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position statement

National Athletic Trainers' Association Position Statement: Preparticipation Physical Examinations and Disqualifying Conditions

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Objective: To present athletic trainers with recommendations for the content and administration of the preparticipation physical examination (PPE) as well as considerations for determining safe participation in sports and identifying disqualifying conditions.

Background: Preparticipation physical examinations have been used routinely for nearly 40 years. However, considerable debate exists as to their efficacy due to the lack of standardization in the process and the lack of conformity in the information that is gathered. With the continuing rise in sports participation at all levels and the growing number of reported cases of sudden death in organized athletics, the sports medicine community should consider adopting a standardized process for conducting the PPE to protect all parties.

Recommendations: Recommendations are provided to equip the sports medicine community with the tools necessary to conduct the PPE as effectively and efficiently as possible using available scientific evidence and best practices. In addition, the recommendations will help clinicians identify those conditions that may threaten the health and safety of participants in organized sports, may require further evaluation and intervention, or may result in potential disqualification.

Key Words: medical history, family history, sudden cardiac death, concussion, sickle cell trait, diabetes, heat illness, hydration

Participation in organized US athletics continues to rise. During the 2010–2011 academic year, more than 7.6 million high school students took part in organized interscholastic sports, compared with 7.1 million in 2005–2006.[1] Similarly, an additional 444 077 National Collegiate Athletic Association student–athletes participated in intercollegiate athletics in 2010–2011, compared with 393 509 in 2005–2006.[2] This growth in participation has led to a concomitant rise in sudden death. Most sudden deaths have been attributed to congenital or acquired cardiovascular malformations involving male football and basketball players.[3–5] Other causes of sudden death include heat stroke, cerebral aneurysm, asthma, commotio cordis, and sickle cell trait.[4,5] As sports participation continues to increase and catastrophic death in athletes receives more attention, the medical community should consider adopting a standardized preparticipation examination (PPE) instrument that, at a minimum and to the extent possible, sets out to ensure a safe playing environment for all and to identify those conditions that might predispose an athlete to injury or sudden death.

For nearly 4 decades, PPE screening has been used routinely in an attempt to identify those conditions that may place an athlete at increased risk and affect safe participation in organized sports. Few would empirically argue the potential benefits of this practice, yet considerable debate exists as to the current efficacy of the PPE, given the significant disparities that presently characterize the examination and the information gathered. Over time, the PPE has become an integral component of athletics and

Table 1. Strength of Recommendation Taxonomy (SORT)[a]

Strength of Recommendation	Definition
A	Recommendation based on consistent and good quality experimental evidence (morbidity, mortality, exercise and cognitive performance, physiologic responses).
B	Recommendation based on inconsistent or limited quality experimental evidence.
C	Recommendation based on consensus; usual practice; opinion; disease-oriented evidence[b]; case series or studies of diagnosis, treatment, prevention, or screening; or extrapolations from quasi-experimental research.

[a] Reprinted with permission from Ebell MH, Siwek J, Weiss BD, et al, Strength of Recommendation Taxonomy (SORT): A Patient-Centered Approach to Grading Evidence in the Medical Literature, 2004;69(3):548–556, *Am Fam Physician*. Copyright 2004 American Academy of Family Physicians. All Rights Reserved.[14]

[b] Patient-oriented evidence measures outcomes that matter to patients: morbidity, mortality, symptoms improvement, cost reduction, and quality of life. Disease-oriented evidence measures intermediate, physiologic, or surrogate end points that may or may not reflect improvements in patient outcomes (eg, blood pressure, blood chemistry, physiologic function, pathologic finding).

sports medicine programs; however, the lack of standardization in the process has created confusion. In addition, the failure to adequately define the primary objectives of the PPE has led to the consensus that, in its current form, the PPE does not address the ultimate goal of protecting the health and safety of the player.

The American Medical Association Group on Science and Technology[6] has asserted that every physician has 2 responsibilities to an athlete during the PPE: "(1) to identify those athletes who have medical conditions that place them at substantial risk for injury or sudden death and to disqualify them from participation or ensure they receive adequate medical treatment before participation and (2) to not disqualify athletes unless there is a compelling medical reason." As the PPE has evolved over the years, it has become increasingly difficult to meet these standards given the many objectives that have been proposed for the screening instrument. Originally, the primary objectives of the PPE were to (1) detect life-threatening or disabling conditions, (2) identify those conditions that predispose the athlete to injury or disability, and (3) address legal and insurance requirements.[7,8] Today, however, those entities charged with developing and revising the PPE (eg, state high school athletic associations, medical associations, state education departments, state health departments, legislators)[9] often have different missions, and as a result, they have sought to influence the makeup of the PPE to address their specific interests. This has led to the identification of a number of secondary objectives, including but not limited to documenting athletic eligibility, obtaining parental consent for participation and emergency treatment, and improving athlete performance.[9] Most notably, the PPE represents the sole source of medical evaluation for 30% to 88% of children and adolescents annually[10,11] and an opportunity to identify conditions that, although not necessarily related to or requiring restriction from athletic participation, nonetheless call for additional follow-up.[9] Some authors[12] have advocated this practice to evaluate the general health of the athlete and to provide an opening to discuss high-risk behaviors, preventive care measures, and nonathletic concerns. Others oppose this view, stating that the PPE "should not be the sole component of health care for athletes"[6] and that the PPE can only be effective if the goals remain specific and properly directed toward the demands of sport participation.[6,13]

RECOMMENDATIONS

Based on current scientific evidence and established best practices, the National Athletic Trainers' Association (NATA) has developed the following PPE guidelines, designed to apply regardless of the sport or an athlete's performance goals. The NATA also identifies those conditions that may threaten the health and safety of those who are active in organized sports, may require further evaluation and intervention, or may result in potential disqualification. The recommendations are categorized using the Strength of Recommendation Taxonomy criterion scale proposed by the American Academy of Family Physicians[14] based on the level of scientific data found in the literature (Table 1).

Medical and Family History

1. A comprehensive medical and family history should be obtained from each participant. This is the cornerstone of the PPE and should take into account the areas of greatest concern for sport participation: specifically, the American Heart Association recommendations for preparticipation cardiovascular screening of competitive athletes (Table 2).[4,15] *Strength of Recommendation: B*
2. The medical and family history provided by the athlete and the parents or guardians should always be reviewed carefully. Both parties should be questioned and specific answers confirmed because the source that provides the most accurate history is unclear.[16,17] *Strength of Recommendation: C*
3. Musculoskeletal injury is a common cause for restriction or disqualification of an athlete, so the medical history should attempt to detect any underlying condition that might predispose an athlete to injury. Special attention in the examination should be given to any areas that have been injured or undergone surgery.[18–21] *Strength of Recommendation: B*

Physical Examination

General Health Screening.

4. For the PPE, a limited general physical examination is recommended. The screening physical should include vital signs (eg, height, weight, and blood pressure); visual acuity testing; cardiovascular, neurologic, and general medical (eg, pulmonary, abdominal, skin, genitalia [for males]) examination; and musculoskeletal examination. Further

Table 2. The 12-Element American Heart Association Recommendations for Preparticipation Cardiovascular Screening of Competitive Athletes[a]

Medical history[b]
- Personal history
  1. Exertional chest pain/discomfort
  2. Unexplained syncope/near syncope[c]
  3. Excessive exertional and unexplained dyspnea/fatigue, associated with exercise
  4. Prior recognition of a heart murmur
  5. Elevated systemic blood pressure
- Family history
  6. Premature death (sudden and unexpected, or otherwise) before age 50 y due to heart disease, in >1 relative
  7. Disability from heart disease in a close relative age <50 y
  8. Specific knowledge of certain cardiac conditions in family members: hypertrophic or dilated cardiomyopathy, long-QT syndrome or other ion channelopathies, Marfan syndrome, or clinically important arrhythmias

Physical examination
  9. Heart murmur[d]
  10. Femoral pulses to exclude aortic coarctation
  11. Physical stigmata of Marfan syndrome
  12. Brachial artery blood pressure (sitting position)[e]

[a] Reprinted with permission from Maron BJ, Thompson PO, Ackerman MJ, et al, Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update. *Circulation*. 2007;115(12):1643–1655.[4]
[b] Parental verification is recommended for high school and middle school athletes.
[c] Judged not to be channelopathies (vasovagal); of particular concern when related to exertion.
[d] Auscultation should be performed in both supine and standing positions (or with Valsalva maneuver), specifically to identify murmurs of dynamic left ventricular outflow tract obstruction.
[e] Preferably taken in both arms.

examination should be based on issues uncovered during the history.[7,15] *Strength of Recommendation: C*

Cardiovascular Screening.

5. Specific questions regarding risk factors and symptoms of cardiovascular disease should be asked during the history portion of the PPE (Table 3).[18] A positive response to any question should be confirmed and further evaluation conducted if necessary. *Strength of Recommendation: C*
6. Auscultation of the heart should be performed initially with the patient in both the standing and supine positions. Auscultation should also occur during various maneuvers (eg, squat to stand, deep inspiration, Valsalva), because these maneuvers can clarify the type of murmur.[22] *Strength of Recommendation: C*
7. Noninvasive cardiac testing (eg, electrocardiography [ECG], echocardiography, exercise stress testing) is not a routine aspect of the screening PPE unless warranted by findings from the personal and family history.[4,5] *Strength of Recommendation: B*

Neurologic Screening.

