Review Paper

Pre-participation Evaluation for Pediatric and Adolescent Athletes in Iran: A Review of Methods, Tools, and Challenges

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ABSTRACT

Background: Pre-participation evaluation (PPE) is an important component of health screening programs for athletes, designed to assess their physical condition and any risk factors associated with possible injuries and illnesses during sports participation. The importance of PPE in preventing injuries among young athletes is widely acknowledged internationally, but it is not properly implemented in Iran because of poor standardization and a lack of appropriately trained personnel.

Objectives: In this study, we aimed to review the evidence about the structure, methods, and models of PPE for child and adolescent athletes in the context of sports medicine practice in Iran.

Methods: This is a narrative review. A comprehensive search of national and international databases was conducted to identify relevant papers.

Results: The findings indicated weaknesses in PPE practice in Iran, with heterogeneity in protocols, lack of comprehensive examiner training, inconsistent frequency and duration of screening, and limited use of standardized history forms and physical exam checklists. Few services are run by sports physicians, and referrals for abnormalities are often unclear. PPE design and integration with comprehensive health promotion programs should be individualized based on age, sport type, and level of performance to improve the system's impact.

Conclusions: An integrated and evidence-based PPE system should be established and enforced in young athletes to ensure their safety and promote long-term health, through standardizing PPE, improving the sports medicine education, and the implementation of a risk stratification personalized system to improve screening effectiveness and prevent adverse events.

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Introduction

Pre-participation evaluation (PPE) is a standard health screening frequently performed on pediatric and teenage athletes to determine their fitness level, assess underlying medical issues, and ascertain whether they are fit enough to participate safely in organized sports. Thus, this type of screening aims to evaluate the athlete's fitness and readiness for organized sports, as well as uncover any existing health issues that might make participation risky [1, 2]. In young athletes, PPE helps identify risks associated with growth and other factors that influence the risk of injury and illness. In accordance with modern sports medicine guidelines, key aspects of PPE include proper collection of medical history, a pediatric-focused physical examination, and recommendations for appropriate referral for detected diseases. PPE can also be conceptualized as a structured cardiovascular health visit that addresses sleep, nutrition, weight, blood pressure, lipid and glucose control, and other cardiometabolic determinants relevant to both athletic performance and long-term health [3].

The physician performing the PPE has ultimate responsibility for granting medical clearance and should interpret the results by considering the athlete's age and overall condition [4]. Although the significance of PPE is widely acknowledged, several issues remain, including inconsistent examination techniques, examiner qualifications, result interpretation, and insufficient standardization of the process [5]. In Iran, where hundreds of children and teenagers are subjected to PPE every year, it has also been suggested that there is a lack of efficiency in the evaluation process due to inconsistent procedures and insufficient awareness of the standardized testing process [6]. Due to unique physiologic and developmental risks associated with children and adolescents in nearly all sports, it is critical that standard terminology is utilized and a scientifically valid framework is maintained to help ensure clarity and quality within discussions of PPE service delivery, evidenced by consensus and new rules/laws governing PPE services in sports, and to help establish an ongoing basis for providing safe services.

In this narrative review, we aimed to summarize evidence on PPE structure, content, and models (office-based or station-based) for child and adolescent athletes in the context of sports medicine practice in Iran. We focused specifically on pediatric and adolescent athletes (typically 6–18 years), acknowledging the physiological, developmental, and psychosocial characteristics unique to this age group that distinguish them from adult athletic populations.

Materials and Methods

The current study was conducted as a narrative review of the literature on PPE among pediatric and adolescent athletes. A comprehensive search was performed across national and international scientific databases to identify relevant publications addressing the principles, objectives, components, and approaches of PPE, with particular emphasis on issues related to children and adolescents and sports medicine practice in Iran. The literature was reviewed regarding key aspects of PPE, including medical history taking, physical examination, cardiovascular and musculoskeletal screening, paraclinical assessments, the frequency and timing of evaluations, qualifications of PPE examiners, office-based and station-based PPE models, and medical clearance for sports participation. Relevant guidelines, consensus statements, review articles, and original research studies were included when they aligned with the scope of this review.

