesportaša. Primjenjujući koronarnu kompjutoriziranu tomografiju (CT), istraživanja su pokazale da asimptomatski sredovječni sportaši imaju viši stupanj koronarnih kalcifikacija u usporedbi s dobnu podudarnim nesportašima<sup>30</sup>. Točna uloga ovog podatka u dugoročnom KV rizičnom profilu sportaša još uvijek nije potpuno razjašnjena. Jedna je hipoteza da viši stupanj koronarnih kalcifikacija može označivati stabilnije, a time i manje rizične aterosklerotske plakove u usporedbi s onima u nesportaša. Međutim, tu pretpostavku djelomično dovode u pitanje rezultati istraživanja u kojem je primjenjivana kombinacija nativnoga (bez kontrasta) CT-a srca i kontrastno pojačane magnetne rezonancije srca u starijih maratonaca i nesportaške kontrolne skupine. U tom je istraživanju veći opseg koronarnih kalcifikacija u sportaša bio povezan s izraženijim kasnim pojačanjem gadolinijem, što upućuje na prisutnost oštećenja miokarda<sup>31</sup>.

### Farmakološka pitanja vezana uz liječenje hipertenzije u sportaša

Budući da se sport općenito smatra aktivnošću koja promiče zdravlje – kako među sportašima, tako i u široj javnosti – sportaše je često teško uvjeriti u realnost dijagnoze bolesti. Usto, s obzirom na to da su većina kompetitivnih sportaša mlade osobe, započinjanje farmakološkog liječenja može zahtijevati ne samo dobivanje pristanka samog sportaša nego i uključivanje te dodatno informiranje i umirivanje roditelja.

U inače zdravih mladih sportaša razumijevanje dugoročnih rizika i posljedica hipertenzije – kao i spoznaja da povišeni AT može negativno utjecati na sportski uspjeh – može olakšati prihvaćanje farmakološke terapije<sup>32</sup>. Prvi korak u liječenju hipertenzije u sportaša sastoji se u promjenama u životnom stilu, uključujući edukaciju i savjetovanje usmjereno na korekciju rizičnih ponašanja koja pridonose hipertenziji. Tek nakon tih koraka može se razmotriti uvođenje farmakološke terapije (**slika 1**).

Aerobna tjelesna aktivnost najčešće ima povoljan učinak na AT te se u većini slučajeva može nastaviti provoditi. To je osobito važno naglasiti u sportaša čiji je trening prije svega usmjeren na snagu<sup>13</sup>. U toj je skupini smanjenje tjelesne mase ključna preporuka; međutim, treba otvoreno reći da prekid visokokalorične prehrane može dovesti do smanjenja sportske uspješnosti. Neovisno o vrsti sporta, svim sportašima s hipertenzijom treba savjetovati smanjenje unosa soli te povećanje unosa kalija prehranom<sup>33</sup>.

Iako su promjene u životnome stilu ključne, one često nisu dovoljne za postizanje optimalne regulacije AT-a. U takvim je slučajevima potrebno započeti farmakoterapiju. Pri tome treba uzeti u obzir dva ključna čimbenika: kao prvo, naglo i agresivno snižavanje AT-a može dovesti do umora i smanjene sportske uspješnosti. Stoga liječenje ne treba započinjati najvišom predviđenom dozom lijeka jer to može negativno utjecati na suradljivost bolesnika. Drugo, u osoba koji se bave natjecateljskim sportovima odabir lijeka mora biti usklađen s antidopinškim propisima kako bi se izbjegla primjena zabranjenih tvari<sup>34</sup>.

Lijekovi prvog izbora u liječenju hipertenzije u sportaša uključuju inhibitore angiotenzin-konvertirajućeg enzima, blokatore angiotenzinskih receptora te blokatore kalcijevih

kanala. Međutim, stariji sportaši koji su se bavili sportovima temeljenima na izdržljivosti nisu u svakom pogledu zdraviji od nesportaša. Koronarna kompjutorizirana tomografija (CT) studije su pokazale da asimptomatski sredovječni sportaši imaju viši stupanj koronarnih kalcifikacija u usporedbi s dobnu podudarnim nesportašima<sup>30</sup>. Točna uloga ovog podatka u dugoročnom KV rizičnom profilu sportaša još uvijek nije potpuno razjašnjena. Jedna je hipoteza da viši stupanj koronarnih kalcifikacija može označivati stabilnije, a time i manje rizične aterosklerotske plakove u usporedbi s onima u nesportaša. Međutim, tu pretpostavku djelomično dovode u pitanje rezultati istraživanja u kojem je primjenjivana kombinacija nativnoga (bez kontrasta) CT-a srca i kontrastno pojačane magnetne rezonancije srca u starijih maratonaca i nesportaške kontrolne skupine. U tom je istraživanju veći opseg koronarnih kalcifikacija u sportaša bio povezan s izraženijim kasnim pojačanjem gadolinijem, što upućuje na prisutnost oštećenja miokarda<sup>31</sup>.

