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Epidemiology, Prevention and Management of Hypertension in Young Athletes: A Narrative Review

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Abstract

Hypertension is one of the most prevalent global health challenges and increasingly affects children and adolescents. Despite well-established cardiovascular benefits of physical activity, recent evidence shows that young athletes are not uniformly protected from elevated blood pressure (BP). They may exhibit unique hemodynamic characteristics shaped by training load and sport-specific demands. This narrative review synthesizes original research published between 2015 and 2025 on the epidemiology, determinants, prevention strategies, and diagnostic considerations of hypertension in adolescent athletes. Eight studies identified through structured searches indicate that elevated BP is relatively common, with prevalence similar to that in the general adolescent population. Excess body weight, sport specialization, and fitness variability contribute substantially to BP elevation. Several studies link elevated BP with early cardiac remodeling, highlighting potential long-term implications even in highly trained youth. Lifestyle interventions, including moderate-to-vigorous activity, targeted conditioning, and improved fitness, support BP regulation. Fitness domains such as aerobic capacity, flexibility, and muscular power independently correlate with BP, emphasizing multifactorial prevention. Diagnostic evaluation requires consideration of athletic physiology. Standardized measurements, repeated assessments, exercise BP testing, and context-specific interpretation, particularly distinguishing physiological adaptations from early pathological changes, are essential for accurate diagnosis and safe sport participation. Overall, hypertension in young athletes remains underrecognized but clinically relevant. Early detection, fitness-oriented prevention, and tailored diagnostic approaches are key to safeguarding cardiovascular health and supporting athletic performance.

Keywords: Hypertension, Adolescents, Athletes, Blood pressure, Cardiovascular health

Introduction

Hypertension, or chronically elevated arterial blood pressure, represents one of the most widespread and clinically important health problems worldwide, contributing substantially to global morbidity and mortality (1-3).

It involves persistently increased pressure within the vascular system, which places excessive strain on blood vessel walls and elevates the risk of major cardiovascular complications, including myocardial infarction, cerebrovascular accidents, and heart failure. According to the World Health Organization, hypertension remains one of the foremost contributors to premature death globally, accounting for approximately 10 million fatalities each year (4). Its development is influenced by a multifaceted combination of genetic predisposition, environmental exposures, and lifestyle behaviors. Well-established risk factors include a positive family history, advancing age, excess body weight, high dietary sodium intake, alcohol overuse, and insufficient physical activity.

Hypertension in childhood and adolescence has emerged as a significant public health concern, with mounting evidence showing that elevated blood pressure (BP) during youth tracks strongly into adulthood and contributes to early manifestations of target-organ damage (5). Traditionally, competitive sports participation has been regarded as inherently cardioprotective, based on well-established associations between physical activity and improved cardiovascular health. However, recent research indicates that young athletes are not uniformly safeguarded against elevated BP (6, 7). Instead, they may exhibit unique hemodynamic characteristics shaped by training load, sport-specific physiological demands, and performance-related stress. As a result, hypertension in adolescent athletes is increasingly recognized as a clinically relevant but frequently under-detected condition (8).

The growing participation of youth in organized and competitive sports heightens the importance of accurate BP assessment in this population. Athletic preparticipation evaluations, school-based screenings, and routine sports medical examinations offer key opportunities for early detection of elevated BP. Yet these evaluations are often performed using non-standardized methods, and normative BP values derived from general pediatric populations may not adequately reflect the physiological adaptations seen in trained adolescents (9). High-intensity training, variations in cardiorespiratory fitness, exercise-induced BP responses, and sport-specific cardiac remodeling all complicate interpretation of BP measurements in athletic settings (10). Consequently, the clinical challenge lies in distinguishing normal adaptive responses from early pathological elevations requiring intervention.

In recent years, a growing number of original studies have examined the epidemiology, risk factors, and cardiovascular implications of elevated BP among young athletes. Evidence from diverse cohorts, including school athletes, suburban and urban sports participants, endurance-trained youth, and high-performance competitors, demonstrates that elevated BP is more common than previously appreciated and is strongly influenced by modifiable factors such as body composition, training characteristics, and physical fitness levels (11). Importantly, several studies have documented associations between elevated BP and early indicators of cardiac remodeling in adolescent athletes, underscoring that even in the presence of high fitness levels, sustained BP elevation may carry long-term clinical consequences.

As awareness of pediatric and athletic hypertension increases, so too does the need for effective preventive strategies. Physical activity interventions, school-based exercise programs, structured conditioning, and broader lifestyle modifications have shown promise in mitigating BP elevation. At the same time, advancements in diagnostic monitoring, including ambulatory BP monitoring, detailed exercise BP testing, and longitudinal assessment of cardiac structure, are enhancing the precision with which clinicians can evaluate BP regulation in highly active youth.

