Preparticipation Evaluation

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Introduction

The preparticipation evaluation (PPE) is a clinical examination that screens athletes for injuries, illnesses, or other potentially serious or deadly conditions prior to their participation in sporting activities [1–5]. By obtaining athlete's medical history, performing a physical examination, and identifying pertinent prohibitive risk factors, the PPE's purpose is to maximize safe participation in sports. Approximately 30 million athletes younger than 18 years and another 3 million athletes with special needs receive PPE to participate in sports every year [6]. In the United States alone, the PPE is used to screen almost 8 million high school athletes per year [8–11]. Ideally, each one receives a PPE prior to the start of their respective seasons [3].

Preparticipation evaluations were first performed over 40 years ago. Early PPEs consisted of obtaining a limited medical history along with a focused physical exam screening for heart murmurs and inguinal hernias [12]. In 1992, five organizations—the American Academy of Family Physicians, American Academy of Pediatrics, American Medical Society of Sports Medicine, American Orthopedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine—jointly published the first edition of the "Preparticipation Evaluation Monograph." This document provided guidance on performing a more comprehensive screening history and physical examination [12]. In 1996, the American Heart Association (AHA) recommended adding questions to the PPE to evaluate for conditions that

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predispose athletes to sudden cardiac death [8, 13]. The PPE Monograph is now in its fifth edition released in 2019.

Goals

The scope of the PPE can be variable depending on the setting in which the examination is conducted, but the goal always remains the same: to promote the health and safety of athletes and to facilitate and maximize safe participation in sports. Often contrary to the perceptions of athletes, coaches, and parents, the goal of the PPE is not to disqualify athletes; rather, it is to promote safe and full participation in sport while identifying individual athletes who may be at elevated risk for morbidity and/or mortality. Most studies show that the PPE denies clearance to roughly 0.3–1.3% of athletes, while 3.2–13.9% require further evaluation [8, 14–18]. It is important to remember that the PPE is fundamentally a screening examination and is not intended to replace a formal full evaluation.

Per the PPE Working Group [3], the PPE's primary objectives are to screen for life-threatening/disabling conditions or conditions that may predispose to injury or illness. Secondary objectives include determining the athlete's general health, serving as an entry point into the health care system if necessary, and providing the opportunity to have health-related discussions with adolescents and young athletes.

Ultimately, the PPE is designed to determine a given athletes clearance to play. The four subsets of clearance are listed below and will be addressed further in the "Clearance" section.

1. Full participation without restriction
2. Participation pending further testing/evaluation
3. Participation in certain sports
4. Disqualification

When thoroughly and consistently performed by appropriately experienced, trained, and licensed physicians, the PPE can be an effective tool for identifying medical and orthopedic conditions that might otherwise affect an athlete's ability to safely participate in sports [14, 19].

Logistics

The timing, setting, and structure of the PPE are all variable and dependent on the age of the participants, the level of athletics, the resources available (i.e., insurance of the athlete), and the type of health care provider present for the examinations [3].

Timing

Ideally, the PPE is performed close enough to the sport season to provide an accurate assessment of health status, while allowing adequate time for referral, consultation, work-up, and/or rehabilitation of any identified health concerns so as not to unnecessarily delay full participation. Six weeks prior to the season is the recommended time frame for assessment. For multi-sport athletes who compete in multiple seasons, the full PPE should be conducted prior to the first season of the year.

Frequency

Over 30 million pediatric and adolescent athletes receive medical clearance each year [20]. There is significant variability in the frequency and content of the exam administered at the secondary school level [21]. Furthermore, no outcome-based research indicates that more frequent PPEs decrease the risk of injury or death in student-athletes; therefore, an optimal frequency has not been established [21].

Given this, the PPE Working Group endorses the recommendations made by Lombardo and Badolato:

- "A comprehensive PPE every 2 years in younger athletes and every 2–3 years in older athletes" [3, 5]
- Annual updates including comprehensive history questionnaire with problem-focused physical examination

The AHA recommends [10] the following:

- High school: full PPE upon entry and then every 2 years
- College: full PPE upon entry and then annual focused History and Physical and blood pressure check

The NCAA recommends [22] the following:

- Full PPE for student-athletes new to campus
- Annual health history update
- Repeat PPE for significant change in health status

It is generally agreed upon that yearly assessment is more applicable during periods of rapid growth and development.

Format

The setting of the PPE may vary based on a number of factors including community access to health care, institutional culture, local/regional regulations, or resources of the individual athlete, family, and/or the school/team/organization. The two most common formats are office-based—in which the history and examination is conducted in the course of a formal office visit with a qualified health care provider—and station-based—where the components of the PPE are broken into separate stations overseen by a team of health care providers.

Office-based evaluations offer the benefit of time, privacy, and in certain situations an established physician-patient relationship when the examiner is the patient's primary care physician. A prior knowledge of the athlete's health history and established rapport with the athlete may increase the efficiency of a comprehensive evaluation. This setting is also better suited for potentially sensitive conversations regarding behavioral risk, substance use/abuse, performance enhancing drug use, disordered eating, body dysmorphia, training habits, and mental health. However, this is not feasible for every student athlete, can lead to lack of communication with athletic staff, and in general is more burdensome to the health care system [23].

Station-based evaluation often includes dedicated stations for registration and sign-in, height and weight, blood pressure, vision screening, past medical history review, physical examination (general medical and musculoskeletal-focused), and final clearance. While ancillary staff may register athletes, obtain vital signs, and assess visual acuity, the history and physical examination are recommended to be performed by a physician or equally licensed and experienced health professional in accordance with local regulations. Optional stations may include nutrition, dental, injury evaluation, flexibility, body composition, and strength/speed/agility/power/balance/endurance. Final clearance should be determined by the supervising physician after all assessments have been conducted. Station-based examinations are time and cost-efficient; however, they may result in rushed examinations, limited privacy, and lack of follow-up [23].

The PPE Working Group considers the athlete's personal physician to be the ideal person to complete a PPE [3]. The PPE Working Group has stated that it considers the gymnasium/locker room-based examination setting "inappropriate" to accomplish the goals and objectives of the PPE process [3]. Countering this, others believe that personal office visits often address other health maintenance issues over those related to athletic clearance, distracting from the focus on safe participation [7]. A retrospective chart review assessing office-based vs. station-based PPEs in 2934 young athletes found no difference in percentage of athletes either excluded or sent for further evaluation [7]. This study did find, however, a statistically significant association between PPE site and reason for exclusion—with higher rates of exclusion for vision-related issues in the station-based setting and higher rates of exclusion for musculoskeletal or cardiopulmonary reasons in the office-based setting [7]. There remains controversy regarding the optimal site to conduct the PPE and the overall effectiveness of the practice.

