Disqualifying Criteria in a Preparticipation Sports Evaluation

Sami F. Rifat, MD; Mack T. Ruffin IV, MD, MPH; and Daniel W. Gorenflo, PhD
Rochester Hills and Ann Arbor, Michigan

Background. This study was undertaken to demonstrate the relative frequency of disqualifying criteria in a complete history and physical sports examination.

Methods. A review was conducted of 2574 preparticipation physical evaluations (PPEs) performed on 11- to 18-year-old student athletes to determine which factors are associated with denial of unrestricted sports participation.

Results. Eighty-five percent of the student athletes passed the screening. Of those who did not, the denial decision was based on the medical history alone in 58% of cases ($P<.05$). A logistic regression analysis identified seven items associated with denial: dizziness with exercise, history of asthma, body mass index, systolic blood pressure, visual acuity, heart murmur, and musculoskeletal examination.

Conclusions. Although physicians often take a complete history and perform physical examinations, relatively few variables appear related to denial of eligibility for participation in organized sports. The history is one of the most important aspects of the PPE. A directed PPE may be more efficient, thereby allowing more time to address other important issues.

Key words. Sports; participation; child; adolescence; physical examination; medical history taking.
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Health care providers perform millions of preparticipation physical evaluations (PPEs) each year. The general goal of this evaluation is to help maintain the health and safety of the athlete during sports participation. Although new PPE guidelines are emerging,[1] there is still great variation in the form and content of evaluations. Many physicians use a traditional history-taking and physical examination format for the PPE, whereas others advocate a limited directed history-taking and physical examination.[2,3] The purpose of this study was to demonstrate the relative frequency of disqualifying criteria in a complete history and physical sports examination. We hypothesized that a limited number of PPE components are important to physicians in making their recommendations regarding sports participation.

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From Rochester Knee and Sports Medicine, P.C., Rochester Hills, Michigan (S.F.R.), and the Department of Family Practice, University of Michigan Medical School, Ann Arbor (M.T.R., D.W.G.). Requests for reprints should be addressed to Sami F. Rifat, MD, 2055 Crooks Rd, Rochester Hills, MI 48309.

Methods

We reviewed the results of 2574 PPEs completed over a 7-year period. The PPEs were performed on 11- to 18-year-old students who attended local junior and senior high schools. The athletes were predominantly white and from middle-class families living in a semirural community.

Preparticipation physical evaluations were required annually for all students participating in intramural and extramural activities. More than 90% of the students included in our study had undergone a PPE during a single prearranged "sports physical day" at our family practice center. Since the examinations were required annually, some students were examined more than once during the study period; however, each examination was recorded as a separate encounter.

A standard procedure and sports physical form was used throughout the study period. The form* was devel-

**Copies of the sports preparticipation evaluation form used in this study are available from the authors.*

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oped by the physicians, coaches, and trainers based on their previous needs and experiences. Students and their parents completed the history portion of the form at home, and the completed form was reviewed by a physician at the time of the evaluation. A parent's or guardian's signature acknowledging review of the history and permission to conduct the physical examination was a prerequisite.

Physical examinations were performed by the residents and faculty of a family practice residency program using the single examiner method. Male and female students were separated into two parallel tracks. The tracks differed only in that students were examined by same-sex physicians, and female athletes did not undergo hernia evaluations. Nurses and medical assistants obtained vital signs and height and weight measurements. Visual acuity screening was assessed with Snellen's eye chart. No laboratory testing was performed. The experience of the examining physicians varied from first-year resident to senior faculty member. Faculty preceptors were available to discuss individual cases with the residents, and any restriction from play was reviewed by a faculty member.

Disposition was assigned by the examining physician. There were four recommendations: (1) pass, (2) pass with follow-up and/or restriction, (3) fail with follow-up, and (4) fail. The recommendations for participation in competitive sports from the American Academy of Pediatrics Committee on Sports Medicine[4] were used as a framework for decision-making. Generally, any condition that was considered by the examining physician as potentially dangerous to the athlete during athletic participation was sufficient justification for restriction.

Analysis

Frequencies of all variables were determined. Individuals who were denied unrestricted participation, ie, recommendations 2, 3, or 4, were grouped together for analysis. Univariate associations between PPE variables and denial of unrestricted participation were calculated using chi-square and *t* test, as appropriate. The associations among predictors were also determined using chi-square or Pearson correlation, as appropriate.