8. If the athlete has a history of concussion, seizure disorder, cervical spine stenosis, or spinal cord injury, a thorough neurologic assessment is necessary.[20,22–24] *Strength of Recommendation: C*

Orthopaedic Screening.

9. The musculoskeletal history screening and examination can be combined for asymptomatic athletes with no previous injuries (Table 4).[18] With an accurate history, the clinician can detect more than 90% of significant musculoskeletal injuries; the screening physical examination is 51% sensitive and 97% specific.[18,19,25,26] If the player has either a previous injury or other signs or symptoms (eg, pain or tenderness; asymmetric muscle bulk, strength, or range of motion; or any obvious deformity) detected during the general screening examination or history, the relevant elements of a site-specific examination should be performed. *Strength of Recommendation: A*

General Medical Screening.

10. The use of routine laboratory or other screening tests such as urinalysis, complete blood count, chemistry profile, lipid profile, ferritin level, or spirometry during the PPE is not supported by current studies.[15,18,27,28] *Strength of Recommendation: B*
11. If the athlete has a history of anemia, then hemoglobin and ferritin levels should be measured.[29,30] *Strength of Recommendation: C*
12. For females who have abnormal menstrual cycles or a personal history of anemia or who are taking iron or other medications, a more detailed laboratory follow-up is warranted.[31] *Strength of Recommendation: C*
13. Athletes with diabetes mellitus type 1 or type 2 should be routinely evaluated for foot conditions (ie, sensory

Table 3. Questions Regarding Presence of Cardiovascular Risk Factors[a]

Have you ever passed out during or after exercise?
Have you ever been dizzy during or after exercise?
Have you ever had chest pain during or after exercise?
Do you get tired more quickly than your friends do during exercise?
Have you ever had racing of your heart or skipped heartbeats?
Have you ever been told you have high blood pressure or high cholesterol?
Have you been told you have a heart murmur?
Has any family member or relative died of heart problems of heart problems or of sudden death before age 50?
Have you had a severe viral infection (for example, myocarditis or mononucleosis) within the last month?
Has a physician ever denied or restricted your participation in sports for any heart problem?

[a] Reprinted with permission from Carek PJ, Mainous AG, A thorough yet efficient exam identifies most problems in school athletes. *The J Fam Pract*. 2003;52(2):127–134, Quadrant HealthCom Inc.[18]

Table 4. The 90-Second Musculoskeletal Screening Examination[a]

Instruction	Observation
Stand facing examiner	Acromioclavicular joints: general habitus
Look at ceiling, floor, over both shoulders, touch ears to shoulder	Cervical spine motion
Shrug shoulders (resistance)	Trapezius strength
Abduct shoulders to 90° (resistance at 90°)	Deltoid strength
Full external rotation of arms	Shoulder motion
Flex and extend elbows	Elbow motion
Arms at sides, elbows at 90° flexed; pronate and supinate wrists	Elbow and wrist motion
Spread fingers; make fist	Hand and finger motion, strength, and deformities
Tighten (contract) quadriceps; relax quadriceps	Symmetry and knee effusions, ankle effusion
"Duck walk" away and toward examiner	Hip, knee, and ankle motions
Back to examiner	Shoulder symmetry; scoliosis
Knees straight, touch toes	Scoliosis, hip motion, hamstrings tightness
Raise upon toes, heels	Calf symmetry, leg strength

[a] Reprinted with permission from Carek PJ, Mainous AG, A thorough yet efficient exam identifies most problems in school athletes. *The J Fam Pract*. 2003;52(2):127–134, Quadrant HealthCom Inc.[18]

function and ankle reflexes), retinopathy, nephropathy, neuropathy, and cardiovascular disease.[32] *Strength of Recommendation: C*

14. An individualized diabetes management plan should be developed for each diabetic athlete to ensure safe and effective monitoring of blood glucose levels during sport participation.[32] *Strength of Recommendation: C*
15. Confirmatory testing is recommended for those athletes who report a history of sickle cell trait and those whose family heritage suggests higher risk. Athletes found to have sickle cell trait should be educated by the medical staff and be monitored carefully for heat- and dehydration-related concerns during training and competition.[33,34] *Strength of Recommendation: C*
16. Lipid profiles should be reserved for those who have a personal history of elevated cholesterol or dyslipidemia and those athletes in whom other cardiovascular risk factors have been identified (by history or examination) that require further investigation as part of a thorough medical evaluation rather than as part of the PPE.[35] *Strength of Recommendation: C*
17. For athletes with a history of elevated cholesterol or lipid levels, longitudinal care by the team physician includes review of previous laboratory results and appropriate management. *Strength of Recommendation: C*

Medication Use.

18. All medications and supplements currently used by the athlete should be reviewed by the examiner during the PPE.[15] *Strength of Recommendation: C*

Nutritional Assessment.

19. Athletic trainers and those who participate in athletic health care should be familiar with the current NATA position statement that outlines the prevention, detection, and management of disordered eating in athletes.[36] *Strength of Recommendation: B*

Heat- and Hydration-Related Illness Risk Factors.

20. Current consensus guidelines[37–39] for heat acclimatization in secondary school athletes should be reviewed. Questions related to previous problems associated with heat acclimatization should be included in the medical history form. *Strength of Recommendation: B*

Mental Health Considerations.

21. As part of the health history portion of the PPE, including questions to determine the mental health status of the athlete should be considered, along with a plan for referral and follow-up where appropriate.[40–42] *Strength of Recommendation: C*

Administration of PPE

22. Privacy must be respected at all times when the findings of the PPE are communicated. Written authorization must be provided by the athlete, or the legal guardian if the athlete is a minor, before any private health information is released.[15] *Strength of Recommendation: C*
23. The PPE may be conducted 4 to 6 weeks before preseason training begins to allow time for proper follow-up of any findings requiring additional evaluation.[15] However, it is also practical and acceptable to conduct the PPE on the day preseason training begins or the day before because athletes usually report 1 to 2 days earlier. Because of this short timeline, clearance for some athletes who require additional evaluation may be delayed. *Strength of Recommendation: C*
24. A complete PPE should be performed at each new level of participation. When warranted during interim years, a review of the medical history and subsequent evaluation should be conducted.[15] *Strength of Recommendation: C*
25. A standardized PPE is most desirable, and as research dictates specific recommendations for what is to be evaluated, a more standardized process should emerge. However, considerable variability still exists. The American Academy of Pediatrics[15] has developed a thorough document that should serve as the minimum template for a standardized PPE instrument. *Strength of Recommendation: C*
26. Both individual and multiple-station PPE screening methods can be effective and beneficial provided the appropriate personnel are available and a systematic approach is used to compile and record findings.[15] *Strength of Recommendation: C*
27. A licensed physician (doctor of medicine or doctor of osteopathy) is the most appropriate person to direct and conduct the PPE. When other health care providers are permitted to conduct the PPE, the same standards and expectations should be maintained in order to meet the

goals and objectives of the screening process.[15] *Strength of Recommendation: C*

Determining Clearance

28. Clearing an athlete to participate in a sport should be based on previously published guidelines and the best evidence available.[43,44] *Strength of Recommendation: C*
29. Team physicians and institutions have the legal right to restrict an individual from participating in athletics, provided the decision is individualized, reasonably made, and based on competent medical evidence.[45,46] *Strength of Recommendation: C*

THE EVIDENCE: BACKGROUND AND LITERATURE REVIEW

A considerable body of work establishes the utility of the PPE when it is properly designed and administered. However, current consensus is that the lack of standardization and the disparate objectives that have shaped the PPE have rendered it less than optimally effective in meeting the ultimate goal of determining the ability of an athlete to participate safely in training and competition. Evidence to support the above-referenced recommendations and the best practices in developing and delivering a comprehensive PPE follows.

Medical and Family History

A medical history should be obtained from each participant. A complete medical history identifies approximately 75% of problems that affect initial athletic participation and serves as the cornerstone of the PPE.[10,47] Unfortunately, these authors noted that the sensitivity of the recommended questionnaires is approximately 50%, far below the usual standard expected in a medical screening test.[16]

Most conditions requiring further evaluation or restriction are identified during the medical history aspect of the PPE process. Rifat et al[48] noted that the history accounted for 88% of the abnormal findings and 57% of the reasons cited for activity restriction. The American Academy of Pediatrics, in the most recent edition of *PPE: Preparticipation Physical Evaluation*,[15] has developed a history form that emphasizes the areas of greatest concern for sport participation. In particular, specific questions regarding medical and family history (Table 2)[4] and risk factors (Table 3)[18,49] for cardiovascular disease should be asked. A positive response to any of these questions should be confirmed and additional evaluation conducted if necessary and warranted based upon further questioning. A specific, effective evaluation that should be conducted to either identify a specific cause for the condition suggested by a positive response or exclude a potentially life-threatening condition has not been delineated or studied.