Results

Pre-participation evaluation history

There has been constant improvement in PPE, a method for identifying risk factors to reduce injury and protect athletes during sport participation. The first use of PPE occurred in the 1940s, when attention to health and fitness increased among both the general population and sport participants [7]. These early methods for identifying health-related issues and assessing an individual's fitness became the framework for developing PPE standards and guidelines. Organizations such as the American Medical Association (AMA) and others created standards for these evaluations in the following decades [8]. This improved the specification of PPE goals and created a systematic model for its use. In 1996, the American Heart Association (AHA) issued a historic statement about cardiovascular screening of athletes [9]. The statement was a milestone in PPE history, highlighting cardiovascular evaluation and providing clear guidance for physicians and other healthcare professionals involved in the process. In the ensuing years, the AMA and the American Academy of Pediatrics (AAP) created a series of PPE guidelines and standards. These efforts further highlighted the importance of PPE in preventing sudden cardiac death (SCD) and promoting overall health among child and adolescent athletes [4, 10].

Pre-participation evaluation goals

Sports organizations and governing bodies widely use PPE methods as a structured approach to assessing athlete health and readiness for participation. Although PPE is widely used to identify cardiovascular and other health risks, the strength of evidence for different screening models remains unclear across settings and populations [2, 11]. What is covered, how it is done, and its efficacy are not organized uniformly by organizations or countries. The goal of PPE is to enhance athletes' health and safety. The PPE goals can be summarized as follows: (i) Establish athletes' general physical and mental health; (ii) Identify conditions that are potentially life-threatening or disabling; (iii) Identify conditions that may predispose the athletes to illness or injury; (iv) Provide an opportunity to discuss health and lifestyle issues with the athlete [11–15].

Pre-participation evaluation aspects

Timing

PPE is ideally performed at least six weeks before the start of the competitive season, allowing sufficient time to address identified medical conditions or musculoskeletal problems before participation. However, the interval between evaluation and competition should not be so long that the athlete's clinical status changes substantially after the examination [16].

Frequency

Recommended PPE frequencies differ based on specific athlete populations and the purpose behind such screenings. One group of researchers recommends yearly PPE for children and adolescents because their body systems are constantly changing; therefore, the detection of potential new diseases or health issues may require an annual test [9, 17]. However, some other experts suggest that PPE should be conducted less frequently, i.e. once every two or three years, as adult athletes do not experience constant physiological changes, rendering annual testing either unnecessary or expensive [18, 19]. The last perspective emphasizes the benefits of personalized evaluations, indicating that the frequency of the test should be dependent on different criteria, such as the age of patients or their competitive level [20].

In conclusion, it seems that the most effective rate of conducting PPEs depends on certain situations and is highly context dependent. Annual PPEs are recommended for children and adolescents due to their fast development and the higher probability of the occurrence of health issues. Healthy adults without any previous diseases who engage in sports activities should undergo PPE once in two or three years. At the same time, those athletes who have some underlying health conditions or have a predisposition to heart or skeletal muscle diseases can benefit from having PPEs more frequently.

Methods

History-taking and physical examination by PPE can be conducted with office-based or station-based techniques, either individually or in groups; each also has its own advantages and disadvantages.

Office-based techniques

In this approach, athletes are evaluated in a clinic by general practitioners, pediatricians, or sports medicine specialists. Office-based techniques have various advantages, such as ensuring privacy, continuity of care, and the physician's understanding of the athlete's family and medical history. However, a detailed office-based evaluation may take too long and may not focus sufficiently on pertinent sports-specific factors [4].

Station-based techniques: In the station-based approach, several specialists evaluate athletes at designated stations, one for each site. The system is time-efficient, sport-specific, cost-effective, and high-yield for screening multiple abnormalities. It can lack privacy and not offer continuity of medical care [4]. Table 1 presents some station-based PPE techniques.

Examiner qualifications

PPE, if possible, should be conducted by sports medicine specialists. While PPE is typically carried out by general practitioners, they are not specifically trained for this purpose in most cases. Therefore, professional athletes' evaluations should be reserved for sports medicine specialists. Physicians responsible for PPE should not only be adequately trained in sports medicine but also refer athletes to relevant specialists when abnormalities are detected during the screening [4].

Pre-participation evaluation components

Under normal circumstances, history taking and physical examination comprise the fundamental components of PPE. In other cases, further paraclinical examinations or measurements of physical fitness parameters may be necessary.