Examiner

MDs and DOs are ideal practitioners to perform the PPE due to their broad clinical training, and the PPE Writing Group states that the ultimate responsibility for the PPE should be a physician [3]. However, state regulations determine which practitioners are licensed to perform PPE at the middle and high school levels, and many states allow non-physicians to perform the PPE. Ultimately, the evaluating practitioner must be familiar with the basic demands of sport in which the athlete is involved and competently screen athletes as discussed below.

Components of PPE

The preparticipation physical evaluation (PPE) includes a targeted medical and family history and a targeted physical examination, with particular focus placed on the musculoskeletal and cardiovascular systems. There are many preparticipation forms in existence; however, at this time the most widely accepted form was created by the PPE Working Group and is currently available in the fourth edition monograph by the American Academy of Pediatrics in 2010 [3] and at https://www.aap.org/en-us/Documents/PPE-4-forms.pdf.

Past Medical and Family History

It is well agreed upon and well studied that the medical history is the most important element of the PPE. General medicine studies show 76–90% of diagnoses are derived from medical history alone [21, 24–27] and studies assessing PPEs specifically show that medical history identifies 65–77% of conditions [19, 28–34]. The process is far from optimized, however, and significant challenges to effective screening remain, in part due to increasing numbers of athletes participating in sports and a lack of standardization of local screening protocols. Furthermore, some studies of the PPE show low reporter reliability, in that only 19–39% of high school athlete's responses on the medical history portion of the form agreed with the answers of their parents on the same forms [28]. For this reason, it is recommended that joint completion of history forms by athletes and parents/guardians is recommended when possible, particularly if the athlete is unclear about family or personal history [10].

The following are considered critical components of the medical history:

1. Past medical history
2. Past surgical history
3. Review of systems
4. Medications
5. Allergies
6. Family history
7. Functional status
8. Social history
9. Toxic habits

It should also cover more sports- and activity-related history, as follows:

10. Current level of activity
11. Prior/current sports participation
12. Type/frequency of participation
13. Training habits
14. Exercise-related past medical history
15. Prior injuries
16. Nutrition/supplements
17. Performance enhancers

Medical history gathering should be broad yet tailored to both the athlete and the desired sport, as many sport-specific risks exist. For example, contact/combat sport athletes should be questioned about prior head and neck injuries, and distance runners should be questioned about stress fracture history, disordered eating, and training load, etc. Any red flags that arise during questioning should trigger additional questioning and directed physical examination.

The following table contains high-yield history questions [35] (Table 4.1).

Injury and Sport Participation History

The examiner should also inquire about an athlete's injury history as it may identify biomechanical or training load errors that predispose to increased future injury risk. Simple screening questions are generally more sensitive than the musculoskeletal examination for detecting injuries and other orthopedic problems [36] (Table 4.2).

Cardiovascular History

The cardiovascular portion of the past medical and family histories is of particular importance to the PPE. Primarily, it is aimed at identifying conditions that predispose athletes to sudden cardiac arrest/death (SCA/D)—conditions that are often rare and difficult to detect.

Table 4.1 High-yield history questions

Past medical history, including any current
Past surgery
Loss of function of any paired organs (e.g., eye, kidney, and testis)
Allergies
Family history
Current medication or supplements
Immunization history
Menstrual history in female athletes
Rapid change in body weight/athlete's perception of current body weight

Table information based on Hergenroeder 2019 [35]

Table 4.2 High-yield injury history

Past musculoskeletal injuries, concussion, spinal injuries
Loss of time from participation and current sequelae of prior injuries
Prior exclusion from sports for any reason
Management and rehabilitation of injuries

Table information based on Hergenroeder 2019 [35]

Sudden cardiac death (SCD) is defined as a non-traumatic, non-violent, and unexpected event resulting from sudden cardiac arrest (SCA) within 6 hours of a previously witnessed state of normal health [18]. SCD is the leading cause of mortality in athletes during sport and exercise [37]. Epidemiological surveys of SCD incidence rates vary, but a 2015 systematic review by Harmon et al. estimates SCD at a rate of approximately 1 in 80,000 high school athletes and 1 in 50,000 college athletes [38]. Further stratification by sex, age, and sport suggests that incidence may be as high as 1:5200 in male Division I NCAA college basketball players [38].

Males have a higher risk than females (ratio is 9:1 at all levels of play), and black athletes have higher risk than white athletes [38–40]. In those under age 30, SCD is usually caused by structural heart defects. In a survey by Maron in 2016 of 842 competitive youth athletes with autopsy-confirmed cardiovascular-related deaths, hypertrophic cardiomyopathy was the leading cause of death (36%), affecting males at a 3.5-fold higher rate than females and affecting minorities more than white athletes [41]. Congenital coronary anomalies, long QT syndrome, and arrhythmogenic right ventricular cardiomyopathy were found to be significantly more common in females than males. Long QT syndrome and arrhythmogenic right ventricular cardiomyopathy were also found to be more common in white athletes than minority athletes. Nonstructural causes such as inherited arrhythmia syndromes and ion channel disorders are much less common in young athletes, making up only 2% of deaths in that cohort [42].

Presently, the American Heart Association [40] recommends a 14-point screening questionnaire that has been endorsed by multiple medical societies and sporting organizations, including the PPE Working Group [3]:

Personal history

1. Exertional chest pain/discomfort
2. Unexplained syncope/near-syncope
3. Excessive exertional and unexplained dyspnea/fatigue associated with exercise
4. Prior recognition of a heart murmur
5. Elevated systemic blood pressure
6. Restricted from sports in the past
7. Had prior heart testing ordered by health care professional

Family history

8. Premature death (sudden/unexpected/otherwise) before the age of 50 years due to heart disease in one or more relatives
9. Disability from heart disease in a first-degree relative <50 years of age

10. Specific knowledge of certain cardiac conditions in family members: hypertrophic/dilated cardiomyopathy, long-QT syndrome, ion channelopathies, Marfan, arrhythmia

Physical exam

11. Heart murmur (check in supine and standing, or with Valsalva)
12. Femoral pulses to exclude aortic coarctation
13. Physical stigmata of Marfan syndrome
14. Brachial artery blood pressure

Enhanced cardiovascular screening of all athletes using clinical tests such as electrocardiograms and echocardiograms has been shown to increase the sensitivity of the PPE for early detection of conditions related to SCD [43], but it is thought by many to lack the cost-effectiveness to be widely implemented [44]. This is discussed in further detail later in this chapter. In 2017, the American Medical Society for Sports Medicine released a position statement on cardiovascular preparticipation evaluation in the athlete and endorsed an individualized approach to implementation of enhanced screening practices in accordance with physician comfort/training and cardiology resource availability [45].