Despite these emerging insights, the literature remains scattered across epidemiology, sports cardiology, pediatric hypertension, and exercise physiology. A synthesis of contemporary evidence is therefore needed to clarify the prevalence, determinants, and clinical implications of elevated BP in adolescent athletes, as well as the effectiveness of prevention and management strategies tailored to this unique group.

The present review addresses this need by integrating findings from original research published between 2015 and 2025. Through a structured literature search and thematic analysis, we examine the epidemiology and risk factors of hypertension in young athletes, the impact of physical and lifestyle interventions on BP regulation, and diagnostic and monitoring strategies suitable for athletic populations. By consolidating current evidence, this review aims to inform sports physicians, pediatricians, cardiologists, athletic trainers, and public health professionals about best practices for identifying and managing elevated BP in adolescent athletes, ultimately supporting safer participation in sport and promoting long-term cardiovascular health.

Methods – Literature Search Strategy

A structured literature search was conducted to identify original research articles examining the epidemiology, prevention, physiological mechanisms, and clinical management of hypertension in adolescent athletes. Searches were performed in PubMed and Scopus, which were selected due to their comprehensive coverage of biomedical and sports science literature.

The following search string was used in both databases:

“Hypertension” AND “Athletes” AND “Adolescent”

To refine results to contemporary evidence relevant to the current understanding of hypertension in youth, the search was limited to studies published between January 2015 and December 2025. Only peer-reviewed original research articles were included. Systematic reviews, narrative reviews, meta-analyses, editorials, conference abstracts, and case reports were excluded.

After removing duplicates, titles and abstracts were screened to identify studies meeting the following inclusion criteria:

1. Populations consisting of athletes, youth engaged in organized sports, or adolescents with high levels of structured physical activity.
2. Studies reporting outcomes related to blood pressure, hypertension prevalence, cardiovascular responses to exercise, lifestyle interventions, or diagnostic assessment.
3. Original empirical design, including cross-sectional studies, longitudinal cohorts, randomized controlled trials, or intervention studies.

Full texts of potentially eligible articles were reviewed for relevance and methodological quality. Studies were excluded if they lacked adolescent-specific data, did not involve athletes or physically active youth, or did not report blood pressure–related outcomes.

A total of 8 studies met the eligibility criteria and were included in the final narrative synthesis. These studies were then organized into three thematic sections:

1. epidemiology and risk factors,
2. lifestyle and physical interventions,
3. diagnostics and monitoring in young athletes.

Epidemiology and Risk of Hypertension in Young Athletes

Hypertension in adolescence is increasingly recognized as a relevant cardiovascular concern, and emerging evidence indicates that it also affects young athletes involved in organized sports. Although regular physical activity promotes cardiovascular health, competitive youth athletes are not uniformly protected from elevated BP. In fact, several contemporary studies suggest that elevated BP may be underdiagnosed in this group, partly due to the common assumption that athletic training inherently reduces cardiovascular risk. Understanding the epidemiology of hypertension among young athletes is therefore crucial for accurate risk stratification and tailored clinical management.

One of the most informative epidemiological assessments comes from the Mississippi study conducted in 2016 (12). This large population-based project examined BP and body weight among adolescent student athletes participating in school sports. The analysis revealed high rates of overweight and obesity, along with a notable proportion of athletes meeting criteria for elevated BP and hypertension. Importantly, the study also demonstrated that the risk of elevated BP among single-sport athletes was 1.59 times higher than in athletes participating in three or more sports (RR = 1.59) and 1.30 times higher compared with two-sport athletes (RR = 1.30), suggesting that greater sport diversification may confer a cardiovascular benefit. Contrary to expectations, the findings demonstrated that participation in school athletics does not guarantee optimal cardiovascular profiles. Instead, youth athletes appear to mirror broader trends seen in general adolescent populations, where lifestyle factors such as diet, socioeconomic status, sleep patterns, and psychosocial stress contribute significantly to increased BP. The study highlighted the importance of standardizing BP measurement during school-based sports evaluations.

Similar conclusions emerged from the large urban cohort evaluated by Kropa et al. in 2016 (13). Among more than 2700 student athletes representing a variety of competitive sports, approximately 15% were found to have elevated or hypertensive BP during preparticipation

cardiovascular screening. Nearly one quarter of the cohort was classified as overweight or obese, with body mass index (BMI) identified as the strongest predictor of abnormal BP values. This dose-dependent relationship between BMI and BP underscores that even regular sports participation cannot fully counteract the hemodynamic effects of excess adiposity. These findings emphasize the need for integrating nutritional counseling, body-weight monitoring, and health education into youth sports programs to mitigate modifiable cardiovascular risk factors.