### Pharmacological Considerations in the Treatment of Hypertension in Athletes

Because sport is generally regarded as a health-promoting activity—by both athletes and the public—it is often difficult to convey the reality of a disease diagnosis to the athlete. Moreover, since the majority of competitive athletes are young, initiating pharmacological treatment may require not only the athlete's consent, but also the involvement and reassurance of parents, when applicable.

In otherwise healthy young athletes, understanding the long-term risks and consequences of hypertension—and recognizing that elevated BP may impair current physical performance—can facilitate the acceptance of pharmacological therapy<sup>32</sup>. The first step in managing hypertension in athletes involves lifestyle modification, including education and counseling aimed at addressing contributing behavioral factors. Only after this should pharmacologic treatment be considered (**Figure 1**).

Aerobic exercise generally exerts a beneficial effect on BP and, in most cases, can be continued. This should be particularly emphasized in athletes whose primary training is strength-based<sup>13</sup>. In this group, weight reduction is a critical recommendation; however, it should be acknowledged that discontinuing high-calorie diets may lead to a decline in performance. Regardless, all hypertensive athletes should be advised to reduce sodium intake and increase dietary potassium consumption<sup>33</sup>.

Although lifestyle changes are essential, they are often insufficient for achieving optimal BP control. In such cases, pharmacotherapy must be initiated. Two primary aspects should be taken into account: Rapid and aggressive BP lowering may lead to fatigue and diminished performance. Therefore, treatment should not begin with the maximum anticipated dose, as this may negatively impact treatment adherence. And in competitive athletes, anti-doping regulations must guide medication selection to avoid prohibited substances<sup>34</sup>.

First-line antihypertensive medications for athletes include angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, and dihydropyridine-type calcium channel blockers, either as monotherapy or in combination<sup>35,36</sup>. Among these, dihydropyridine calcium channel blockers are

kanala dihidropiridinskog tipa, primijenjene kao monoterapija ili kombinacijska terapija<sup>35,36</sup>. Među tim su lijekovima dihidropiridinski blokatori kalcijevih kanala osobito poželjni zbog svoje učinkovitosti te činjenice da ne zahtijevaju rutinsko praćenje bubrene funkcije.

Beta-blokatori, iako nisu potpuno zabranjeni, ubrajaju se u skupinu tvari zabranjenih u pojedinim sportovima te su ograničeni u određenim sportovima poput golfa i streljaštva<sup>34</sup>. Uprkos tomu, beta-blokatori se najčešće ne smatraju optimalnim izborom u liječenju hipertenzije u sportaša. Naime, beta-blokatori često dodatno smanjuju broj otkucaja srca u mirovanju u sportaša koji se bave sportovima temeljenima na izdržljivosti – pri čemu su ti sportaši često već bradikardni – te smanjuju maksimalnu frekvenciju srca koja se postiže tijekom napora. Neselektivni beta-blokatori također inhibiraju  $\beta_2$ -receptore u dišnim putevima, čime narušavaju respiratornu učinkovitost te posljedično smanjuju i uspješnost u sportu<sup>37</sup>.

Diuretici se ubrajaju među najčešće zabranjivane skupine lijekova u natjecateljskim sportovima, uključujući tiazide, diuretike Henleove petlje i antagoniste mineralokortikoidnih receptora. Razlog je tim zabranama prije svega mogućnost njihove uporabe za prikrivanje prisutnosti drugih sredstava za poboljšanje uspješnosti<sup>34</sup>. U slučajevima kada je primjena diuretika medicinski opravdana, ona može biti dopuštena – ali isključivo uz prethodno podnošenje i odobrenje zahtjeva za izuzeće radi liječničke terapije<sup>34</sup>.

## Povratak sportu u sportaša s hipertenzijom

Kada je arterijsku hipertenziju moguće adekvatno regulirati, sudjelovanje u sportskim aktivnostima – uključujući i natjecateljske sportove – najčešće se smatra dopuštenim. Međutim, u početnoj fazi liječenja ili u slučajevima kada AT nije zadovoljavajuće kontroliran, osobito kada sistolički tlak prelazi 160 mmHg, ne preporučuje se sudjelovanje u treningu visokog intenziteta dok se ne postigne odgovarajuća antihipertenzivna terapija.