Logistic regression analysis was then performed to assess the independent associations between denial of unrestricted participation and the variables identified by the univariate analyses. Sex and variables with a P value $<.10$ were included in the logistic regression analyses.[5] Although weight and body mass index (BMI = height/weight^2) were both significant, only BMI was used in the modeling.

Table 1. Recommendation Assigned to Student Athletes Following Sports Preparticipation Physical Evaluations

Recommendation Assigned	No. of Student Athletes	% of Total
(1) Pass	2183	84.8
(2) Pass with follow-up and/or restriction	325	12.6
(3) Fail with follow-up	63	2.5
(4) Fail	3	0.1
Totals	2574	100

Results

Population Characteristics

The study population included 1361 male student athletes ranging in age from 11 to 18 years (mean age, 14.7 years) and ranging in grade level from 5th to 12th (mean grade level, 9.4). There were 1213 female student athletes ranging in age from 11 to 18 years (mean age 14.4 years) and ranging in grade level from 6th to 12th (mean grade level, 9.2). The recommendations assigned to these students are reported in Table 1. Approximately 85% of the student athletes (2183/2574) passed with no restrictions. No significant difference ($P<.05$) was observed in recommendations based on examination year, age, grade, sex, or primary sport.

The frequencies of abnormal findings in the students' histories and physical examinations are reported in Table 2. Tables 3 and 4 report the reasons cited for restriction. A musculoskeletal problem, asthma, and vision difficulty were the most frequently reported reasons for restriction found in the histories. Decreased visual acuity, heart murmur, and elevated blood pressure were the most common physical examination findings cited for restriction. The histories accounted for a far greater number of abnormal responses and the majority (58%) of the reasons cited for restriction.

Univariate Analysis

Table 5 reports the associations between the history and physical examination findings and the denial of unrestricted participation. Twenty-four of 44 variables were found to be associated ($P<.05$) with denial of unrestricted participation. Nine of these variables were found as a result of the medical history and 15 on physical examination.

Table 2. Relative Frequency of Abnormal Responses Elicited from History and Physical Findings Among 2574 Student Athletes Undergoing Sports Preparticipation Physical Evaluation

History	No. of Student Athletes	Physical Findings	No. of Student Athletes
Wears dental appliances	664	Abdominal tenderness	124
History of injury requiring treatment by a physician	656	Decreased visual acuity	117
Wears glasses or contact lenses	639	Abnormal musculoskeletal examination	83
History of bone or joint injury	425	Heart murmur	72
History of surgery	388	Varicocele	48
History of hospitalization	353	Elevated blood pressure	36
Allergies	304	Skin rash or lesion	25
Medications	232	Wheezing or crackles	23
History of asthma	187	Ears (otitis, external or middle)	19
History of concussion	158	Eyes (not acuity)	12
History of dizziness, fainting, convulsions, or headache	157	Genitalia	12
History of hernia	85	Irregular heart rhythm	11
History of chronic illness	76	Teeth	10
History of high blood pressure or heart problems	66	Head	9
History of skin disease	57	Hernia	4
History of hearing problems	48	Splenomegaly	3
Missing an organ	33	Allergic sequelae	2
History of heat stroke	30		
History of persistent cough	23		
History of a kidney problem	7		

Logistic Regression Analysis

Twenty-seven variables ($P<.10$) were included in the analysis. Ten variables were excluded from the logistic modeling because of either low incidence rates or a high proportion of missing data (history: hearing difficulty, cough; physical: head, ears, eyes, chest, genital, hernia, varicocele, skin). Nine variables were not statistically associated with denial of unrestricted participation in the initial logistic models.

A forward stepwise logistic regression model was used. Three interaction terms, namely, systolic blood pressure (SBP) by sex, SBP by BMI, and BMI by sex, were added to our logistic model.[6,7] Two of these interaction terms (SBP by sex, and BMI by sex) that did not contribute significantly to the model were dropped. The final model appears in Table 6.

Discussion

In this study, we retrospectively reviewed PPEs that were similar to those conducted in many primary care offices in that they included a complete history and physical examination. The results of our study suggest that essential components of the PPE should include a directed medical history and a few key physical examination items. The logistic regression analysis identified seven variables and one interaction term that were particularly important in the preparticipation evaluation.

Dizziness with Exercise

Dizziness during or after exercise is believed to be associated with hypertrophic cardiomyopathy (HCM), the most common cause of sudden death in young athletes.[3,7] This symptom may also be present in persons with cardiac arrhythmias or coronary artery anomalies.[7–10] In children and adolescents, the incidence of sudden cardiac death is quite low, and there are few clinical predictors.[11] Many authors believe, however, that these symptoms, if present, may identify athletes at risk.[7–11] Our study confirms that clinicians place importance on this symptom in a medical history.