The attitudes and knowledge of athletes and parents regarding the PPE appear inconsistent. Although most student–athletes do not see value in the PPE with regard to safe athletic participation, they do believe that the PPE prevents or helps to prevent injuries, and yet clear evidence to support this assumption is lacking.[49] Furthermore, parents and student–athletes may not provide reliable historical information on which to base participation decisions.[17] For example, unreliable information may be obtained regarding cardiovascular and musculoskeletal conditions, areas related to the mortality and morbidity associated with athletic activity. Therefore, the historical information provided by a minor or college-aged athlete should be reviewed directly with the athlete during the PPE and, when possible, confirmed with a parent or guardian.

Physical Examination

General Screening Examination. A well-established consensus[15] from physicians' and sports medicine groups has been published detailing the specifics of the essential components of the PPE. The US Preventive Services Task Force describes an effective screening test as satisfying 2 major requirements: (1) it must be effective for early detection and (2) it must be accurate.[50] That is, the test must be able to detect the target condition earlier than would be possible without screening and with sufficient accuracy to avoid producing large numbers of false-positive and false-negative results (accuracy of screening test). The process of screening for and treating persons with early disease should improve the likelihood of favorable health outcomes (eg, reduced disease-specific morbidity and mortality) compared with treating patients when they present with signs or symptoms of the disease (effectiveness of early detection).

For the PPE, a limited physical examination is recommended. The screening physical examination should include vital signs (eg, height, weight, and blood pressure); visual acuity; and cardiovascular, pulmonary, abdominal, skin, genitalia (for males), neurologic, and musculoskeletal examination. Further examination should be based on potential concerns uncovered during the history.[7,15]

Although another provider may record the initial vital signs for efficiency, the data should always be reviewed by the physician. The vital sign values are for screening only and should not be used to make a diagnosis (eg, hypertension). Abnormal vital signs may be an indication to withhold clearance pending further data collection or evaluation. In addition to checking the pulse rate, the clinician should palpate the radial and femoral pulses in both extremities. Subtle cardiovascular signs may be present in pulse wave abnormalities (Table 5).[51,52]

The head and neck examination should include the following basic components: inspection of the head; eye gaze and vision; nose and symmetry of turbinates and septum; teeth, posterior oropharynx, and tonsils; ear canals and tympanic membranes; and palpation for enlarged cervical lymph nodes or thyroid. If symptomatic abnormalities are identified, the athlete should be referred for appropriate management.

Vision screening for athletes has become part of the comprehensive assessment of the PPE for many organizations. During the past decade, the PPE has been expanded to include vision screening as required for clearance before participation.[53] The medical history form should inquire about past vision-related symptoms and interventions. Vision screening may be performed with a Snellen eye chart as part of a multistation examination: results of monocular and binocular vision testing with and without correction should be noted.[54] If screening uncovers a

Table 5. Conditions Associated with Abnormal Arterial Pulse Waves[a]

Pulse Findings	Associated Conditions
Large-amplitude, rapidly rising pulse or "water-hammer" pulse	Hypertrophic cardiomyopathy, aortic regurgitation, severe mitral regurgitation, or patent ductus arteriosus
Small-amplitude, slow-rising pulse (pulsus parvus et tardus)	Aortic stenosis, low cardiac output
Alternating strong and weak pulse (pulsus alternans)	Left ventricular systolic dysfunction
Abnormal rate or rhythm	Arrhythmia or conduction disturbance
Pulse amplitude decreases or disappears on inspiration (pulsus paradoxus)	Cardiac tamponade, severe congestive heart failure, severe chronic obstructive pulmonary disease or asthma, constrictive pericarditis
Double peak pulse	Aortic regurgitation with or without aortic stenosis, hypertrophic cardiomyopathy

[a] Reprinted with permission from Giese EA, O'Connor FG, Brennan FH, Depenbrock PJ, Oriscello RG, The athletic preparticipation evaluation: cardiovascular assessment. *Am Fam Physician*. 2007;75(7):1008–1014. Copyright 2007 American Academy of Family Physicians. All Rights Reserved.[52]

significant visual impairment or abnormality, a complete ocular examination, including dilated retinoscopy, is warranted.

In 2008, Huffman et al[55] defined injuries to the eye as "rare injuries and conditions" based upon data compiled from 100 high schools over the course of 2 academic years. A greater risk of eye injuries is associated with certain sports. In women's lacrosse, the rate of eye injuries has been reported as 0.43 per 1000 athlete-exposures, accounting for 11.5% of all women's lacrosse injuries. These data were collected before rule changes requiring protective goggle wear.[56]

A preparticipation eye examination may be helpful in identifying persons who are at risk for eye injury in high-risk activities such as basketball, water sports, baseball, and racquet sports, although many others could also be included.[57] Baseball has been cited as the leading cause of sport-related eye injury.[58] In particular, an athlete with monocular (single-eye) function should be identified and instructed in additional precautions before being cleared to play.[57]

The pulmonary examination should include inspection and auscultation of both the anterior and posterior lung fields. Inspection should reveal symmetric motion of the ribs and diaphragm and may be combined with palpation. Auscultation should be performed directly against the skin in a quiet environment. The patient should take slow, deep, and quiet breaths through an open mouth. Auscultation should be done with care taken to note symmetry of breath sounds or any abnormal sounds, such as wheezing.[59]

The abdominal screening examination is conducted with the athlete lying supine. Auscultation for bowel sounds should be performed first to avoid palpation-induced cessation of sounds. The 4 abdominal quadrants should be palpated to examine spleen and liver size and identify any mass or inguinal lymphadenopathy.[54]

In male athletes, the contents of the scrotum should be palpated and the presence of 2 descended testicles of normal structure noted; any hernias should be detected. The scrotum and hernia examination is typically performed with the patient standing. The inguinal hernia is evaluated by placing a gloved finger up through the scrotum and into the inguinal canal. Any bulge or mass detected on Valsalva maneuver or coughing suggests a hernia.[54] If the patient is asymptomatic but a bulge or mass is palpable, the presence of a hernia should be noted. Further evaluation can occur at the discretion of the physician.

Cardiovascular Risk Factors. In the United States, the mortality associated with athletic participation is most often the result of acute sudden cardiac death (SCD), a condition that occurs in about 0.5 per 100 000 high school athletes per academic year or 1 in 60 000 participants over a 3-year high school period.[60,61] As such, the cardiovascular examination requires further consideration.

In the United States, the most common cause of SCD in young athletes is hypertrophic cardiomyopathy (HCM), followed by congenital coronary artery anomalies, particularly those of abnormal aortic sinus origin (Figure).[4,60,62–66] Hypertrophic cardiomyopathy is a primary familial malformation with heterogeneous clinical and morphologic expression, complex pathophysiology, and a diverse clinical course.[67] The most characteristic morphologic feature of this disease is symmetric thickening of the left ventricular wall associated with a nondilated cavity. The most common congenital malformation of the coronary arteries is anomalous origin of the left main coronary artery from the right (anterior) sinus of Valsalva.[60,63]

In addition to HCM and congenital coronary artery anomaly, other causes of SCD in athletes include myocarditis, Marfan syndrome, valvular heart disease, dilated cardiomyopathy, premature coronary artery disease, and myocardial bridge.[3,68] Although these conditions individually account for 5% or fewer of athletic-related SCD cases, the following conditions together cause about 40% of cases: aortic rupture and Marfan syndrome, myocarditis ($\leq$5%), and dilated cardiomyopathy (0%–4%).[69] Mitral valve prolapse is possibly the most common cardiac abnormality in the general population (1%–3%) and is reported to be a cause of SCD in young athletes, although with highly variable rates, ranging from 0.7% to 10%.[3,60,70] The relationship between mitral valve prolapse and SCD is not completely known. Exertional syncope, family history of SCD, and severe mitral regurgitation in individuals with mitral valve prolapse are believed to further increase the athlete's risk and justify restricted sport participation.[71] In a small subset of young athletes who have died suddenly (2%–5%), no structural cardiac abnormalities could be detected despite careful examination of the heart at autopsy.[68,72]

Screening for predisposing conditions is severely limited by several factors: the low prevalence of relevant cardiovascular lesions in the general youth population; the low risk of sudden death, even among persons with an unsuspected abnormality; and the relatively large size of the competitive athletic population.[6,60] An estimated