Ako je hipertenzija dobro kontrolirana, ali sportaš ima visok KV rizik (SCORE >5 %) ili je opaženo oštećenje ciljnih organa, ne preporučuje se provođenje treninga snage visokog intenziteta. Nasuprot tomu, sportaši s dobro reguliranom hipertenzijom i bez dokaza o oštećenju organa mogu bez ograničenja sudjelovati u svim vrstama sportskih aktivnosti.

U odraslih osoba s hipertenzijom koje se bave preventivnom rekreacijskom tjelesnom aktivnošću preporučuje se provođenje treninga snage najmanje triput tjedno, u kombinaciji s aerobnom aktivnošću umjerenog do visokog intenziteta (najmanje 30 minuta po treningu, 5 – 7 dana u tjednu), jer takva razina tjelesne aktivnosti pridonosi sniženju vrijednosti AT-a u mirovanju i ukupnog KV rizika<sup>38</sup>.

## Zaključak

Arterijska je hipertenzija prisutna ne samo među osobama koje se bave natjecateljskim sportovima nego i u osoba koje se redovito bave rekreacijskom tjelesnom aktivnošću. Sportsko-medicinski probirni pregledi pružaju zaštitu sportašima jer omogućuju rano otkrivanje hipertenzije i postavljanje sumnje na supkliničke KV poremećaje, čime se osigurava pravodobna dijagnostička obrada i, prema potrebi, započinjanje učinkovite terapije.

particularly preferred due to their efficacy and the lack of requirement for renal function monitoring.

Beta-blockers, while not universally banned, fall under the category of sport-specific prohibited substances, meaning they are only restricted in certain sports such as golf and shooting<sup>34</sup>. Nevertheless, beta-blockers are generally sub-optimal for treating hypertension in athletes. They tend to further reduce resting heart rate in endurance athletes—who are often bradycardic at baseline—and they lower the attainable maximum heart rate during exertion. Moreover, non-selective beta-blockers inhibit  $\beta_2$ -receptors in the airways, impairing respiratory efficiency and thus athletic performance<sup>37</sup>.

Diuretics are among the most widely prohibited classes of medications in competitive sport, including thiazides, loop diuretics, and mineralocorticoid receptor antagonists. This is primarily because they may be used to mask the presence of other performance-enhancing substances<sup>34</sup>. In cases where diuretic use is medically justified, it may still be permitted—but only if a Therapeutic Use Exemption is formally requested and granted in advance<sup>34</sup>.

## Return to sport in athletes with hypertension

When hypertension is appropriately managed, participation in sports—including competitive sports—is generally permitted. However, during the initial phase of treatment or in cases where BP is not adequately controlled, particularly when systolic BP exceeds 160 mmHg, high-intensity training is not recommended until proper antihypertensive therapy has been established.

If hypertension is well controlled but the athlete has a high CV risk (SCORE >5%) or documented target organ damage, then high-intensity resistance training is not advised. In contrast, athletes with well-managed hypertension and no evidence of organ damage may participate in any type of sport without restriction.

For hypertensive adults engaging in preventive recreational sports, it is recommended to perform resistance training at least three times per week, in combination with moderate to high-intensity aerobic exercise (minimum 30 minutes per session, 5–7 days per week), as this helps reduce resting BP and overall CV risk<sup>38</sup>.

## Conclusion

Arterial hypertension is present not only among competitive athletes but also in individuals who engage in regular recreational physical activity. Sports medical screening examinations offer enhanced safety for competitive athletes by facilitating the early detection of hypertension and raising suspicion of subclinical CV abnormalities, thereby enabling timely diagnostic evaluation and, when necessary, the initiation of effective therapy.

In the management of hypertension in athletes, lifestyle modifications—including adjustments to training regimens and the discontinuation of dietary supplements or prohibited substances that may contribute to elevated BP—can be effective on their own. Pharmacological treatment largely follows the same principles as in the general population; however,

U liječenju hipertenzije u sportaša promjene životnog stila – uključujući prilagodbu treninga te prekid uzimanja dotada prehrani ili zabranjenih tvari koje mogu pridonositi povišenju AT-a – mogu biti učinkovite već same po sebi. Farmakološko liječenje uvelike slijedi ista načela kao i u općoj populaciji; međutim, terapijske je strategije pokatkad potrebno prilagoditi antidopinškim propisima i mogućem negativnom utjecaju pojedinih lijekova na uspješnost u sportu.

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therapeutic strategies may require adjustment due to anti-doping regulations and the potential for performance impairment associated with certain medications.

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