Georgeson et al. (2017) (14) expanded the epidemiological perspective by evaluating suburban adolescent athletes. Their study confirmed that elevated BP and excess body weight are widespread even in physically active youth populations. In a cohort of more than 900 athletes, approximately 15% met criteria for elevated BP, and the prevalence of overweight and obesity was strongly associated with higher BP levels. These findings reinforce that participation in school sports does not inherently protect against cardiometabolic risk. The authors emphasized that elevated BP may go unrecognized during routine pre-participation evaluations if measurements are not performed carefully and interpreted using age-, sex-, and height-specific percentiles. They highlighted the clinical importance of accurate screening in this population, as undetected elevated BP in adolescence may track into adulthood.

The longitudinal perspective provided by Wellman et al. (2020) (15) adds important context to the epidemiology of elevated BP in active youth. Although the study focused broadly on adolescents rather than athletes specifically, its analysis of physical activity intensity and frequency is highly relevant to athletic populations. The authors found that engagement in physical activity more intense than light was associated with a lower likelihood of exhibiting BP values in the hypertensive range over time. Notably, this relationship remained significant even after adjusting for BMI, suggesting that the protective effect of higher-intensity activity is at least partially independent of body weight. The study did not evaluate athletes exclusively, but its findings support the broader principle that regular participation in moderate or vigorous physical activity may reduce the long-term risk of elevated BP during adolescence.

The role of sport-specific training adaptations is highlighted in the work of Pentikäinen et al. (2021) (16), who compared resting BP and electrocardiographic characteristics among youth endurance athletes, non-endurance athletes, and non-athletes. Endurance athletes showed lower resting BP and a higher prevalence of sinus bradycardia, consistent with common endurance-training adaptations. Nonetheless, some athletes displayed elevated BP despite high fitness

levels, demonstrating that athletic conditioning does not universally guarantee optimal hemodynamic status. This interindividual variability further supports the need for individualized assessment rather than assumptions based solely on sport type or training intensity.

A more detailed understanding of BP responses in athletic settings is provided by Wuestenfeld et al. (2022) (17), who evaluated BP during maximal ergometer testing in a large cohort of competitive adolescent athletes. Their findings showed that these athletes reached significantly higher peak systolic BP values during exercise compared with reference values from non-athlete youth reported in previous studies. Using these data, the authors established the first age- and sex-specific exercise BP percentiles for young high-performance athletes. Echocardiographic assessments demonstrated stress-related cardiac adaptations in most participants, consistent with the elevated exercise BP responses. These results indicate that higher peak BP during exertion can represent a normal physiological response in trained youth and provide clinicians with normative ranges to better interpret exercise BP testing in this population.

Collectively, these studies illustrate that hypertension in young athletes is driven by multiple interacting factors, including body composition, fitness level, sport specialization, and individual cardiovascular physiology. While regular physical activity provides substantial health benefits, it does not eliminate the risk of elevated BP in this population. Routine and longitudinal BP screening, supported by standardized measurement techniques and sport-specific interpretation, is therefore essential for early identification of at-risk athletes and for guiding targeted preventive interventions.

Physical and Lifestyle Interventions in the Prevention and Control of Hypertension

Lifestyle-based strategies, including structured physical activity and behavioral modification, are central to preventing and managing elevated BP among adolescents, including those engaged in competitive sports. Although athletic participation generally promotes cardiovascular health, evidence shows that young athletes remain susceptible to elevated BP, especially when excess body weight, inconsistent training patterns, or suboptimal lifestyle habits are present. Understanding the effectiveness of targeted interventions is therefore essential for optimizing cardiovascular outcomes in this group.

The longitudinal study by Wellman et al. (2020) (15) demonstrated that adolescents who engaged more frequently in and at higher intensity levels of physical activity had a lower likelihood of developing elevated BP over the follow-up period. While not focused exclusively on athletes or seasonal training variations, the findings indicate that greater physical activity intensity and frequency may contribute to better BP outcomes in youth.

Chuang et al. (2023) (18) provided important evidence linking physical fitness to BP regulation in school-aged children. In their cross-sectional analysis of 360 participants, children in the hypertensive subgroup demonstrated higher BMI and waist–height ratio percentiles, as well as poorer performance in multiple fitness domains, including the 800-m run, standing long jump, and 1-min sit-ups, compared with normotensive peers. Mediation analyses revealed that aerobic fitness (800-m run percentile) and flexibility (sit-and-reach percentile) mediated the association between adiposity and systolic BP percentile, while muscular power (standing long jump percentile) showed a direct inverse association with diastolic BP percentile. In multivariable models, both the standing long jump percentile and BMI percentile emerged as independent predictors of pediatric hypertension. These findings highlight that physical fitness contributes meaningfully to BP status beyond body weight alone and support the value of monitoring and promoting fitness, not only healthy weight, as part of pediatric BP prevention strategies.