Neurologic History

The most important neurological conditions that the PPE practitioner should be screening for include history of previous concussions/head injuries, seizure disorders, headaches, recurrent stingers or burners, or prior transient quadriparesis or cervical cord neuropraxia [3].

Concussions are complex pathophysiological processes that result in a "traumatically induced transient disturbance on central neurologic function," and have no radiographic findings [46, 47]. The fact that multiple classification systems of sport-related concussion exist exemplifies our evolving understanding of this entity, its pathophysiology, and its management. Concussions are common, underrecognized, and underreported, and it is estimated that between 300,000 and 2,000,000 sport-related concussions occur each year [48–50]. This is largely because no validated, objective measures are available to diagnose concussion and subsequently when true recovery has occurred [51, 52]. It is important to note a history of head injuries/previous concussions, as once an athlete suffers one concussion they are more likely to have a second [53–55]. Moreover, the identification of persistent neurologic symptoms related to recent or remote concussion should trigger more comprehensive assessment, and should delay clearance of the athlete until successful completion of a graded return-to-play exercise protocol has occurred.

In evaluation during the PPE, the practitioner should inquire into the history of head injuries, acuity/severity of past episodes, and any persistence of symptoms. Persistent concussive symptoms syndrome should be considered in those with symptoms for greater than 4–6 weeks and should trigger a more in-depth investigation. Additionally, the PPE is a great opportunity to counsel athlete's on the increased risk of subsequent head and musculoskeletal injury that follows a concussion. For athletes with a history of multiple head injuries, the PPE can serve as an opportunity to assess the risks and demands of continuing their sport.

Other Medical Comorbidities and Review of Systems

There are a multitude of medical conditions that may require special consideration during the PPE, depending on the individual's needs and the sport involved. Diabetic athletes need to pay special attention to hydration, diet, and insulin therapy. Sickle cell disease patients may be allowed limited participation of non-contact/non-collision sports, but they must avoid overheating, dehydration, and chilling. Fever and diarrhea are indications for postponing an athlete's participation in sports due to the risk of heat illness, dehydration, and orthostatic hypotension, all of which make exercise dangerous. HIV and various skin conditions (i.e., herpes simplex, impetigo, scabies, and molluscum contagiosum) may cause concern for other athletes. Athletes with these skin conditions should avoid sports involving mats and cover all skin lesions. Athletic personnel should always use universal precautions when handling blood or body fluids with visible blood.

Lastly, a targeted review of systems should be performed (and expanded if necessary) to help identify issues that may warrant further evaluation (Table 4.3).

Table 4.3 High-yield review of systems

System	Symptoms
Constitutional	Weight loss/gain, fatigue malaise, mono/flu symptoms
Musculoskeletal	Back pain, neck pain, joint pain/stiffness, stress fracture history
Cardiovascular	Syncope, dizziness, chest pain, dyspnea, palpitations during exercise
Neurologic	Previous head or neck injury, concussion symptoms (fatigue, sleep difficulties, difficulty concentrating, headaches), neurologic symptoms, exercise-related syncope, stingers/burners, and seizure disorder
Respiratory	Shortness of breath/dyspnea/cough with exercise, declining exercise tolerance
Gastrointestinal	Abdominal pain, change in bowel habits, incontinence, previous episodes of gastric bleeding
Genitourinary	Hematuria, dysuria, incontinence, prior trauma
Gynecologic	Menstrual frequency, age of menarche
Dermatologic	Rash, wounds
Hematologic	Easy bruising, history of coagulopathy, history of venous or arterial thrombosis
Psychiatric/ behavioral	Mood disorder/depression screening, social integration and peer group assessment, history of self-harm, satisfaction with sport, body image, health and performance goals

Based on information from PPE Monograph, Netter's Sports Medicine, and UpToDate [3, 23, 35]

Physical Exam

The physical exam portion is the second key component of the PPE. It should be comprehensive and organ system-based and should follow the medical history and review of systems sections. Areas of emphasis for the physical examination section include assessment of vital signs, vision, hearing, and the cardiovascular, pulmonary, neurological, and musculoskeletal organ systems. The physical examination form from the fourth edition monograph is available at the link https://www.aap.org/en-us/Documents/PPE-Physical-Examination-Form.pdf. The most common abnormal PPE findings are elevated blood pressure and abnormal vision [5]. The following table is based on the fourth edition monograph and UpToDate and is a summary of key findings to document and/or assess [3, 35] (Table 4.4).

Additional Testing

Routine lab, cardiac, and pulmonary screening tests for all athletes are not endorsed by the PPE Working Group because there is a lack of data supporting their implementation and usage [3]. Notable exceptions include sickle cell trait testing, which has been mandated by the NCAA for Division I athletes since 2010, with Divisions II and III following shortly thereafter (approved in 2012 and 2013, respectively). Additional lab testing should be directed by responses to medical history and physical examination.

Table 4.4 Key physical exam findings

System	Key findings/tests
General	Height Weight BMI Blood pressure Heart rate Visual acuity (+/− correction)
Appearance	Overall morphology (i.e. Marfan stigmata)
Cardiovascular	Should follow the AHA recommendations [40] Precordial auscultation in supine and standing positions A systolic murmur that increases with decreased venous return (i.e., Valsalva) and decreases with increased venous return, i.e., squatting should raise concern for hypertrophic cardiomyopathy (HCM) ➔ further workup Grade III/IV systolic murmurs and all diastolic murmurs ➔ further workup prior to clearance Recognize physical characteristics of Marfan syndrome (e.g., arm span greater than height, chest wall deformities, hyper-extensible joints, aortic/mitral regurgitation murmurs, myopia, and ectopia lentis) Routine augmented screening with ECG or any other cardiovascular testing is not currently recommended by the AHA [10] At this time, it remains to be seen whether standardizing ECGs proves to be a practical, acceptable component to the general sports screen in the United States (*see section* "Cardiovascular History")

Table 4.4 (continued)