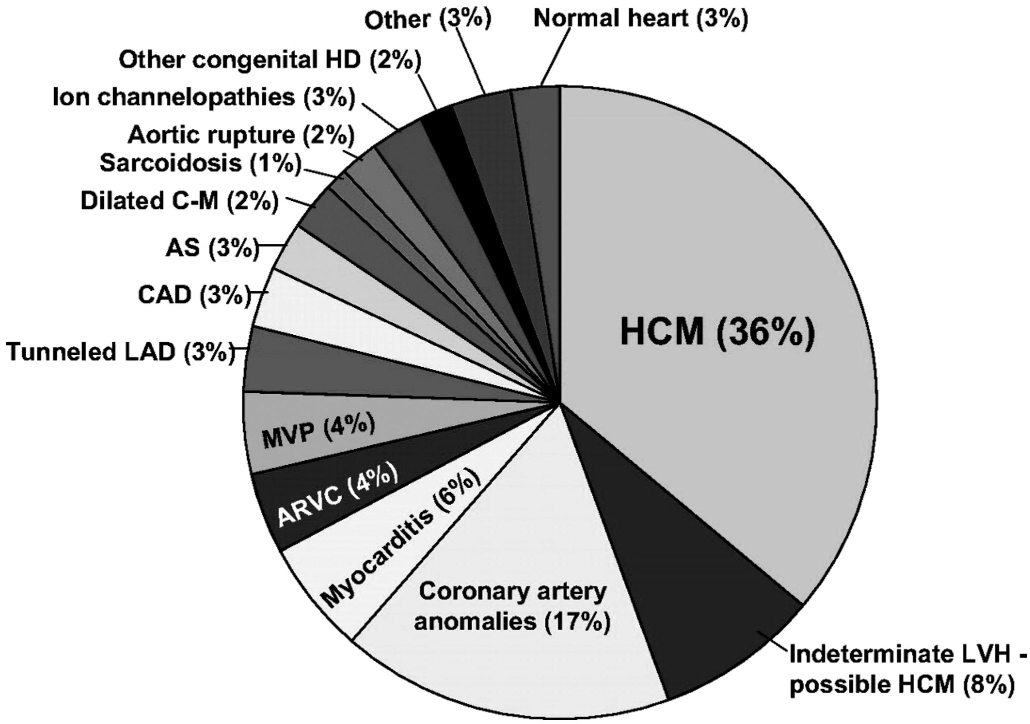

Figure. Distribution of cardiovascular causes of sudden death in 1435 young competitive athletes. From the Minneapolis Heart Institute Foundation Registry, 1980–2005. ARVC indicates arrhythmogenic right ventricular cardiomyopathy; AS, aortic stenosis; CAD, coronary artery disease; C-M, cardiomyopathy; HD, heart disease; LAD, left anterior descending; LVH, left ventricular hypertrophy; and MVP, mitral valve prolapse. Reprinted with permission from Maron BJ, Thompson PO, Ackerman MJ, et al, Recommendations and considerations related to preparticipation screening for cardiovascular abnormalities in competitive athletes: 2007 update. *Circulation*. 2007;115(12):1643–1655.[4]

200 000 children and adolescents would have to be screened with currently available techniques to detect the 500 athletes who are at risk for SCD and the 1 individual who would actually experience it.[73]

At present, the common cardiac conditions that limit athletic participation are rarely detected during the PPE. The most prevalent congenital heart diseases (ventricular septal defect, atrial septal defect, patent ductus arteriosus, pulmonic stenosis, and aortic stenosis) are generally recognized early in life and are therefore unlikely to be first detected during the PPE.[74] Even when cardiac abnormalities are detected, the findings leading to disqualification are most often rhythm and conduction abnormalities, valvular abnormalities, and systemic hypertension, which are not the cardiac abnormalities associated with SCD in athletes.[70,75] In an analysis of 125 408 athletes, 3190 (2.5%) were disqualified.[76] Cardiovascular abnormalities (eg, arrhythmias, valvular abnormalities [including mitral valve prolapse], hypertension) led to disqualification in one-half of affected individuals. Less frequent abnormalities resulting in disqualification included congenital, rheumatic, or ischemic disease; pericarditis; and cardiomyopathy.

Auscultation of the heart should be performed initially by a physician with the patient in both standing and supine position. Auscultation should also occur during various maneuvers (eg, squat to stand, deep inspiration, Valsalva) that may alter the intensity of the murmur and assist in clarifying the underlying cardiac abnormality.[22] Any systolic murmur grade 3 through 6 or louder, any murmur that disrupts normal heart sounds, any diastolic murmur, or any murmur that intensifies with the previously described maneuvers should be evaluated further with diagnostic studies (eg, ECG, echocardiography) or consultation before participation. Sinus bradycardia and systolic murmurs are common, occurring in more than 50% and between 30% and 50% of athletes, respectively, and may not warrant further evaluation in the asymptomatic athlete.[77] The S_3 and S_4 heart sounds are also common in asymptomatic athletes without underlying heart disease.[77,78]

Noninvasive cardiac testing (eg, ECG, echocardiography, exercise stress testing) is not considered a routine aspect of the screening PPE.[15] Such testing is not cost-effective in a population at relatively low risk for cardiac abnormalities, and it cannot consistently identify athletes at actual risk.[71,79–82] A high proportion of normal athletes have left ventricular hypertrophy or left and right atrial enlargement, resulting in abnormal ECGs with increased voltage, repolarization changes, and Q waves, as well as resting bradycardia and abnormal atrioventricular conduction.[83] The sensitivity of ECG in identifying significant cardiovascular disease was 50%, and the positive predictive value was 7%.[82]

Maron et al[84] found that including ECG as a primary screening test in a large group of intercollegiate competitive athletes did not appreciably enhance the sensitivity of an informed history and physical examination in detecting significant cardiovascular disease. Furthermore, ECG was responsible for a large number of false-positive observations. In a review of 2 large registries comprising young competitive athletes who died suddenly, Basso et al[63] reported that standard ECG testing under resting or exercise conditions was unlikely to provide clinical evidence of myocardial ischemia and would not be reliable as a screening test in large athletic populations.

A benefit of an initial cardiovascular screening protocol that includes family and personal history, physical examination, basal 12-lead ECG, and limited exercise testing has been identified.[70] The authors stated that HCM was an uncommon cause of death in young competitive athletes and suggested that recognizing and disqualifying affected competitive-sport athletes during the PPE might have prevented sudden death due to HCM. The rate of sudden death was greater for athletes than for controls in this study. Of note, more than 25% of nonathletes experiencing sudden death had an "other" or unidentified cause (compared with 10% of athletes), making comparisons difficult.

The incidence of SCD in young competitive athletes substantially declined in the Veneto region of Italy after the introduction of a nationwide systemic screening, from 3.6 per 100 000 person-years to 0.4 per 100 000 person-years.[85] As noted by Thompson and Levine,[86] the limitations of this study included the following: a population-based observational report and not a temporally controlled comparison of screening versus nonscreening in athletes; separate analysis of the routine use of ECG compared with more limited screening versus nonscreening in athletes; and, compared with other studies, the relatively high annual death rate before the program at 1 per 27 000 athletes and the lowest annual death rate achieved with screening of 0.4 deaths per 100 000 person-years. In addition, the occurrence rates for this study included all events, not only those associated with exertion. Finally, the screening ECG resulted in an 8%–9% false-positive rate, a rate similar to that in a previously discussed study.[70]

In a prospective study[80] of 5600 high school–aged athletes, ECG was more sensitive in detecting cardiovascular abnormalities requiring further testing before clearance than cardiac history, auscultation or inspection, or blood pressure measurement. Although athletes with cardiovascular conditions such as arrhythmias, conduction abnormalities, hypertension, or severe aortic root regurgitation were not cleared, no athlete in this study was diagnosed with HCM. Compared with a specific cardiovascular history and physical examination ($84 000) and 2-dimensional echocardiography ($200 000), 12-lead ECG ($44 000) was the most cost-effective preparticipation cardiovascular screening method per year of life gained.[47,81]

Although ECG has not been consistently demonstrated as an effective screening tool during the PPE, the results may have some benefit in specific cases. As noted by Maron et al,[84] abnormal ECG is common in conditions such as HCM (in which as much as 90% of ECG is abnormal), myocarditis, arrhythmogenic right ventricular dysplasia, long- and short-QT syndrome, congenital atrioventricular block, Brugada syndrome, and pre-excitation syndrome. Other conditions associated with sudden death during exertion, such as Marfan syndrome, coronary artery anomalies, and catecholamine-induced ventricular tachycardia, might not be detected with resting ECG. In a case-control study[87] from a database of 12 550 trained athletes, 81 athletes without apparent cardiac disease but with ECG characterized by a specific abnormality (diffusely distributed and deeply inverted T waves) were identified. Of these athletes with abnormal ECG, 5 (6%) were ultimately proved to have cardiomyopathy, including 1 death from arrhythmogenic right ventricular dysplasia. In contrast, none of the 229 controls had a cardiac event or received a diagnosis of cardiomyopathy 9 ± 3 years after the initial evaluation. Finally, Pelliccia et al[82] noted that ECG maintains a high predictive negative value (about 96%), indicating that normal ECG reflects a low likelihood of cardiac disease.