Overall, evidence indicates that physical and lifestyle interventions represent powerful tools in the prevention and control of hypertension in young athletes. While sports participation contributes to cardiovascular health, it must be complemented by structured conditioning and supportive lifestyle practices to ensure optimal BP regulation and long-term cardiovascular well-being. This conclusion is consistent with current evidence in the available scientific literature (19).

Diagnostic and Monitoring Strategies for Managing Hypertension in Young Athletes

The diagnosis of hypertension in young athletes requires consideration of the physiological characteristics unique to this population. Regular training affects hemodynamics, heart rate, and cardiac structure, meaning that standard thresholds and interpretations may lead to both false-positive findings and missed subtle abnormalities. Appropriate selection of measurement methods and correct interpretation of results, always in the context of sport type and training stage, are therefore essential.

Preparticipation evaluation (PPE) is a standard opportunity to measure BP in athletes. According to Hedman et al. (2019) (20), BP readings during PPE frequently reach values at or above the threshold for hypertension, and therefore the authors highlight the need for standardized BP measurement procedures. The authors also report that athletes with elevated systolic BP showed higher left ventricular (LV) mass-to-volume ratios, suggesting a measurable association between BP and cardiac structural changes. Furthermore, Hedman et al. repeat BP measurements when the initial value is ≥140/90 mmHg, indicating that elevated readings warrant confirmation. Since the study identified associations between higher BP and cardiac structural parameters, it is reasonable to consider that, in clinical practice, elevated BP in an athlete may justify further cardiac evaluation to differentiate physiological training-related remodeling from potential early pressure-related changes. However, this interpretation is not explicitly stated in the original article and should be regarded as a clinically informed extrapolation rather than a direct conclusion by the authors.

Exercise testing provides valuable diagnostic information on BP regulation under dynamic load. Wuestenfeld et al. (2022) (17) established age- and sex-specific percentiles for maximal systolic BP in adolescent elite athletes, demonstrating that previously available reference values, derived from non-athletic populations, do not adequately reflect physiological responses in trained youth. The authors emphasize that these newly developed upper limits can support clinicians in distinguishing normal exercise-related BP elevations from values that may warrant closer scrutiny. As such, exercise BP assessment serves as a complementary tool in cardiovascular evaluation, particularly when sport-specific reference standards are necessary to interpret the hemodynamic response accurately.

By consistently analyzing the available evidence, it becomes clear that the diagnostics and monitoring of hypertension in young athletes must incorporate both standard clinical tools and assessment elements specific to the athletic population. Precise resting BP measurement, interpreted in the context of training characteristics, is the starting point but is often insufficient on its own. Exercise testing and its sport-specific reference norms help identify abnormal hemodynamic responses. When elevated BP values are recorded, an evaluation of cardiac structure may be warranted, particularly when there is concern for pressure-related remodeling.

Taken together, the findings of the discussed studies highlight the need for an integrated diagnostic approach that enables clinicians to distinguish physiological training adaptations from potential early signs of hypertension in young athletes. Such an approach is essential for

ensuring safe clearance for training and competition while also allowing for the timely identification of individuals who may require further monitoring or evaluation.

Conclusions

Hypertension in young athletes is increasingly recognized as a significant but often underdiagnosed concern. Although sports participation promotes cardiovascular health, elevated BP remains common and is influenced by factors such as excess adiposity, variable conditioning, and sport-specific physiological demands. Several studies demonstrate that even mildly elevated BP may be associated with early cardiac remodeling, underscoring the importance of timely detection.

Effective prevention requires more than reliance on athletic training alone. Aerobic conditioning, improved cardiorespiratory fitness, and targeted lifestyle strategies, including healthy nutrition, adequate sleep, and reduced sedentary behavior, have all been shown to reduce BP in adolescents. These measures are especially relevant for athletes whose sports provide limited endurance stimulus or who exhibit additional risk factors.

Accurate diagnosis is essential. Standardized BP measurements, repeated assessments, ambulatory BP monitoring, and exercise BP testing improve diagnostic precision and help differentiate physiological adaptations from early hypertension. When elevated BP persists, individualized evaluation and follow-up are warranted.

Overall, safeguarding cardiovascular health in young athletes requires structured BP screening, careful interpretation of athletic adaptations, and proactive implementation of fitness and lifestyle interventions. This integrated approach supports both athletic performance and long-term cardiovascular well-being.

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Conceptualisation and Methodology: AH

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In preparing this work, the author(s) utilized AI for the purpose of enhancing the clarity and readability of the text. After using this tool, the author(s) have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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