System	Key findings/tests
Musculoskeletal	Perform a thorough screening musculoskeletal examination (i.e., "two-minute musculoskeletal exam") General inspection: overall symmetry/asymmetry, and then should proceed through all major joints and high-risk areas (i.e., shoulder, knee, and ankle) looking for deformity, swelling, abnormal joint movement, and limited range of motion (ROM) Sport-specific orthopedic exam Target injuries or abnormalities raised during the history/review of systems Assessment of current and/or previous injuries/joint biomechanics Investigation of the treatment and rehabilitation of prior injuries in a sport-specific context Determine risk for future injury Counsel appropriate training, equipment modification, therapy needs, or further workup as indicated
Neurology	Especially important in athletes involved in contact sports (e.g., football and soccer) Concussion pre-testing Focal deficits, neuropathy, coordination, balance *See detailed discussion in section* "Neurologic History" *below*
Eyes/ears/note/ throat	Check for asymmetric pupils, abnormal hearing, Snellen testing Athletes with best-corrected visual acuity less than 20/40 in one or both eyes should be referred for further evaluation but not excluded from participation
Lymph nodes	Lymphadenopathy should prompt further evaluation to rule out infectious or malignant process
Lungs	Wheezing, crackles, stridor during lung auscultation (especially after exercise) should raise the suspicion of asthma vs. other underlying pulmonary condition
Abdomen	Organomegaly, e.g., mononucleosis splenomegaly, is a disqualifying condition to avoid potentially splenic rupture
Skin	Rule out communicable/contagious condition (varicella, impetigo, tinea corporis, scabies, molluscum contagiosum, and herpes simplex virus) If present, athlete should not be in close contact nor share equipment sports (e.g., gymnastic mats)
Genitourinary (males only)/renal	Tanner stages, hernia, single testicle, single kidney Boys with a single testicle should wear a protective cup but are considered safe to play, individuals with one kidney are generally considered safe to play
Pain assessment	Assess any current pain generators
Functional assessment	Assess overall functional status
Additional investigation	Lab work Imaging Specific cardiac investigations based on screening responses EKG Echo Exercise stress test Cardiac MRI PFTs Further imaging Subspecialty consultations

Based on information from PPE Monograph, Netter's Sports Medicine, and UpToDate [3, 23, 35]

Unfortunately, cigarette smoking, alcohol, and other drugs are seen among athletes just as they are among the general population, and it is important to always ask about drugs in the routine health history of a patient. Whether or not a urine specimen is necessary to rule out drugs is case sensitive. At the professional and college level, athletes may be required to undergo routine urine testing. Sometimes there are physical clues of drug abuse—unexplained seizures, high blood pressure, and rapid or abnormal pulses—which may be the result of cocaine abuse. Pupil size is another important clue in the acute drug overdose setting. Evidence of anabolic steroid use, "blood doping," or other such practices unfortunately is more difficult to assess on exam alone. Disproportionate muscular hypertrophy or male secondary sex characteristics in the female athlete may provide hints of steroid use [3].

Including ECG and/or echocardiogram as routine part of the PPE has long been a point of controversy among health care providers taking care of athletes. Preparticipation screening with ECG has been associated with a decrease in the rate of sudden cardiac death in athletes in Italy. In the *New England Journal of Medicine* in 1998, Corrido et al. published findings of almost 20 years of preparticipation screening of young (<35 years of age) athletes from the Veneto region of Italy [56–58] . These PPEs consisted of history, physical, and ECG, with additional testing as indicated. Of the 33,735 young athletes screened, 621 were disqualified for cardiac reasons. Based on positive screening, 3061 patients were referred for echocardiography, with 22 showing evidence of HCM. Of the 621 disqualified, 4 ultimately died, and none of the 22 patients disqualified for HCM died. In a follow-up study, Corrido reported an approximately 90% decline in sudden death incidence among competitive athletes, attributed to reduced deaths from cardiomyopathies [56, 58, 59].

Several issues with these "Italian studies" were raised in the American Heart Association PPE Screening update in 2007. First, the original study was performed in a small region (18,368 square km), where nearly all the residents were ethnically homogenous. It is difficult to compare these results when projected to the Unites States—a much more diverse population. Furthermore, the significantly larger size and population of the United States translate to a much larger athlete cohort to be screened, which ultimately means that the financial resources, manpower, and logistics for universal ECG screenings would be considerable. Finding qualified physicians to accurately interpret the results and the cost associated with working up false positives would add significantly to medical costs of running these tests. Last but not least are the undesirable, unwarranted disqualification from sport and the psychological impact of a false diagnosis (with false positive rates reported as 10–40% in prior studies) [10, 60].

In 2014, the American Heart Association (AHA) and the American College of Cardiology (ACC) released a scientific statement which stated as follows:

> There is insufficient information available to support the view that universal screening ECGs in asymptomatic young people for cardiovascular disease is appropriate or possible on a national basis for the United States, in competitive athletes or in the general youthful population, and practical issues essentially exclude either strategy from any realistic consideration… Furthermore, there is insufficient evidence that particularly large-scale/mass

screening initiatives are feasible or cost-effective within the current US healthcare infrastructure, or that routine 12-lead ECGs (supplemental to history and physical examination) provide added mortality benefit for prevention of sudden cardiovascular death [40].

In 2016, the American Medical Society for Sports Medicine (AMSSM) released its stance cardiovascular preparticipation screening in athletes. Namely, they acknowledged that an ECG performed at an experienced center may have improved detection of cardiac conditions with potential risk for SCD, but that the "absence of definitive outcome-based evidence at this time precludes endorsing any single or universal cardiovascular screening strategy for all athletes, including legislative mandates" [45].

As ECG research with regard to the athlete has continued, so has our understanding of ECG findings. Regular and long-term participation in exercise (minimum of 4 hours per week) changes the structure of the heart and this change is reflected in the ECG. It is important to remember that ECG findings in athletes (such as enlarged cardiac chamber size and increased vagal tone) are considered normal physiological adaptations to regular exercise and do not require further evaluation. Whether performed for screening or diagnostic purposes, ECG interpretation is an essential skill for all physicians providing care for athletes [37].

PPE Considerations in Specific Sporting Populations

Athletes with Organ Loss or Impairment

Athletes with one kidney who have undergone organ transplant or have chronic organ enlargement need individual assessment before clearance for contact/collision sports. An athlete with acute organ enlargement (such as an enlarged spleen from EBV mononucleosis) may not be cleared for contact/collision sports. Athletes with one functional eye must take special precautions to protect the intact eye and must realize that depth perception is decreased, making them more prone to injury. Athletes who have undergone eye surgery or serious eye injury likewise need special protective eye gear. Sports involving a puck or ball carry an increased risk for these individuals.