Table 1. Example of a station-based PPE

Station	Objective	Personnel
Waiting area	Entry into the system, registration, and detailed instructions for completing required forms	Receptionist and administrative support staff
Anthropometry and vital signs	Height, weight, BMI, blood pressure, heart rate, visual acuity	Qualified personnel such as nurses, paramedics, medical students, general practitioners
Medical examination	History taking and physical examination to assess eligibility for participation in training and competition or referral	General practitioner
Specialist examinations	Orthopedic assessment, cardiac evaluation, pulmonary function tests, or other system-based evaluations	Relevant specialist
Optional stations	Educational and vaccination areas	Qualified specialist

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History taking

A complete medical history forms the basis of PPE. According to studies, 88% of all medical issues and 64-75% of severe musculoskeletal complaints requiring withdrawal or restriction from sport can be identified by taking a complete personal and family medical history. Thus, personal and family history is more sensitive than physical examinations [4, 21]. For young athletes under 18 years, medical history questions are answered by both the athlete and the parents. Completion of the history form by athletes or their parents is more accurate and reduces error. Completing these forms before the examination allows families to mention things the athlete may be unaware of or has forgotten, especially family history and childhood events [4]. The history form should contain information on disease, past or recent trauma, hospitalization, previous operation, functional impairment, heat or cold-related issues, use of medications, supplementation, dietary supplements, substance abuse, allergies, immunizations, menstrual disorders in female athletes, sudden weight change, previous ban from sport and disease or neurological/psychological disorder family history. A standardized questionnaire can be strengthened by explicitly covering exercise-induced symptoms, family history of cardiovascular disease, medication use, supplements or performance enhancers, and psychosocial or lifestyle factors in one instrument [4, 22]. A review of systems should include questions for all body systems, with the cardiovascular system given the highest priority. A positive response to questions in this section should guide further evaluation and follow-up. Below, we provide key history-taking questions in PPE:

Cardiovascular system

Questions should cover chest pain, discomfort, tightness, or pressure with exertion, syncope or near-syncope not accounted for, dyspnea, fatigue, or palpitations with exercise not accounted for, previously diagnosed heart murmurs, systemic hypertension, previous restriction from sports participation, previous diagnostic tests, family history of premature death (age <50) due to cardiac disease in one or more relatives, incapacitation resulting from cardiac disease in close relatives under age 50, and family history of structural or conduction heart diseases such as hypertrophic or dilated cardiomyopathy, long QT syndrome, ion channelopathies, or clinical arrhythmias. Also, they need to be screened for manifestations suggestive of Marfan syndrome such as kyphoscoliosis, high-arched palate, pectus excavatum, arachnodactyly, hyperextensibility, myopia, mitral valve prolapse, and aortic insufficiency [2, 23].

Musculoskeletal system

Taking a history of previous fractures, dislocations, sprains, and muscle or ligament strains that required treatment or rehabilitation is important. Patterns of musculoskeletal injuries are sport-specific. Fracture and ligament injuries occur more in collision or contact sports, while overuse injuries, stress fractures, and tendinopathies occur in endurance or non-contact sports [24].

Neurological, integumentary, and visual systems

One should enquire about headaches, seizures, spinal and spinal canal issues, and concussions [25]. Also, questions should cover rashes such as herpes and fungal or bacterial infections [4]. Sports participants need to have vision adequate for sports involvement. Ask about a history of eye problems or injury [26].

Immunologic system (allergies and vaccination)

Question athletes about wheezing, exercise-induced shortness of breath, coughing, asthma, or allergies in the past and during exercise. Asthma is a common

chronic respiratory condition in children and adolescents, and exercise-induced bronchospasm is reported in a substantial proportion of individuals with asthma. Consider diagnosing asthma in athletes who experience wheezing or respiratory symptoms during exercise [27-29].

Athletes must follow the vaccination schedule recommended by international organizations such as the Centers for Disease Control and Prevention (CDC) or World Health Organization (WHO). The pre-participation screening will include an assessment of the athlete's vaccinations. In addition to routine immunizations, the annual influenza vaccine is required. Other vaccinations may also be advised depending on disease epidemiology, travel needs, or emerging infections like coronavirus. This should be verified on PPE [30].

Nutritional status

Eating disorders and body image concerns occur most frequently with sports that have weight categories or where appearance or thinness is central to performance [31].

Menstrual health

In cases of primary or secondary amenorrhea, evaluation should include consideration of the female athlete triad (disordered eating, amenorrhea and osteoporosis). More recent consensus statements have expanded this concept to the broader framework of relative energy deficiency in sport (RED-S), which includes the triad components within a wider spectrum of physiological consequences of low energy availability [32, 33].

Physical examination

A regular physical examination should include at least an assessment of anthropometric factors, vital signs, and the visual, musculoskeletal, and cardiovascular systems. Additional tests may be done if history taking results in findings [16, 25].