History of Asthma

A history of asthma was the most frequently cited reason for initial restriction or referral for follow-up. Exercise-

Table 3. Reasons from Medical History Cited for Recommendation Assigned to Student Athletes

Reasons for Restriction	Recommendations: Pass with Follow-up and/or Restriction (2)	Fail with Follow-up (3)	Fail (4)	Total
Musculoskeletal				
Nonspecific pain/injury	13	10	2	25
Neck pain/injury	—	1		1
Wrist injury	1	—	—	1
Back injury/scoliosis	8	1	—	9
Knee pain/injury	26	1	—	27
Heel pain/injury	1	—	—	1
Ankle pain/injury	9	1	—	10
Subtotal	58	14	2	74
Asthma	30	1	—	31
Vision difficulty	21	6	—	27
Difficulty hearing	11	—	—	11
Chronic/recurrent illness	10	—	—	10
Headache	10	—	—	10
Dizziness/syncope with exercise	7	2	—	9
Heart murmur	6	3	—	9
Recent surgery	—	6	—	6
Mouthguard required	3	—	—	3
Allergy	2	—	—	2
Bruising	1	1	—	2
Chest pain	2	—	—	2
Abdominal pain	1	—	—	1
Enlarged spleen	1	—	—	1
Hernia	1	—	—	1
Missing paired organ (eye)	1	—	—	1
Varicocele	1	—	—	1
Total	166	33	2	201

induced bronchospasm (EIB) is usually not a reason for disqualification, and studies show a 10% to 15% incidence in competitive athletes.[12] We would expect 250 to 350 athletes with EIB in our population. One hundred eighty-seven athletes reported a history of asthma, only 31 of whom were restricted because of this condition. Thirty were required to use medications with exercise (recommendation 2), and one student required further evaluation.

A history of coughing or wheezing after strenuous exercise is a common symptom in persons with EIB. Because persons with allergies are more likely to experience EIB,[12] athletes should be queried regarding the presence of allergies. Regular or occasional medication use, including antihistamines, also may indicate the possibility of EIB.

Table 4. Physical Examination Reasons Cited for Recommendation for Restricted Sports Participation

Reasons for Restriction	Recommendations: Pass with Follow-up and/or Restriction (2)	Fail with Follow-up (3)	Fail (4)	Total
Decreased visual acuity	35	4	—	39
Heart murmur	16	8	—	24
Elevated blood pressure	17	3	—	20
Skin lesion/rash	15	—	—	15
Varicocele	12	1	—	13
Musculoskeletal				
Scoliosis	7	—	—	7
Knee laxity	—	1	—	1
Patellar pain	1	—	—	1
Subtotal	8	1	—	9
Ear pain/infection	7	1	—	8
Hernia	2	4	—	6
Obesity	6	—	—	6
Single testicle	4	—	—	4
Arrhythmia	—	2	—	2
Abdominal mass	1	—	—	1
Hydrocele	1	—	—	1
Paronychia	1	—	—	1
Systolic click	1	—	—	1
Thyroid enlargement	1	—	—	1
Wheezing	1	—	—	1
Total	128	24	0	152

Body Mass Index

Body mass index is the most widely used ratio to assess an individual's adiposity.[13] In our study, six students required further follow-up because they were overweight; however, none was disqualified from participation. This result supports the belief that most overweight children would benefit from physical activity but that a few may require a physician's guidance.

Elevated Systolic Blood Pressure

Although SBP was the only factor associated with denial of unrestricted participation, and isolated persistent systolic hypertension is abnormal in children,[7] both systolic and diastolic blood pressure measurements should be considered in the PPE. The report of the Second Task Force on Blood Pressure Control in Children defines hypertension as average systolic and/or diastolic blood pressures ≥95th percentile for age and sex with measure-