Female Athletes

There are specific medical and musculoskeletal concerns that should be considered in the preparticipation evaluation of the female athlete.

It is well documented that female athletes are at higher risk of musculoskeletal conditions such as non-contact anterior cruciate ligament injuries (ACL), recurrent dislocation of the patella, patellofemoral pain syndrome, and adolescent idiopathic scoliosis [61]. Specifically, ACL injuries are four to eight times more likely in females vs. males (highest incidence being basketball, gymnastics, lacrosse, and

Table 4.5 Risk factors for ACL injuries

Environmental (e.g., surface and shoes)
Anatomical (e.g., increased Q angle, narrow intercondylar notch, increase in posterior tibial slope)
Hormonal
Poor core muscle control
Greater quadriceps-to-hamstrings strength ratio
Gluteal muscle weakness

[a]*Based on Female Athlete Issues for the Team Physician: A Consensus Statement–2017 Update* [63]

soccer), and women are also more likely to undergo ACL reconstruction surgeries at three times the rate of men [62]. Causes of noncontact ACL injuries are likely multifactorial and are listed in Table 4.5.

If these risk factors are identified, the athlete may be educated accordingly, including exposure to ACL injury prevention programs (including dynamic stretching, strengthening, functional balance, agility, and plyometric exercises) [62].

Concussions are also more likely to occur in female athletes at both high school and collegiate levels [63–65] and cause more severe symptoms when compared with their male counterparts regardless of sport [66, 67]. While female athletes often report more symptoms at baseline and after concussion than male athletes, it remains unclear whether female athletes actually have worse initial outcomes or slower recovery [62].

It is also important to identify those at risk of nutritional deficit (especially calcium and vitamin D) in general and especially during puberty. Fractures are more common in teenage girls with low bone density [68], and the group with the lowest intake of vitamin D from food has also been found in both teen and adult females [68]. A history of stress fractures is essential to identify as it should que a more detailed investigation on irregular menstrual cycles, nutritional status, bone health, possible training errors/altered sports-specific biomechanics, as well as the possibility of disordered eating patterns. It has been shown that female collegiate athletes in both running and "aesthetic" sports (i.e., gymnastic, figure skating) commonly develop stress fractures [69, 70]. Adequate nutritional/vitamin/caloric intake is vital for bone health, and often in sports, particularly where "aesthetics" are subjectively judged, under-nourishment can arise and has the potential to cascade into other aspects of the athletes help. The PPE can serve as an opportune moment to begin to address some of these concerns.

Athletes with menstrual irregularities including any history of amenorrhea or oligomenorrhea require additional workup by a physician. A pregnancy test should always be obtained if pregnancy is expected, and if positive, clearance should be obtained by the clinician who is following the pregnancy. Regarding treatment of injuries in this population, nonsteroidal medications are contraindicated in the first trimester (because of a decreased likelihood of implantation) and in the third trimester (because of the risk of premature closure of the ductus arteriosus) [71]. Other reported risks to the fetus include intraventricular hemorrhage, necrotizing enterocolitis, and periventricular leukomalacia [72]. Cortisone and prednisone, in contrast, are generally considered safe, although there is a theoretical risk of development of cleft palate in the first trimester with very high doses [71].

The female athlete triad is a medical condition that has been described in physically active girls and women. It involves one or more of the following conditions that are often interrelated: low energy availability (LEA), disordered eating/eating disorders (DE/ED), menstrual dysfunction, and bone mineral density (BMD). Each of the above conditions exists on a spectrum. This condition has been reclassified as Relative Energy Deficiency in Sports (RED-S) and will be explained in detail in the next section, as the condition is no longer believed to affect exclusively females.

RED-S

In 2014, the International Olympic Committee (IOC) published a consensus statement which encouraged a reconceptualization of the condition then referred to as the "female athlete triad" and redefined it as "Relative Energy Deficiency in Sport" or RED-S [73]. RED-S is now used to describe a syndrome in which low energy availability can lead to multiple medical problems in *both* men and women [63]. In RED-S, an athlete's dietary energy intake is insufficient to support his or her energy expenditure necessary for health, activities of daily living, growth, and sporting activities [73, 74]. The "uncoupling" of energy availability with energy expenditure impairs broad physiologic function, including metabolism, menstrual function, bone health, immunity, protein synthesis, as well as cardiovascular, renal, gastrointestinal, and central nervous systems deficits. Psychological consequences can either precede RED-S or be the result of RED-S.

Compared to non-athletes, both female and male athletes are at higher risk of developing an eating disorder [73]. This is especially true for athletes participating in sports where low body weight or leanness confers a competitive advantage. Screening for disordered eating behaviors, eating disorders, and related health consequences should be a standard component of preparticipation examinations, and team physicians should be knowledgeable of the updated diagnostic criteria for eating disorders in the Diagnostic and Statistical Manual-V [73–75]. The IOC has developed a clinical assessment tool for primary care clinicians to help diagnose relative energy deficiency in sport which categorizes athletes into "red, yellow, and green light" categories that correlate with high, medium, and low risks, respectively, as well as guide decisions on return to play [76]. They recommend that treatment of RED-S should be undertaken by a multidisciplinary team of health professionals and should focus on correcting the relative energy deficit by increasing energy intake and/or decreasing energy output, with repeat bone mineral density testing every 6–12 months [76].

There are questions on the PPE monograph that address diet/weight issues, and the examiner should be careful not to overlook any positives on the history or the physical exam that might suggest disordered eating or malnourishment. The RED-S Clinical Assessment Tool (RED-S CAT) [76] is a supplemental tool that can help screen for RED-S and counsels on management of return-to-play decisions, although validation is still needed [77]. As our knowledge of this condition expands, it is important that the PPE practitioner help recognize prevent RED-S by educating athletes, their families, coaches, school administrators, and communities about proper nutrition and healthy athletic participation.

Disabled Athletes

There are approximately two to three million athletes in the United States with physical and mental disabilities who participate in organized sports. It is important to be sensitive to the ethical and legal issues involved with this population, as well as their particular risk factors. For example, patients with severe lupus and rheumatoid arthritis, who may or may not be on steroid treatment, are prone to injuries from weakened tendons and capsular structures. Athletes with rheumatoid arthritis are also at risk due to possible neck instability and should avoid collision/ contact sports, diving, and swimming breast/butterfly strokes.