Echocardiography and stress testing are the most commonly recommended diagnostic tests for patients with an abnormal cardiovascular history or examination. With the assistance of clinical information, echocardiography has distinguished nonobstructive HCM from the athletic heart syndrome.[75,88]

Unfortunately, ECG lacks specificity in diagnosing HCM and identifying the patients with HCM at risk for SCD. Pelliccia et al[82] found that a substantial minority of participants (11%) had a clinically significant increased ventricular wall thickness, which made clinical interpretation of the echocardiographic findings difficult in individual athletes. Furthermore, some patients with HCM tolerate particularly intense athletic training and competition for many years and even maintain high levels of achievement without incurring symptoms, disease progression, or sudden death.[89] Echocardiography is unable to identify these athletes.

Although screening for underlying cardiovascular disease is limited, certain triggers or risk factors are present in the athletic population. In general, sports activity in adolescents and young adults is associated with an increased risk of sudden death (relative risk = 2.5, 95% confidence interval = 1.8, 3.4, $P < .0001$); however, participation in sports is not believed to be a cause of the greater mortality.[90]

Certain populations of athletes appear to be at higher risk for SCD. For instance, 4 sports (American football, basketball, track, and soccer) are associated with most of the sudden deaths. Additionally, approximately 90% of deaths on the athletic field have occurred in males, most of whom were African American and in high school.[61,68,91] Interestingly, the prevalence of HCM in elite athletes is significantly less than in the general population, suggesting that the demands of strenuous exercise on the cardiovascular system may hinder athletic activity in most individuals with HCM.[92]

The prevalence of underlying cardiovascular disease in athletes experiencing SCD appears to vary with ethnic background and nationality. Of 286 sport-related deaths related to cardiovascular disease, 102 athletes died of HCM, and a majority of the affected individuals (55%) were black.[64] The Brugada syndrome, in which right bundle branch block with persistent ST segment elevation in the right precordial leads is associated with susceptibility to ventricular tachyarrhythmias and SCD, is more prevalent in those of Asian descent.[93] Although HCM is the most common cause of sudden death in young athletes in the United States, arrhythmogenic right ventricular dysplasia is the most common cause of sudden death among Italian athletes.[94] Arrhythmogenic right ventricular cardiomyopathy is characterized morphologically by myocyte death, with replacement by fibrous or adipose tissue (or both types) in the right ventricle.[67]

The consensus panel recommendations of the 36th Bethesda Conference for eligibility and qualification of competitive athletes are predicated on the prior diagnosis of cardiovascular abnormalities and the anticipated sporting activity (Table 6).[43,95] However, the ways in which these diseases are identified (including through preparticipation screening) and how athletes come to be evaluated for competitive eligibility may involve several different scenarios. Athletes may be referred for assessment of clinical symptoms or signs suggesting underlying cardiovascular disease; recognition may occur in routine clinical practice, triggered by findings on history and physical examination; or young athletes may be suspected of having cardiovascular disease by virtue of formal large-population screening examinations that are customary before participation in competitive athletics.

Neurologic Screening. An athlete reporting a previous neck injury should undergo a complete neck evaluation. The athlete should be evaluated for neurologic symptoms and have full range of neck motion, good strength in neck flexion and extension, and symmetric strength on lateral flexion.[23] Symptoms in the arms, hands, or legs should prompt cervical radiographs, including flexion-extension views. Any concern regarding cervical stenosis should prompt further evaluation, including radiographic studies.[23] Players with a history of neurapraxia (eg, burner or stinger) while participating in sports can be cleared for activity if they are free of any neck or radicular pain and have full range of motion and strength. If previous transient or recurrent quadriplegia is reported, cervical radiographic studies are required before the athlete can be cleared.[20,96] Torg and Ramsey-Emrhein[24] and Torg et al[97] categorized a list of congenital, developmental, and postinjury lesions involving the cervical spine as absolute or relative contraindication or noncontraindication to participation in contact sports. These authors have identified spear tackler's spine as an absolute contraindication to participation.[97] *Spear tackler's spine* is defined as developmental stenosis of the cervical canal, straightening or reversal of the cervical lordotic curve, preexisting posttraumatic radiographic abnormalities of the cervical spine, and documented use of spear tackling techniques.[24,97] Additional spinal conditions and participation guidelines for contact sports are described in Table 7.[24,97] Contact-sport activities are listed in Table 8.[44]

Recent attention to the potential seriousness of concussions and resultant complications has led many clinicians to ask more questions and perform further assessment during the PPE. An estimated 300 000 concussions occur annually in the United States.[96] Athletes with a history of concussion appear to be at higher risk for future concussions. Athletes with multiple concussions may experience long-term sequelae, and an unresolved concussion may lead to postconcussion syndrome and second-impact syndrome.[19,20,22,96] Despite the lack of universal agreement as to the definition of a concussion, commonalities do exist in the clinical, pathologic, and biochemical markers used to classify the presence of a head injury.

The NATA[98] has previously established well-defined guidelines for the management of sport-related concussions, and sports organizations such as the National Collegiate Athletic Association[34] have followed suit by developing concussion-management plans. These also include recommendations for obtaining baseline normative values before the sport season, which can be used after an injury to track recovery and aid in return-to-play decisions. Additional resources such as the consensus statement[99] from the Fourth International Conference on Concussion in Sport held in Zurich, Switzerland, in 2012 and the position statement[100] of the American Medical Society for Sports Medicine provide prudent recommendations.

Because concussion is the most common head injury in contact or collision sports, any previous head trauma should be assessed. An athlete who reports a history of concussion should be assessed to ensure that all symptoms have resolved, and a complete neurologic evaluation should be performed.[19,20,22,96] Many experts suggest that athletes with a history of 2 or 3 concussions without loss of consciousness or 1 or 2 concussions with loss of consciousness be referred for further evaluation. This referral usually includes neuropsychological testing, to establish neurologic function, and imaging studies.[23] The complexity of concussions and the lack of large outcome studies have hampered the development of evidence-based management recommendations. The physician determining clearance for an athlete with a history of concussions should be familiar with the current literature and commonly referenced clinical recommendations.[96]

Individuals playing sports that are associated with a higher risk of concussion may be considered for baseline testing during the PPE. These sports include but are not limited to football, soccer, diving, gymnastics, baseball, softball, lacrosse, wrestling, boxing, ice hockey, skiing, cheerleading, basketball, pole vault, equestrian, and judo and martial arts. Furthermore, any athlete with a history of a concussion should undergo a preparticipation assessment. Athletes with a history of 3 or more concussions or delayed recovery may need to be considered for temporary or permanent disqualification from contact sports.[98]

The rationale for performing neurocognitive assessment testing during the PPE is to establish individual baseline measures before any head injury as an aid in diagnostic and return-to-play decision making. Baseline testing can also help to identify attention-deficit disorder and other learning disabilities as well as any residual effects of previous head injuries.[98] Obtaining baseline information requires the use of objective assessment tools. Ideally, neurocognitive testing should be performed on 1 individual at a time. To ensure accurate information that can be used for baseline and return-to-play decision making, the assessment tools must be reliable and valid, and trained personnel must administer standardized instructions. Exertional testing can be conducted as a baseline data measurement and used to compare performance after a head injury.[98,101–104] In the absence of preinjury baseline data, postinjury assessment is compared with general population normative data. To establish the most accurate data relative to injury timelines, history questionnaires and assessment testing should be completed before participation and allowing enough time for any further assessment deemed warranted because of baseline findings; the additional assessment should be completed before the athlete is cleared to participate.

Computed tomography and magnetic resonance imaging are not suggested for general baseline screening. However, for those individuals with a history of concussion or

Table 6. Classification of Sports According to Cardiovascular Demands[a]

Increasing Dynamic Component →; Increasing Static Component ↑

	A. Low ($<40\%$ Max O_2)	B. Moderate ($40–70\%$ Max O_2)	C. High ($>70\%$ Max O_2)
III. High ($>50\%$ MVC)	**IIIA (Moderate)** Bobsledding/luge Field events (throwing) Gymnastics Martial arts Sailing Sport climbing Water skiing Weight lifting Windsurfing	**IIIB (High Moderate)** Body building Downhill skiing Skateboarding Snowboarding Wrestling	**IIIC (High)** Boxing Canoeing/kayaking Cycling Decathlon Rowing Speed-skating Triathlon
II. Moderate ($20–50\%$ MVC)	**IIA (Low Moderate)** Archery Auto racing Diving Equestrian Motorcycling	**IIB (Moderate)** American football Field events (jumping) Figure skating Rodeoing Rugby Running (sprint) Surfing Synchronized swimming	**IIC (High Moderate)** Basketball Ice Hockey Cross-country skiing (skating technique) Lacrosse Running (middle distance Swimming Team handball
I. Low $<20\%$ MVC	**IA (Low)** Billiards Bowling Cricket Curling Golf Riflery	**IB (Low Moderate)** Baseball/softball Fencing Table tennis Volleyball	**IC (Moderate)** Badminton Cross-country skiing (classic technique) Field hockey Orienteering Race walking Racquetball/squash Running (long distance) Soccer Tennis

[a] Reprinted with permission from Mitchell JH, Haskell W, Snell P, Van Camp SP, Task Force 8, Classification of sports. *J Am Coll Cardiol*. 2005;45(8):1364–1367, Elsevier, Inc.[95]

delayed recovery, such imaging tests may be beneficial to assist with decision making.[98]