Anthropometric measurement

Monitoring weight trends can identify abnormal weight loss or gain, which may indicate eating disorders, low energy intake, disordered weight gain behavior, or steroid use [34]. Height curves are monitored to diagnose slowing down of growth, which may be a symptom of other diseases such as endocrine disease, nutritional disease, deficiency in energy, or delayed puberty and growth. These conditions may make the child susceptible to overuse injury and contact sports injury [35].

Heart rate and blood pressure

The evaluation is useful in the early recognition of possible cardiac problems such as hypertension or abnormal heart rhythm. These findings should be recognized during the PPE since patients with underlying cardiovascular diseases can have a higher risk for adverse cardiac events during intense physical activity and may need additional workup to clear them for participation in athletics [36].

Respiratory rate and oxygen saturation

Respiratory rate and oxygen saturation can also yield useful information about cardiopulmonary status and pulmonary health. A high respiratory rate or low oxygen saturation can indicate respiratory diseases such as exercise-induced bronchoconstriction or asthma, and further investigation is needed before sport participation [36].

Body temperature

Body temperature is another vital component to assess potentially underlying medical disorders that may temporarily prohibit an athlete from participating in sport due to infection. Deviations from a normal body temperature may be indicative of endocrine diseases such as thyroid disease and can potentially affect an athlete's metabolism, energy level, and endurance [37].

Visual system

During PPE, visual acuity of all athletes should be evaluated to ensure that their vision is at least 20/40 with or without correction for sporting participation. Athletes with vision worse than 20/40 in one eye, even with correction, require additional ophthalmologic tests. Specifically, patients with vision below 20/40 in one eye should use eyewear to protect the unaffected eye and prevent injury [34, 38].

Cardiovascular system

Cardiac auscultation should be performed in both erect and supine positions or during the Valsalva maneuver to detect other heart sounds or murmurs. Radial and femoral pulses should also be examined on each side, with attention to any disparity in pulse timing, es-

Table 2. Musculoskeletal examination methods during PPE

Assessment Areas	Execution Method
Posture and acromioclavicular joint symmetry	Standing facing the examiner
Cervical spine movements	Looking up at the ceiling, turning toward shoulders, tilting each ear to the corresponding shoulder
Trapezius muscle strength	Shoulder shrug against resistance
Deltoid muscle strength	Shoulder abduction to 90 degrees against resistance
Rotator cuff muscle movements	External rotation of shoulders in 90-degree abduction position
Elbow movements	Flexion and extension of the elbows
Elbow and wrist movements	Pronation and supination of wrists with arms close to the body and elbows bent at 90 degrees
Hand and finger movements, strength, and deformities	Spreading fingers apart, making a fist
Lower limb symmetry and swelling in knees or ankles	Contracting and relaxing quadriceps muscles in a sitting position
Hip, knee, and ankle joint movements	Duck walking
Shoulder symmetry and scoliosis	Standing with the back to the examiner
Hip joint movements, hamstring tightness	Touching toes with fingers without bending the knees
Calf muscle symmetry and strength	Standing on heels and toes

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pecially in hypertension. Any deviation of pulse timing should be further investigated [34, 39, 40].

Musculoskeletal system

To evaluate the musculoskeletal system, a 90-second musculoskeletal screening examination can be employed. The components of this screening are outlined in Table 2 [41].

Paraclinical measures

Routine paraclinical tests and cardiovascular or pulmonary screening tests during PPE remain controversial. Most PPE guidelines discourage routine paraclinical tests [4]. However, the following paraclinical evaluation guidelines should be considered:

Blood test

If an athlete is diagnosed with anemia, hemoglobin and ferritin status must be determined. Type 1 or type 2 diabetic athletes should be screened periodically for foot pathology (e.g. sensory loss and reflexes), ocular, renal, neurological, and cardiovascular complications. Lipid profile assessment is recommended for patients with a personal history of hypercholesterolemia or dyslipidemia and for athletes found to have cardiovascular risk factors on history or physical examination [39].

Electrocardiogram

The role of routine electrocardiogram (ECG) remains one of the central controversies in PPE. Contemporary review evidence indicates that ECG can improve detection of occult cardiovascular disease, but the optimal protocol remains debated and is likely best individualized according to athlete characteristics, sport exposure, and local expertise [42]. This debate remains unresolved because the evidence base for broad PPE programs is largely observational, and screening should ultimately be judged by patient-centered outcomes as well as detection rates [43]. Advocates of ECG screening state that it may increase the diagnosis of certain deadly cardiac disorders such as hypertrophic cardiomyopathy and primary electrical diseases.