Athletes with spinal cord injuries have their own set of medical concerns. For example, overuse upper extremity injuries including tendinopathies and carpal tunnel syndrome are very common among the wheelchair-dependent population. Exercises that strengthen the rotator cuff and scapular stabilizers should be initiated early. Also, paralyzed athletes can accumulate fluid in the immobilized extremities during physical activity, which diminishes cardiac return and cardiac output. These individuals should be advised to use compressive garments during exercise. Paraplegic athletes with high thoracic injuries (above the T6 neurological level) have problems regulating body temperature and should be advised to avoid exposure to extreme climate environments. Autonomic dysreflexia is another concern in paraplegic athletes with a neurological level above T6. This is a condition in which an unopposed sympathetic cascade results in severe HTN, sweating, flushing, and potentially end-organ damage. This is followed by baroreceptor-mediated slowing of heart rate through increased vagal tone. Interestingly, autonomic dysreflexia has been shown to decrease ratings of perceived exertion and may account for up to a 10% increase in performance and is used as a performance enhancement technique among elite paraplegic athletes. This practice of inducing autonomic dysreflexia for performance gains is termed "boosting," and it should be discouraged during preparticipation evaluation and counseling as it is not only dangerous to the athlete but also considered a form of "doping" (illegal performance enhancement) by the International Paralympic Committee. Other concerns in weak, immobilized, or insensate athletes include urinary tract infections, constipation, and skin issues such as pressure sores or persistent fungal infections, which must be identified and addressed.

There are a multitude of committees representing the disabled athlete, such as the Committee on Sports for the Disabled, the US Cerebral Palsy Athletic Association, and the Special Olympics. Patients should be aware of these groups and know how to contact them for more information.

Although many opportunities exist for individuals with impairments, the two most limiting factors for participation in athletics are awareness and access [78]. Athletes with impairments have been among the groups with the most rapidly increasing levels of sports participation over the past few decades. With advances in medicine and an emphasis on maintaining physical fitness, the disabled athlete population is growing. It is estimated that the disabled population in the United States is approximately 55 million according to the US Census Bureau [79]. Lower limb injuries are more common in ambulatory athletes (visually impaired, amputee, cerebral palsy), whereas upper limb injuries are more frequent in athletes who use a wheelchair [80]. Athletes with lower limb deficiency are at risk for injuries in both the intact and residual limbs. The distal residual limb is often the site of skin trauma caused by the prosthesis. Asymmetry is also commonly noted at the ipsilateral hip, as well as the pelvis and lumbar spine, as a result of increased hip power, pelvic rotation and obliquity, and spine lateral flexion and extension to improve clearance of the prosthesis during swing phase and to increase excursion and propulsion. Such asymmetries may predispose athletes with these limb deficiencies to hip, sacroiliac, and lumbar spine pain. Alternatively, the intact limb may experience significantly elevated forces compared with the residual limb from increased reliance by the athlete. This may increase the risk for overuse injuries such as tendinopathies and stress fractures of the intact limb, as well as long-term degenerative changes such as osteoarthritis [42].

The Pediatric Athlete

Sports participation is hugely popular in the American pediatric population. Estimates show that 3 to 5 million athletes of ages 6–18 years participate in sports-related activities in the United States [81]. Injuries are also quite common in the pediatric population, and as the number of athletes in the United States is rising, unfortunately so is the number of musculoskeletal overuse injuries [82]. Despite the risks, it is generally agreed that physical activity, including sport, is both physically and psychologically beneficial [83]. The PPE is not only a good opportunity to screen for injuries and health risks in the pediatric population, but also it is an important opportunity to guide and educate young athletes, their parents, and coaches to ensure safety [84].

The world of sports is experiencing a phenomenon of sports specific training—or “sports specialization”–in younger and younger athletes. While some promote the notion that this is a logical step in enhancing an athletes ability in a given sport, research is showing that early sports specialization carries risk of “over specialization” and may contribute both burn out and overuse injuries [83, 85]. In fact, some evidence shows that pediatric athletes should avoid sports specialization until puberty [85] and that brief breaks from specific sports allow for adequate recovery of overloaded structures [82]. According to Brown and Moran, practitioners should counsel both athletes and parents that the maximum training of a specific sport is 5 days per week, and 2–4 consecutive months per year should be taken off from a specific sport, depending on the specific sport and position on the team [84].

There are certain relatively common and often sports-specific injuries to be particularly aware of when administering the PPE. Adolescent baseball pitchers are more likely to develop "little league shoulder" (proximal humeral epiphysioloysis) and "little league elbow" (medial epicondylar apophysitis)—both are lesions in the immature skeleton associated with the mechanics of throwing [84]. "Gymnast wrist" is often the result of utilizing the extremity as a weight-bearing limb (gymnasts experience highest wrist stress of all other athletes/sports) most common in gymnasts who are 8–15 years old [86, 87].

Osgood-Schlatter and Jumper's knee (or Sinding-Larsen-Johansson) are both common pain syndromes of the knee. Osgood-Schlatter occurs at the distal patellar tendon insertion site and is the most common knee condition in young athletes. It is most common during periods of rapid growth in girls (ages 10–13) and boys (ages 12–14) [86, 88]. Jumper's knee is a tendinopathy of the patellar tendon at the attachment site at the inferior pole of the patella, and equally common in boys and girls, and—as the name implies—is seen commonly in athletes that frequently jump [86, 89]. Patellofemoral pain syndrome is another very common disorder that most likely results from poor patellar tracking within the femoral groove, resulting in synovial irritation. Osteochondritis dissecans is an osteochondral lesion that affects the subchondral bone and overlying articular cartilage, and is a rare cause of knee, elbow, or ankle pain in pediatric athletes. Sever's disease is inflammation of the calcaneal apophysis (the attachment of the Achilles tendon to the calcaneus) superiorly and the plantar fascia inferiorly [88, 90].

In general, the workup and treatment for most of the above injuries are similar—radiographs should likely be obtained, and treatment often includes rest, ice, possibly NSAIDs, and eventually a return to stretching and strengthening exercises. For osteochondritis dessicans, the affected limb should be placed into partial or complete non-weight-bearing restrictions (sometimes complete immobilization) and a surgical consult should be made to evaluate the need for surgery [88, 89]. Training volume, intensity of sport participation, and the presence or absence of pain with sport specific activities are critical components of the history and analysis of these should not be missed in this population.