Orthopaedic Screening. Most studies have shown that musculoskeletal findings are the major category of abnormalities leading to restriction of sports activities.[18–21] The knee is most commonly affected, followed by the ankle.[12,18,20,22] Therefore, every PPE should include a musculoskeletal component. The orthopaedic screen should be used to identify conditions that would make sports participation unsafe, giving specific consideration to the sport for which the athlete is being screened, and to facilitate conditioning programs for injury prevention.[23] Clearance for participation must be based on the degree and type of injury and the requirements of the sport. Participation may be possible in activities that do not directly affect the injured area. Additionally, protective padding, taping, or bracing may allow the athlete to compete safely. Along with sport participation limitations, the physician should identify appropriate strength and conditioning activities.[96]

Ideally, the orthopaedic PPE should take place 4 to 6 weeks before the sport season,[22,23] but this is often not possible. However, this time frame will allow athletes to engage in conditioning programs for problem areas that can be addressed with rehabilitation.[23] Those conducting the

PPE must take into account the time needed for follow-up examinations before the athlete can be cleared. Of the conditions identified during the PPE, 14% required follow-up before clearance for participation[12,96]; 43.2% of these were related to knee problems.[105] Referral is warranted when the examiner is uncertain of the athlete's ability to participate because of the injury. The referral should be made to a sports medicine specialist, but the original physician should be involved in reevaluation after the consult or required rehabilitation has been completed.[96]

The first component of the orthopaedic PPE is a complete history of previous injuries and surgeries. A previous musculoskeletal injury is a major risk factor for reinjury, especially if the original injury was not properly rehabilitated.[12,18–20,22] Any history of injury, sprain, strain, fracture, or undiagnosed localized swelling or pain should be reported on the orthopaedic history form.[96] A complete history will identify approximately 75% of the problems that affect athletes and could result in restriction from sport.[10,11,17–19,25] If the athlete has reported a previous injury, the examining physician must inquire about the specific course of treatment and postinjury rehabilitation. This will aid the physician in determining the need for follow-up evaluation, rehabilitation, or restrictions.[22] Also, discrepancies are known to occur when athletes and their parents complete separate history questionnaires.[17] Therefore athletes, especially younger athletes, should be encouraged to complete the medical history with their parents to ensure accuracy.

The second component of the orthopaedic PPE is the physical examination. A quick 90-second screen can be used for athletes with no previous injuries (Table 4).[18] This screen is 51% sensitive and 97% specific for detecting injury.[18,19,25,26] If the athlete has a history of previous injury or other signs and symptoms of injury on the basic examination, then the screening should be supplemented with a more comprehensive site-specific evaluation.[18,25,106] During a more comprehensive assessment, several signs must be evaluated. There should be no joint effusion, no abnormal range of motion or symptomatic ligament instability, and at least 80% to 90% of normal strength in the affected extremity.[19,20,96] If any of these findings are abnormal, further treatment will be needed before the athlete can be cleared to participate. Follow-up treatment may take the form of referral to a sports specialist, diagnostic testing, or a rehabilitation program.[96] In addition, some authors[106] suggest supplementing the general orthopaedic screen with a more sport-specific musculoskeletal examination, including a thorough evaluation of the joints under the most stress for that particular sport.

Laboratory and Diagnostic Screening. The use of routine laboratory or other tests such as urinalysis, complete blood count, chemistry profile, lipid profile, ferritin level, or spirometry during the PPE has not been supported by sports medicine societies.[15,18,27,28] However, several tests have been recommended for the screening process. Laboratory and other diagnostic studies should be considered based upon the results of the screening questions and physical examination findings.

Anemia. In college-level sports, anemia and iron deficiency are more common than previously thought and are probably present in a significant percentage of athletes. Di Santolo et al[107] evaluated the prevalence of iron-deficiency anemia among nonprofessional female athletes compared with the general population. Nearly 20% of athletes in the study were anemic, and almost one-third had iron deficiency.

The role of screening for anemia remains unsettled. A complete blood count and ferritin have been recommended for all athletes entering an intense training program. In 2003, authors[108] of a survey of National Collegiate Athletic Association Division I-A schools found that only 43% screened for iron-deficiency anemia in female athletes. A few researchers[29,30,109] have prospectively screened specific populations of elite athletes. Furthermore, the effect of screening for anemia in an asymptomatic athlete is not known.

Sickle Cell Trait. Sickle cell disease is caused by a mutation in hemoglobin at the sixth amino acid, with the glutamine being replaced by a valine residue (sickle cell hemoglobin [HbS]). The resulting change in the hemoglobin molecule leads to polymerization in low oxygen conditions. This process distorts the red blood cells, leading to a "sickle-shaped" cell that clogs small arterioles.

Patients with sickle cell disease typically become symptomatic at a young age, whereas patients with sickle cell trait may be asymptomatic and unaware that they carry the gene. Athletes with sickle cell trait demonstrated no stress-test evidence of cardiac strain or ischemia in comparison with a normal group.[110] In military recruits who experienced sudden death, the relative risk associated with sickle cell trait was 28.[111] Although sickle cell trait confers little risk for cardiovascular complications in most athletic contexts, several recent reports have described vaso-occlusion[112] and sudden death associated with severe heat- and dehydration-induced sickling crisis in patients with sickle cell trait.[113] Recent detailed reviews[30,114,115] of the physiology of sickle cell trait in athletes suggest that this condition may not be benign, as previously thought, but likely confers a slightly higher risk in high-intensity sports associated with an increased chance of heat injury and dehydration.

The NATA has recommended confirming the sickle cell train (HbAS) status of all athletes.[33] The prevalence of the gene is much higher in athletes of Mediterranean or African descent. At the time of the PPE, prior laboratory results should be available for review by the medical staff.

Diabetes Mellitus. The PPE should include a thorough review of the athlete's personal and family history for the presence of diabetes mellitus, type 1 or type 2. The NATA position statement[32] provides essential information to the athletic trainer and other health care providers for proper management of diabetic athletes who are participating in sport. Once identified, these athletes should be screened regularly for retinopathy, nephropathy, neuropathy, and cardiovascular disease, as well as sensory function of the foot and ankle reflexes. Furthermore, a diabetes care plan should be implemented to ensure safe and effective monitoring of blood glucose levels during sport participation. Finally, appropriate guidelines should be followed postinjury to mitigate the potential sequelae associated with trauma-related hyperglycemia, such as infection and poor wound and fracture healing.

Lipid Disorders. Routine screening for lipid disorders in athletes is not considered an integral aspect of the PPE.

Table 7. Spine Condition Participation Recommendations[a]

No Contraindication	Relative Contraindication	Absolute Contraindication
Klippel-Feil anomaly type II lesion involving fusion of 1 or 2 interspaces at C3 and below in an individual with full range of motion and the absence of occipitocervical anomalies, instability, disc disease, or degenerative changes	Developmental narrowing of the cervical canal with 1 episode of cervical cord neurapraxia	Odontoid anomalies: odontoid agenesis, odontoid hypoplasia, os odontoideum
Developmental stenosis with a Torg ratio <0.8, with no instability	Episodes of cervical cord neurapraxia with intervertebral disc disease or developmental changes (or both)	Atlanto-occipital fusion
Spina bifida occulta	Episode of cervical cord neurapraxia associated with MRI evidence of cord defect or cord edema	Klippel-Feil anomaly, type I lesion involving mass fusion
	An episode of cervical cord neurapraxia associated with ligamentous instability, symptoms of neurologic findings lasting longer than 36 h and/or multiple episodes	Spear tackler's spine as defined by Torg et al[24,97]
	Healed nondisplaced Jefferson fractures: athlete must have full, pain-free ROM with no neurologic findings	Atlantoaxial instability
	Type I and II odontoid fractures: athlete must have full, pain-free ROM with no neurologic findings	Atlantoaxial rotatory fixation
	Lateral mass fractures of C2: athlete must have full, pain-free ROM with no neurologic findings	Acute fractures
	Stable displaced vertebral body compression fracture without a sagittal component: athlete must be asymptomatic, be neurologically normal, and have full, pain-free ROM	Vertebral body fracture with sagittal component
	Stable fractures involving the posterior neural ring: athlete must be asymptomatic, be neurologically normal, and have full, pain-free ROM	Vertebral body fracture with or without displacement but with associated posterior arch fractures or ligamentous laxity (or both)
	Ligamentous injuries: instability <3.5 mm of displacement of 1 vertebra in relation to another or <11° of rotation as demonstrated on lateral radiographs	Comminuted fractures of the vertebral body with displacement into the canal
	Healed disc herniation treated conservatively or with discectomy and fusion as long as fusion is solid, there are no symptoms or neurologic findings, and ROM is full	Any fracture with associated pain, neurologic findings, and limited ROM
	Treated disc disease with residual instability is a relative contraindication	Healed displaced fractures involving the lateral masses with resulting facet incongruity
		C1-C2 fusion
		Ligamentous injuries: instability as demonstrated by more than 3.5 mm displacement of 1 vertebra in relation to another or greater than 11° of rotation as demonstrated on lateral radiographs
		Acute disc herniation

Abbreviations: MRI indicates magnetic resonance imaging; ROM, range of motion.