In juvenile athletes, common adaptive ECG findings include sinus bradycardia, incomplete right bundle branch block, and sinus arrhythmia, whereas confirmed high-risk conditions appear to be uncommon. Accordingly, ECG interpretation in pediatric PPE should be explicitly age-, sex-, and sport-sensitive to avoid over- calling physiologic remodeling as pathology [44].

Table 3. Classification of sports according to the contact level

Contact or Collision	Limited Contact	Non-contact
Basketball	Cycling	Archery
Boxing	Fencing	Badminton
Diving	Field sports (high jump, pole vault)	Bodybuilding
Ice hockey	Gymnastics	Discus, weight, and javelin throw
Martial arts	Equestrian	Power-lifting
Ski jumping	Skating	Running
Football	Skiing	Swimming
Water polo	Volleyball	Table tennis
Wrestling	Surfing	Tennis
Water polo	Squash	Bowling
Handball	Weight-lifting	Rowing
Rugby	Field hockey	Golf
Gymnastics	Surfing	Diving
Parkour	Baseball	-

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The shortcomings of routine ECG screening include the prevalence of false-positive readings and the subsequent need for further, expensive investigation, as well as the rarity of SCD among athletes. Thus, routine ECG screening is not universally recommended. However, in athletes with concern for cardiovascular disease, appropriate investigations such as ECG and echocardiography may diagnose cardiac abnormalities and therefore reduce the risk of SCD [2, 45-47].

When screening reveals red-flag cardiovascular symptoms or clearly abnormal ECG findings, temporary restriction from high-intensity training is prudent until expedited downstream evaluation is completed. By contrast, selected asymptomatic athletes with borderline findings may continue some activity under shared decision-making, prompt specialist follow-up, careful documentation, and an established emergency plan [48].

Clearance for sports participation

After the required evaluation is done, the physician should first determine the level and degree of contact involved in the athlete's sport discipline (Tables 3 and 4). In granting medical clearance, the following inquiries should be answered:

Does the athlete's participation in the sport create a greater risk of illness or injury?

Does the athlete's participation in the sport place other participants at greater risk of illness or injury?

Can the underlying condition be controlled so that participation is safe?

Can participation in sport be withheld on a temporary basis pending treatment or evaluation?

If clearance for participation in certain sports is denied, is the athlete safe to take part in other sports or activities?

Eventually, the following five decisions are typically made by the physician for the athlete:

No limitations for any activity.

Full clearance with recommendations for further evaluation or treatment.

No activity until evaluation, treatment, or rehabilitation is completed.

Table 4. Classification of sports according to the intensity and dynamic or static demands

	High to Moderate Dynamic and Static Demands	High to Moderate Dynamic and Low Static Demands	High to Moderate Static and Low Dynamic Demands
High to Moderate Intensity	Boxing	Badminton	Archery
	Rowing	Fencing	Motorsport
	Rugby	Field hockey	Diving
	Cycling	Football	Throws
	Downhill skiing	Squash	Gymnastics
	Fencing	Skiing	Karate or Judo
	American football	Table tennis	Water skiing
	Ice hockey	Volleyball	Weight-lifting
	Middle distance running	Baseball	Equestrian
	Water Polo	Long distance and cross-country running	Motorcycling
	Wrestling	Racquet sports	Martial arts
	Skating	-	Surfing
	Triathlon	-	Rock climbing
	Bodybuilding	-	-
	Swimming	-	-
	Tennis	-	-
	Handball	-	-
	Basketball	-	-
Low Intensity (Dynamic and Static Demands)	Bowling	-	-
	Cricket	-	-
	Golf	-	-
	Shooting	-	-
	Yoga	-	-

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Qualified to take part in restricted activities only.

Ineligible for participation in any sport or physical activity.

Conclusion

PPE for pediatric and adolescent athletes is a vital platform that brings together injury prevention, cardiovascular screening, and health promotion into one process. Despite international recommendations on essential PPE steps, practice in Iran still varies in screening procedures, examiner qualifications, and referral systems. PPE should be considered more than a formality and recognized as a risk-stratified process tailored by age and type of sport. Given the findings and the importance of PPE in preventing potential problems and injuries among athletes, it is recommended that the following be considered at the national level for maximum effect: Establishing a national criterion for conducting standardized pre-participation screenings for athletes across different sports, approval of all the forms and standards prepared by all the organizations and centers

of the country, utilization of one form in schools for all student-athletes, limiting the administration of these evaluations to qualified doctors, specifically sports medicine physicians.

Ethical Considerations

Compliance with ethical guidelines

This article is a narrative review and did not involve human or animal subjects.

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Authors contributions

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Conflicts of interest

The authors declared no conflict of interest.

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