Masters Athlete

The current growth in the number and proportion of older adults in the United States is unprecedented in United States' history. By 2050, it is projected that Americans aged 65 or older will number nearly 89 million people—more than double the number of older adults in the United States in 2010 [91]. Regular physical activity has been widely endorsed as a key element to healthy aging [91] and American culture is increasingly interested in fitness—especially fitness that focused on "pushing the limits" [92]. While not all of the aging population will classify as a "masters athlete," data already suggests that the number of masters athletes is on the rise. For example, the number of participants in the National Senior Games quadrupled from 1987 to 2011 despite stricter qualifying standards [93], and the number of athletes older than 50 years in the New York City marathon increased 119% from 1983 to 1999 [94, 95].

Definitions for masters athletes vary slightly, but typically they are older than 35 years (age when cardiovascular morbidity increases) who either trains for or takes part in athletic competitions designed for older participants [95–97]. The masters athlete population is diverse: they may be experienced competitors who continue athletic pursuits after their sports careers have ended, could be individuals who return to sport after extended periods of inactivity, or might just participate and train intermittently [95]. Ideally, a multidisciplinary team would care for a masters athlete; however, for obvious reasons this is not usually the case. Therefore, encounters with the masters athlete during an office meeting or a PPE are an opportunity to perform appropriate screening and a basic evaluation.

Preparticipation screening should include a general evaluation of the patient's overall health, evaluating for vision loss, diabetes, and hypertension, among other relevant risk factors [95]. Routine Snellen testing [98], basic metabolic profile, glycated hemoglobin (HbA1C), complete blood counts to assess for anemia, and blood pressure readings all help to screen athletes [95, 99, 100].

Underlying coronary artery disease (CAD) has been shown to be the primary cause of sudden cardiac death in masters athletes [101–103]. Although regular physical activity reduces cardiovascular and all-cause mortality, even masters athletes with high fitness level can exhibit elevated cardiovascular risk and be at heightened risk for SCD during periods of vigorous-intensity activity [97]. Morrison's 2018 "MASS" study (Masters Athlete Screening Study) was a cross-sectional study in which a "European" preparticipation screening evaluation was performed on masters athletes. It included an ECG, the AHA 14-element recommendations, and calculation of Framingham Risk Score (FRS). Among the 798 athletes, 64% underwent additional evaluations. Cardiovascular disease was detected in 11.4%, with CAD (7.9%) being the most common diagnosis. High FRS (>20%) was seen in 8.5% of the study population. Ten athletes were diagnosed with significant CAD; 90% were asymptomatic. A high FRS was most indicative of underlying CAD (PPV 38.2%). The researchers' conclusions were that comprehensive preparticipation screening including an ECG and FRS can detect cardiovascular disease and that an exercise stress test should be considered in those with risk factors, regardless of fitness level [97].

According to Tayrose et al., a 12-lead electrocardiogram (ECG)—in addition to the American Heart Association's 14-element screening with a focused history assessing for exertional symptoms and a physical examination emphasizing the cardiovascular system—*should* be part of a routine evaluation for all masters athletes older than 40 years [95].

Below are some guidelines regarding clearance for masters athletes with cardiac conditions based on the Maron et al. [98] recommendations:

1. High-intensity activity restriction should include atherosclerotic coronary artery disease (with more than 50% luminal narrowing and particularly in patients with an ejection fraction less than 50% or evidence of exercise-induced myocardial

ischemia), as well moderate to severe systemic hypertension (>160 mm Hg systolic or > 100 mm Hg diastolic pressures).
2. Athletes may return to play once blood pressure is controlled, however they should undergo blood pressure monitoring every 2 months.
3. Masters athletes who have had recent cardiac events should be recommended to inpatient or outpatient cardiac rehabilitation [99].

Bone mineral density starts decreasing in the fourth decade of life, and any fracture in the masters athlete should prompt screening for osteoporosis. This assessment includes history and physical exam (looking for height loss, low body weight, a Dowager hump, and scoliosis), and could result in obtaining a dual-energy X-ray absorptiometry (DEXA) and laboratory testing [104]. Primary prevention of osteoporosis and related fractures involves educating patients about appropriate use of calcium, vitamin D, and exercise (both weight-bearing and strengthening exercises) [104]. Proactive and intensive programs such as "Fracture Liaison Services" help identify, educate, and treat those with osteoporosis and have been shown to reduce fracture rates by 16–56% [105–107].

From a musculoskeletal standpoint, general recommendations for masters athletes are to keep exercising, including aerobic, resistance, flexibility, and balance. Common musculoskeletal injuries in masters athletes include rotator cuff injuries, Achilles tendinopathies, and meniscal tears in the knee [108]. Moderate OA is not a contraindication to exercise, and in fact simple strengthening programs (i.e., of the quadriceps) have shown decreased pain from OA and are recommended [109]. Based on small retrospective studies and expert opinion, the general recommendation for returning to sport after arthroplasty is somewhat joint and sport specific, but a safe rule of thumb is that high-impact activities should be avoided in favor of lower-impact activities, at least in the initial rehabilitative/recovery stages [95].

Regarding NSAIDs in the masters athlete, this population may have higher likelihood of gastrointestinal (e.g., gastritis and dyspepsia) and renal insults that may have detrimental effects on muscle and ligament healing [110]. Additionally, long-term NSAID use may increase the risk of cardiovascular insults, including hypertension, myocardial infarction, congestive heart failure, and stroke [110].

Overall, masters athletes represent a unique population and should be cared for using a multidisciplinary approach. The PPE is an important tool for this population as it can be of high yield to determine if there is an underlying cardiac condition that precludes athletic participation, or if such a condition can be modified to optimize the individual for play. While still controversial, a 12-lead ECG can be considered for all masters athletes older than 40 years, and ECG exercise testing should be performed for older athletes with one or more cardiac risk factor (i.e., diabetes, family history of myocardial infarction, dyslipidemia) [98]. Per recommendations from the ACSM, masters athletes (and adults in general) should engage in moderate to vigorous aerobic exercise for 20–30 minutes, 3–5 days per week, in addition to resistance, flexibility, and balance exercises [111]. OA and prior joint arthroplasty should generally not preclude participating in athletic events. When rehabilitating soft tissue injuries such as sprains or strains, conservative treatments such as rest, ice, elevation, and physical therapy should be the first line of treatment. NSAIDs can be considered but must be carefully monitored for gastrointestinal, renal, and cardiovascular side effects [95].