[a] Reprinted from Torg JS, Ramsey-Emrhein JA, Management guidelines for participation in collision activities with congenital, developmental, or postinjury lesions involving the cervical spine. *Clin J Sport Med*. 1997;7(4):273–291, with permission from Elsevier,[24] and Torg JS, Sennett B, Pavlov H, Leventhal MR, Glasgow SG, Spear tackler's spine: an entity precluding participation in tackle football and collision activities that expose the cervical spine to axial energy inputs, *Am J Sports Med*. 1993;21(5):640–649. Copyright © 1993 by *Am J Sports Med*. Reprinted with permission from SAGE Publications.[97]

Moreover, restricted participation in athletic activity based on elevation of specific lipid profiles is not supported by the literature. Substantial evidence documents the favorable effect of exercise on blood lipid profiles.[35,116,117]

Exercise-Induced Bronchospasm. The prevalence of exercise-induced bronchoconstriction (EIB) in athletes has been reported to range from 6% to nearly 21% in a group of elite athletes; therefore, screening for this condition is often recommended.[118–120] Despite this relatively high prevalence, successfully screening for this condition is difficult. Many athletes who report symptoms of EIB do not demonstrate laboratory study results consistent with this

Table 8. Classification of Sports by Contact[a]

Contact/collision	
	Basketball
	Boxing[b]
	Cheerleading
	Diving
	Extreme sports[c]
	Field hockey
	Football (tackle)
	Gymnastics
	Ice hockey[d]
	Lacrosse
	Martial arts[e]
	Rodeo
	Rugby
	Skiing, downhill
	Ski jumping
	Snowboarding
	Soccer
	Team handball
	Ultimate Frisbee
	Water polo
	Wrestling
Limited contact	
	Adventure racing[f]
	Baseball
	Bicycling
	Cheerleading
	Canoeing or kayaking (white water)
	Fencing
	Field events (high jump, pole vault)
	Floor hockey
	Football (flag or touch)
	Handball
	Horseback riding
	Martial arts[e]
	Racquetball
	Skating (ice, in-line, roller)
	Skiing (cross-country, water)
	Skateboarding
	Softball
	Squash
	Volleyball
	Weight lifting
	Windsurfing or surfing
Noncontact	
	Badminton
	Body building[g]
	Bowling
	Canoeing or kayaking (flat water)
	Crew or rowing
	Curling
	Dance
	Field events (discus, javelin, shot put)
	Golf
	Orienteering[h]
	Power lifting[g]
	Race walking
	Riflery
	Rope jumping
	Running
	Sailing
	Scuba diving
	Swimming
	Table tennis
	Tennis
	Track

[a] Reproduced with permission from Rice SG, American Academy of Pediatrics Council on Sports Medicine and Fitness, Medical conditions affecting sports participation. *Pediatrics*. 2008;121(4):841–848. Copyright © 2008 by the American Academy of Pediatrics.[44]

Table 8. Continued.

[b] The American Academy of Pediatrics opposes participation in boxing for children, adolescents, and young adults.
[c] Extreme sports has been added since the previous statement was published.
[d] The American Academy of Pediatrics recommends limiting the amount of body checking allowed for hockey players 15 years and younger, to reduce injuries.
[e] Martial arts can be subclassified as judo, jujitsu, karate, kung fu, and tae kwon do; some forms are contact sports and others are limited-contact sports.
[f] Adventure racing has been added since the previous statement was published and is defined as a combination of 2 or more disciplines, including orienteering and navigation, cross-country running, mountain biking, paddling, and climbing and rope skills.
[g] The American Academy of Pediatrics recommends limiting bodybuilding and power lifting until the adolescent achieves sexual maturity rating 5 (Tanner stage V).
[h] Orienteering is a race (contest) in which competitors use a map and a compass to find their way through unfamiliar territory.

diagnosis.[121–124] The sensitivity and specificity of EIB testing are inadequate for its use as an effective medical screening tool.

For those who have a history of asthma and continue to be active, no additional workup is necessary. How frequently the athlete needs an albuterol rescue inhaler should be noted, and appropriate workup and treatment should be obtained to minimize symptoms.[125] As part of the clearance process, it may be prudent to recommend that these athletes be observed for any symptoms during participation and that a rescue inhaler be kept available to the athlete at all times.

In their medical histories, some athletes report a history of allergic rhinitis or childhood asthma that they have "grown out of." Up to 50% of those who had remission of their asthma symptoms during adolescence or earlier will have recurrent symptoms in adulthood.[126] A history of wheezing alone is insufficient to diagnose asthma or EIB. In the athlete, EIB is most often accompanied by symptoms of cough, wheezing, chest tightness, dyspnea, or excess mucus production. In elite winter-sport athletes, 2 or more symptoms suggestive of asthma had a sensitivity and specificity of 50% and 78%, respectively, for EIB assessed with a field-based exercise test.[123] However, symptoms do not uniformly predict EIB. In 107 collegiate athletes, Parsons et al[127] found that the prevalence of EIB was 35% and 36% in athletes with and without symptoms of EIB, respectively. In addition, athletes in high-ventilation sports were significantly more symptomatic (48%) than athletes in low-ventilation sports (25%), with no difference in EIB prevalence between groups.

Because EIB can hinder performance, it may be appropriate to field test peak-flow measurements before and after an 8-minute bout of exercise in those patients with a history of asthma or allergy. A decrease in peak flow rate of 10% to 15% is consistent with EIB.[128,129] Although the routine use of spirometry in the PPE is neither practical nor recommended, an exercise challenge test should be conducted under carefully controlled conditions when indicated as part of further evaluation. Those with a significant decrease in peak flow should receive a formal diagnosis of EIB only after a controlled laboratory challenge test.[130]

Medication Use. All medications and supplements currently used by the athlete should be reviewed by the examiner during the PPE. Listed medications may alert the examiner to medical conditions that have not been disclosed on health forms. The use of these medications and their underlying medical justification should be assessed at the time of the PPE and a suitable monitoring program instituted. This review should include both prescription and over-the-counter medications. Also, although parents or athletes may consider these medications inconsequential, many cold preparations and supplements contain either active ingredients that can affect athletic performance or banned substances. Supplements are not regulated by the Food and Drug Administration and may contain unlabeled contaminants including banned substances (including ephedra).[131] Athletes should be questioned about the use of popular energy drinks because these can cause symptoms such as palpitations and diarrhea. In certain cases, it may be prudent to arrange team or individual meetings with student–athletes, separate from the PPE, to review and discuss the appropriate use of medications and supplements as well as their potential effects on performance.

Nutritional Assessment. Proper nutrition is essential for optimal athletic performance. At the PPE, the athlete's height and weight should be evaluated as an initial screen for undernutrition or obesity, and any concerns about disordered eating should be pursued. A previous NATA position statement[36] described screening and management strategies for patients suspected to have disordered eating behaviors.

Heat-Related Illness and Hydration Risk Factors. The PPE is an appropriate setting to identify a previous history of exertional heat illness and provide education about preventing heat illness and maintaining proper hydration.[39] All athletes should begin exercise well hydrated and be allowed to acclimate appropriately to conditions that contribute to the onset of heat illness. Athletes, coaches, and parents should be educated regarding appropriate hydration strategies before and during exercise and during recovery. If the athlete has a history of heat illness (ie, heat cramps, heat syncope, heat exhaustion, heat stroke), extra attention to these measures is warranted. Younger athletes are more susceptible to heat injury and often do not adequately hydrate.[38,39] The NATA has developed a position statement[132] regarding proper fluid replacement and a consensus statement[37] detailing guidelines for preseason heat acclimatization.

Mental Health Considerations. Recent studies on mental health concerns faced by teenagers and young adults reveal a growing trend in both incidence and severity. From 1996 to 2007, the rate of psychiatric hospital discharges rose by more than 80% for 5- to 13-year-olds and by 42% for older teens.[133] The US Substance Abuse and Mental Health Services Administration[134] reported that young adults ages 18 to 25 years had the highest level of mental illness at 30%, up from 19.5% from 2009. In 2010, the National Institute of Mental Health[135] reported that 1 in 5 teens in the United States suffered from a mental disorder severe enough to affect daily life.

The full range of mental health concerns found in the general population is also found in athletes. Participation in athletics does not grant the athlete immunity from the stressors that may contribute to a mental health problem. In fact, the additional visibility athletes receive may heighten stress.[40] Specific questions may be included in the medical history portion of the PPE to help identify an athlete who may need referral for a mental health evaluation (Table 9).[41] Any *yes* answers should trigger a private discussion between the physician and athlete. The physician can then determine if the athlete needs to be referred for evaluation by a mental health care professional.