Table 5. Results of Univariate Analysis

History Variable	*P* Value	Physical Variable	*P* Value
Sex	.308	Height	.775
Grade in school	.484	Weight	.033
Age	.664	Body mass index	.002
History of chronic illness	.021	Systolic blood pressure	<.001
History of hospitalizations	.104	Diastolic blood pressure	.083
History of surgery	.011	Head examination	<.001
History of injury	.046	Visual acuity	<.001
Medications	.303	Eyes	<.001
Organ missing	.477	Ears	<.001
History of heat stroke	.977	Oropharynx	.399
Dizziness with exercise	<.001	Chest	<.001
History of concussion	.944	Heart	<.001
Vision problems	.048	Heart murmur	<.001
Difficulty hearing	<.001	Abdominal examination	.999
Dental problems/braces	.240	Enlarged liver	.999
History of asthma	<.001	Enlarged spleen	.952
History of cough	.085	Hernia	<.001
Heart problems	.061	Genitalia	<.001
Abdominal problems	.999	Varicocele	<.001
History of hernia/genital problems	.004	Skin	<.001
History of skin problems	.933	Musculoskeletal examination	<.001
History musculoskeletal injury	<.001		
Allergy	.999		

ments obtained on at least three occasions.[7] There is no evidence that aerobic exercise in hypertensive children imposes a significant risk. Since exercise training is of potential benefit, the task force recommends that participation be limited only in individuals with severe hypertension who have not yet had adequate response to therapy.[7] Severe hypertension is defined as average systolic and/or diastolic blood pressures ≥99th percentile for age and sex.[7] Since there is little information documenting the safety of static forms of exercise such as weightlifting in hypertensive children, only aerobic exercise is currently endorsed.[7]

Table 6. PPE Items Accounting for Most Recommendations for Denied Participation in the Final Statistical Model

Variable	Odds Ratio	95% CI	*P* Value
Dizziness with exercise	2.81	1.78–4.43	<.001
History of asthma	3.58	2.38–5.38	<.001
Body mass index	0.60	0.480–0.762	<.001
Systolic blood pressure	0.92	0.883–0.960	<.001
Visual acuity	53.03	31.69–88.77	<.001
Heart murmur	12.11	7.47–19.64	<.001
Musculoskeletal examination	51.10	28.07–93.02	<.001
Systolic blood pressure by body mass index	1.00	1.00–1.01	<.001
Constant	—	—	.008

NOTE: Specificity = 97.7%; sensitivity = 44.9%; overall correct classification = 89.3%; positive predictive value = 78.6%; negative predictive value = 90.4%.
CI denotes confidence interval.

Blood pressure elevations discovered during the PPE have been shown to correlate with persistently elevated blood pressure.[14] Therefore, the PPE may effectively screen for hypertension in this population. Our study indicates that most physicians consider this an important indicator.

Visual Acuity

Current recommendations state that vision should be corrected to better than 20/50 for safe participation, particularly in collision or contact sports.[1] Unfortunately, there are few objective data to support this recommendation.

Nonetheless, many believe that grossly intact vision is important for safe participation.

Heart Murmur

Innocent or functional heart murmurs are common in children and adolescents. Differentiating innocent murmurs from those with potentially serious consequences, such as hypertrophic cardiomyopathy, is the main purpose of cardiac auscultation in the PPE. Unfortunately, many persons with potentially fatal cardiac problems may have no physical signs and appear generally healthy.[15] In our study, a heart murmur was one of the most frequent physical examination findings requiring physician follow-up. Because of the potentially fatal consequences of hypertrophic cardiomyopathy, most physicians consider the evaluation of heart murmurs, particularly new murmurs, to be very important in screening athletes prior to participation.[1,7,16]

Musculoskeletal Examination

The musculoskeletal examination often produces the highest yield of abnormal findings in the PPE.[17–19] Traditionally, the examination has employed a screening format with attention to areas of previous injury, in addition to a more thorough evaluation of the ankles and knees. A history of a musculoskeletal injury was one of the most frequent abnormal responses in the PPE (Table 2) and was cited as a reason for restriction in 83 persons. This accounted for the largest portion of restrictions (21%) in the evaluation. A thorough musculoskeletal evaluation should be a prime focus in the PPE.

Interaction Term

The relationship between blood pressure and obesity is well known, though not as well described in children as in adults.[20] The interaction between SBP and BMI was found to be significant ($P<.001$) in our logistic modeling.

Variables not appearing in Table 6 either were not used to determine disposition in our population or occurred so rarely that they did not achieve statistical significance. Some items, such as Tanner staging and menstrual history, were not a part of our original history-taking and physical examination, and therefore were not included.

Although the sensitivity of the model is not optimal, it represents an improvement over the traditional history and physical examination. In the context of the preparticipation screening, a "traditional" history and physical examination does not perform as well as a directed PPE in predicting disposition. These results have led the authors to develop a new Preparticipation Physical Evaluation form (Appendix) with the hope that it will be more efficient than the traditional history and physical examination. The new PPE form is similar to that endorsed in the Preparticipation Physical Evaluation monograph,[1] the result of a joint committee consisting of representatives from the American Academy of Family Physicians, American Academy of Pediatrics, American Medical Society for Sports Medicine, American Orthopedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine.