Clearance

The goal of the PPE is to foster the safest participation possible for athletes of all ages in the sports they love, while identifying athletes at higher risk of morbidity/mortality and mitigating that risk wherever possible. Overall, most studies show that only a small percentage of athletes (0.3–1.9%) are denied clearance to participate [5, 112]. Clearing an athlete to play means a practitioner has no reason to believe that sports participation places the athlete at an unacceptably higher risk of serious injury, illness, or death than their peers [113]. The following are questions that the practitioner should be asking themselves when they are performing the PPE when considering and determining the clearance level of an athlete (adopted from online publishing from Epocrates [113]):

- Does a finding place an athlete at an increased risk of injury, illness, or death?
- Can safe participation be achieved with a reasonable intervention (e.g., rehabilitation, medication, or protective device?)
- Is limited participation acceptable during treatment?
- Does clearance failure from one sport mean no clearance for all sports?

Per the PPE monograph, there are four initial categories of clearance [3]:

1. Cleared for all activities without restriction
2. Cleared with recommendations for further medical workup/treatment
3. Not cleared—clearance status to be revisited, pending further workup/treatment/rehabilitation
4. Not cleared for certain types of sports or for any sports

The decision to limit or prohibit an athlete from sport is significant and serious. It often should not take place without the consultation of a specialist in the area of concern, as the physical and psychological repercussions of missed participation in physical and the psychosocial benefits of exercise/team participation should not be lightly overlooked. In the unfortunate situation when an athlete is not given full and unrestricted clearance to play, it is paramount to ensure that the restrictions, workup, treatment, and acceptable alternative activities the athlete may participate in are entirely understood by the athlete and their parents/guardians [3]. There is extensive documentation in the literature [1] outlining myriad conditions and the relative “qualified” or “not qualified” to participate that all physicians performing a PPE should be familiar with.

Ultimately, the health care provider must act out in the best medical interest for the athlete, as opposed to in response to the pressures and demands of parents, coaches, or organizations. Clearance should not be granted until the medical examiner is satisfied that such clearance is medically appropriate.

Medicolegal

The Rehabilitation Act of 1973 and Americans with Disabilities Act of 1990 prohibit exclusion of otherwise qualified athletes from participating in federally funded programs, and gave legal protection to medically disabled athletes. These acts prevent discrimination against individuals solely on the basis of their medical conditions [114]. However, in Knapp v. Northwestern University, it was established that schools can medically disqualify collegiate athletes from sports participation [115]. Examiners must be cognizant of sharing of medical information regarding and athlete apropos the Health Insurance Portability and Accountability Act (HIPAA) and the Family Educational Rights and Privacy Act (FERPA). Generally, clearance status may be shared with coaching staff; however, releasing specific medical information normally requires signed consent [113]. Interpretations of FERPA and Good Samaritan laws vary from state to state, and every examiner should understand how these laws work where they practice and ensure they are appropriately covered by state law and/or malpractice insurance (5).

Implementation Issues

Most US states require student athletes to undergo some type of PPE; however, there is still no recognized standard or federal regulation controlling the content of the PPE, nor a universally agreed standard for determining clearance. Currently, each state determines the content, comprehensiveness, and length of its respective PPE form, as well as the type of HCP licensed to perform the PPE [3]. This variance was demonstrated in a 2015 study that showed only 19 US states required or recommended the use of the 2010 PPE monograph [116]. A contrast is Italy, where a nationally standardized system has existed since 1982, under which all competitive athletes receive a comprehensive PPE performed by a specially trained sports medicine physician that is paid for by the Italian National Health System [57]. The American College of Sports Medicine (ACSM) and the Federation Internationale du Medicine du Sport (FIMS) have called for the development of an electronic PPE, using human-centered design, stating it would be comprehensive, create a database, simplify administration, allow remote access to clinical data, and provide the much-needed data for prospective studies in this area [117]. As of now, there is no current plan in place to standardize the PPE in the United States.

Limitations of the Current PPE Paradigm

A systematic review from 2005 determined that PPEs do not detect exercise-induced bronchospasm, are poorly predictive of which athletes are at increased risk of orthopedic injuries, and detect only a very small percentage of cardiac abnormalities among athletes who subsequently die suddenly—the strength of recommendation for all being rated a C [118]. A significant limitation to understanding the effectiveness of the PPE is the lack of large-scale prospective tracking programs or randomized controlled trials examining PPE [118]. Data shows that the PPE identifies musculoskeletal abnormalities [119, 120]; however, another study of 712 intercollegiate athletes found no correlation between musculoskeletal abnormalities found during PPE and subsequent injury occurrence [121]. Sensitivity and specificity of PPE are bound to vary due to many factors: severity/subtlety of injury/illness, timing of injury, honesty and recall of the athlete or parent/guardian, experience and acumen of the examiner, and environmental, logistical, and technical factors [113].

To date there is little data showing that the PPE affects the overall morbidity and mortality of athletes [13], and there continues to be debate regarding the nature, content, and efficacy of the examinations themselves [113]. Despite this, the PPE is widely performed. The National Federation of State High School Associations (NFHS) "considers the PPE a prerequisite" (however they don't have the authority to standardize or require it) [3]. Every state requires some level of PPE for scholastic athletes, the NCAA "recommends" it, and the Special Olympics and many collegiate institutions require a PPE upon entrance to an athletic program [3]. However, generally speaking, across youth sports governing bodies, there remains a lack of uniform or consistent requirements for the PPE and several studies showing many high school and college PPE forms do not follow American Heart Association guidelines regarding cardiac screening [3, 15–17].

Despite the lack of standardization and efficacy data, the author societies who developed the PPE monograph endorse that when "thoroughly and consistently performed by qualified and license physicians … [the PPE] may be an effective tool in identifying medical and orthopedic conditions that might affect an athletes ability to participate safely in sports" [3]. Others argue that it is an important pillar of adolescent health care, as the PPE may be the only contact in a given year that a young American has with our health care system [19].

Conclusion

In conclusion, the ultimate purpose of the PPE is to promote the health and safety of the athlete in training and competition. It serves as a screening tool for injuries, illness, and other factors that could potentially cause harm to an athlete, thereby allowing a medical examiner the opportunity to prevent injury or illness. The PPE can also serve as the establishment of a medical home for many young athletes that may not have any other regular access to a physician and can serve as a venue for education and guidance to both athletes and their parents, through ever-expanding and increasingly competitive—and potentially dangerous—youth sports. Despite the lack of efficacy data and uniform/consistent content, the PPE is and should be widely performed. It will continue to evolve along with the growth of sports medicine and is a vital component for any practitioner of sports medicine to be familiar with.

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