PPE Administration

All information obtained or associated with the PPE process should be regarded as private health information and stored in secure locations compliant with applicable Health Insurance Portability and Accountability Act (HIPAA) and Family Educational Rights and Privacy Act (FERPA) regulations. In most cases, the athlete (or guardian if the athlete is a minor) must provide written consent for any health information other than eligibility status to be relayed to school personnel. In addition to these federal regulations, individual states may have more stringent laws that supersede federal standards.[15] Certified athletic trainers and team physicians must be familiar with state and federal regulations to ensure that PPE information is handled in compliance with the applicable law. Institutions should have their policies and procedures reviewed by legal counsel or risk management officers to ensure legal compliance. Additionally, all school personnel should undergo training on privacy policies and the appropriate handling of athletes' health information.

Information related to allergies and chronic medical conditions should be available to appropriate personnel for use only in emergency situations. This information should be readily accessible during both home competitions and travel events. Measures should be taken to ensure this information is kept secure both at the institution and during travel to safeguard privacy and permit access only by necessary personnel. Health information should be disclosed only on the advice of legal counsel or written authorization or, if necessary, because of a public health risk. If information transmission is deemed necessary for a public health risk, every attempt should be made to limit information to what is necessary for the public to know and to eliminate identifying information.[15]

Timing. Although evidence-based support is lacking, experts recommend the PPE be conducted 4 to 6 weeks before preseason practice. Residual injuries and further evaluation of abnormalities can be addressed during that time period. Some authorities recommend that a PPE be performed only when the athlete begins a new level of competition. During the intervening years, the athlete's medical history should be reviewed and a problem-focused physical evaluation conducted. The frequency with which the PE should be performed to allow for the successful completion of the intended objectives is not known.

Instrument. The American Academy of Pediatrics[15] has developed a thorough document that should serve as the minimal template for a standardized PPE instrument. Individual institutions and organizations may supplement the information included, considering the need to control costs and the time required to complete the PPE process.

Methods. The PPE can be conducted either by the athlete's personal physician or as part of a larger-scale group screening. The PPE can be effectively administered in both settings, and each allows for the individual assessment of an athlete. However, examination by the athlete's personal physician has clear advantages, including continuity of care given the established relationship, the physician's familiarity with the athlete's medical and family health history, and past medical records that can be accessed for comparison with current status. Thus, previously diagnosed conditions and any omissions on the health history questionnaire can be addressed. Additionally, the preexisting relationship between the student–athlete and physician may allow for more honest disclosure of new problems or behaviors that may affect the athlete's performance. Conversely, a potential disadvantage of the personal physician examination is a lack of understanding about the implications of the examination findings as they relate to risk factors for participation.[15]

The PPE can also be conducted effectively in a group setting. A large-scale PPE conducted by an appropriate medical team and coordinated by a sports medicine physician may also have beneficial aspects. Many athletes do not have a primary care physician or do not have the monetary means to seek a one-on-one physician clinical visit. For these athletes, the group PPE offered by the school is the only means of receiving an adequate PPE.[10,11] To ensure quality, several factors should be considered when conducting a group PPE. As stated previously, one benefit of the PPE conducted by the primary care physician is the assumption that the examiner is knowledgeable about the athlete's health history. For the group PPE, all athletes should be encouraged to complete a thorough, standardized health history questionnaire; the questionnaire should be completed in its entirety and honestly, with the assistance of a parent or guardian. Additionally, a well-rounded medical team should be assembled to conduct the group PPE. Most commonly, the team physician organizes this group, which often includes primary care sports medicine physicians and orthopaedic specialists. Some group PPEs also include the services of a sport cardiologist and other specialist consultants to address a wide range of problems. The history questionnaire should be reviewed and the physical examination conducted by the same physician for an individual athlete to ensure consistency of evaluation. Having multiple subspecialty consultants available during the group PPE also allows for a more comprehensive examination, depending on the condition in question, and facilitates a more efficient response to concerns that may arise, potentially resulting in decreased need for follow-up and reduced time in obtaining athlete clearance. Having a team of professionals present to collaborate on the possible need to disqualify an athlete from participation is also helpful. Although disqualification does not usually occur at the PPE but at follow-up evaluation, the conversation among physician, athlete, and parents can be started at this time.[15]

Depending on the availability of additional personnel to assist in the group PPE process, the services of certified athletic trainers, physical therapists, nutritionists, and exercise physiologists may also be of considerable value in conducting administrative tasks, collecting vital signs, administering patient education, providing consultation on rehabilitative exercises, and helping with the organization and flow of the process. School administrators and coaches can assist with order and discipline to ensure efficiency and promote a calm environment conducive to a medical examination. The final consideration for a group PPE is an appropriate location. The location should provide both a space large enough to accommodate the number of expected athletes and private, quiet areas for physician evaluations. Additionally, adequate space for patient and parent consultation should be available.[15]

Table 9. Mental Health–Related Survey[a]

Statement	Yes/No
I often have trouble sleeping.	
I wish I had more energy most days of the week.	
I think about things over and over.	
I feel anxious and nervous much of the time.	
I often feel sad or depressed.	
I struggle with being confident.	
I don't feel hopeful about the future.	
I have a hard time managing my emotions (frustration, anger, impatience).	
I have feelings of hurting myself or others.	

[a] Adapted from Carroll and McGinley.[41]

All data documented on the PPE should be handled carefully, thoroughly, accurately, and privately to ensure that the screening process is complete. Any follow-up testing or additional information necessary to complete the PPE must be performed and reviewed by the examining physician so that an appropriate judgment can be made regarding the athlete's status for participation.

Personnel. A physician (doctor of medicine or doctor of osteopathy) with clinical training in dealing with potential problems or risk factors associated with athletic participation should be the responsible party in coordinating and conducting the PPE.[15,136,137] The physician should be knowledgeable in the medical and family history of the athlete and remain current on existing research related to clearance considerations and disqualifying conditions associated with athletic participation. The physician should also be prepared to refer athletes to specialists when concerns arise that are beyond their expertise and be able to work with a student-athlete's primary care physician, where appropriate, in managing chronic conditions.[15,137] In many states, health care professionals other than physicians are permitted to conduct the PPE. These health care professionals should be held to the same standard as a doctor of medicine or doctor of osteopathy in assuming responsibility for conducting an adequate PPE. Standardized health questionnaires are recommended to ensure that adequate evaluations and screenings are performed, regardless of the examiner.[137] To promote greater uniformity and standardization, information such as that contained in this manuscript and similar documents[15] should be widely disseminated to all medical groups and athletic organizations involved in the PPE.

Determination of Clearance

Occasionally, an abnormality or condition is found that may limit an athlete's participation or predispose him or her to further injury. In these cases, the team physician should review the following questions as the athlete's ability to meet the criteria for participation is being determined[15]:

1. Does the condition pose an unacceptable risk or place the athlete at increased risk for further injury?
2. Does the condition place other participants at risk for injury?
3. Can the athlete safely participate with treatment (eg, medication, rehabilitation, bracing, padding)?
4. Can limited participation be allowed while treatment is being completed?
5. If clearance is denied for certain sports or sport categories only, in which activities can the athlete safely participate?

A specific risk analysis to provide the physician with guidance in answering these questions has not been developed.[138] Furthermore, the specific threshold used in the decision depends upon numerous factors, including the specific sport, desires of the athlete and parent, and available protective equipment.

Clearance to participate in a particular sport should be based on previously published guidelines such as those of the 36th Bethesda Conference and the American Heart Association[43] and the American Academy of Pediatrics.[44] Participation recommendations are based on the specific diagnosis, although multiple factors, including the sport classification and the athlete's specific health status, affect the decision. Whether these clearance guidelines effectively limit the participation of athletes at risk for further injury without limiting the participation of athletes with minimal or no risk is unclear and has yet to be studied. Furthermore, the effects of inappropriately excluding the individual with minimal or no risk of athletic-associated injury or death are unknown.

A team physician and institution have the legal right to restrict an individual from participating in athletics as long as the decision is individualized, reasonably made, and based on competent medical evidence.[46] As a result of the decision in *Knapp versus Northwestern University* and as noted by Maron et al,[45] difficult medical decisions involving participation in competitive sports can be resolved by physicians exercising prudent judgment (which is necessarily conservative when definitive scientific evidence is lacking or conflicting) and relying on the recommendations of specialist consultants or guidelines established by panels of experts.

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DISCLAIMER

The NATA and NATA Foundation publish position statements as a service to promote the awareness of certain issues to their members. The information contained in the position statement is neither exhaustive nor exclusive to all circumstances or individuals. Variables such as institutional human resource guidelines, state or federal statutes, rules, or regulations, as well as regional environmental conditions, may impact the relevance and implementation of these recommendations. The NATA and NATA Foundation advise members and others to carefully and independently consider each of the recommendations (including the applicability of same to any particular circumstance or individual). The position statement should not be relied upon as an independent basis for care but rather as a resource available to NATA members or others. Moreover, no opinion is expressed herein regarding the quality of care that adheres to or differs from the NATA and NATA Foundation position statements. The NATA and NATA Foundation reserve the right to rescind or modify its position statements at any time.

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