While important areas of the history and physical examination were identified in this study, some results were more negative than expected. Several factors may account for this. Since the study relies on participants' self-report, omissions secondary to poor recall undoubtedly occurred. Furthermore, the examining physicians were not the primary care providers for many of the athletes, and some, ie, interns, lacked significant clinical experience. Finally, the results obtained from our study population may not apply to other populations.

There has been debate about whether the single- or multiple-examiner evaluation method is most effective. Some authors believe that the multiple-examiner method provides a higher yield of abnormal findings.[21] The advantage of the single-examiner method, as practiced by many physicians in the community, is that it allows greater physician-patient interaction.

The results of this study raise several important questions. Are significant variables being omitted from the PPE? What variables should be included in a standard screening preparticipation evaluation? What is the predictive value of these variables? How effective is the PPE in identifying athletes at risk for injury?

For years, the PPE has consisted of several factors believed to be important in identifying individuals at risk for injury during athletic participation. Unfortunately, these beliefs have not been confirmed by objective research. No study has prospectively identified the most predictive screening variables or combination of variables. Furthermore, researchers have not shown that outcomes are improved in those who have "passed" sports physical examinations. In fact, little is known about that population. These knowledge gaps complicate the debate over the form and content of the PPE.

Clearly, further research is needed to determine the effectiveness of the PPE in identifying athletes at risk of injury and to describe the content of the examination that most efficiently accomplishes this goal. Directed PPE models may be more cost-effective and increase the clinicians' efficiency, thereby freeing more time to address other important issues in this age group. This investiga-

tion indicates that a few key components appear related to determining eligibility for participation in organized sports. Our model may serve as a template for future study.

Acknowledgments

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Appendix: Sports Preparticipation Evaluation Form Developed As an Alternative to the Traditional Evaluation Instrument

PREPARTICIPATION PHYSICAL EVALUATION

NAME:_____ MALE / FEMALE (circle one)

AGE:_____GRADE:_____

DATE OF BIRTH:_____

ADDRESS:_____

_____

PHONE:_____

Circle the sports you play:

Baseball	Basketball
Cheerleading	Cross-country
Field Hockey	Football
Softball	Track
Volleyball	Wrestling

Other:_____

Instructions: Please review all of the questions below and answer them as truthfully as possible. It is important to include all pertinent information. Parents or guardians must sign below.

Current Medications: _____

	Yes	No	Explain
1. Has anyone in your family died suddenly before the age of 50?	____	____	
2. Have you ever passed out or felt dizzy during exercise?	____	____	
3. Do you have asthma or allergies?	____	____	
4. Have you ever broken a bone, worn a cast, or injured a joint?(such as an ankle or knee)	____	____	
5. Have you ever been knocked out (concussion)?	____	____	
6. Do you have a chronic illness or see a doctor regularly?	____	____	
7. Do you have only one of any normally paired organ? (such as eyes, kidneys, etc.)	____	____	

For Women Only:

8. How old were you when you had your first period? _____

9. Do you have regular periods? ____ ____

I have reviewed the above questions with my son or daughter and I give permission for my child to undergo the Preparticipation Physical Evaluation and to participate in sports.

Signature of Parent or Guardian:_____ Date:_____

(over)

PHYSICAL EXAMINATION

Physicians: Please complete all the information below.

Height :_____
Weight :_____
BP:_____/_____

Vision: (R) 20/_____
(L) 20/_____
(B) 20/_____
Corrected Y / N (circle one)

BP Reference Range:
10-12 y/o, >125/80
13-15 y/o, >135/85
16-18 y/o, >140/90

Vision Reference Range: Is corrected or uncorrected vision better than 20/50 with both eyes?

Cardiopulmonary Examination:	Normal	Abnormal	Explain
Lungs	____	____	
Pulses	____	____	
Heart	____	____	

Musculoskeletal Screening:		
Neck	____	____
Shoulder	____	____
Elbow	____	____
Wrist	____	____
Hand	____	____
Back	____	____
Knee	____	____
Ankle	____	____
Foot	____	____

Tanner Stage: (Optional) 1 2 3 4 5

Other: (Physical examination pertinent to historical information)

Recommendation:

___ 1. Pass

___ 2. Pass with restrictions: _____

___ 3. Deferred until: _____

___ 4. Failed, Reason: _____

Physician Signature:_____ Date:_____