A prospective study of preparticipation sports examinations of 2670 young athletes: method and results

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More than 17 million young people in this country participate in organized sports. Seven million high school students engage in interscholastic competition.[1] Although such widespread athletic participation is beneficial to the physical well-being of developing adolescents, there is an accompanying risk of injury and death.[2, 3] In an attempt to reduce this risk, all states have enacted laws requiring students to have regular preparticipation physical examinations.[4] Sports-oriented medical examinations can decrease morbidity and mortality by identifying risk factors before participation. Unfortunately, school sports physicals are frequently considered ineffective, inconvenient, or too costly, and there is little baseline data available from these examinations.[5, 6] The purpose of this study was to establish baseline examination data from a large group of young athletes studied prospectively and to evaluate the screening effectiveness, convenience, and cost of this comprehensive approach.

Patients and methods

The subjects of this study were students from suburban Cleveland area high schools aspiring to participate in interscholastic and intramural sports during the 1980–1981 playing season. The students were examined only from the standpoint of screening for safe sports participation, i.e., for the detec-

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tion of high-risk medical contraindications to participation and the detection of lower-risk conditions that would benefit from further evaluation and rehabilitation. We emphasized that these examinations were not a substitute for regular medical care. Explicit treatment information was not provided to students with sports risk factors, but follow-up evaluation with either a coach, school nurse, or family doctor was required.

Twelve orthopaedic surgery residents at or above the PGY-2 level performed more than 90% of the examinations. Three internal medicine residents at the PGY-3 level who were familiar with musculoskeletal diagnosis performed the remaining examinations. The screening physicians studied detailed instructions regarding organization, screening criteria, evaluation forms, and the physical examination algorithm before performing any examinations.

Organization

These examinations were performed at participating schools at least six weeks in advance of the playing season. Each school received advance instructions for arranging a four-station group examination work area and instructions for volunteers to help the physicians. We provided only physician(s). A team of one physician and four volunteers screened 50 students or less per session. Availability of physicians and volunteers influenced the number of students that could be scheduled. The athletes hand-carried their health forms through the four stations in the following order: (1) registration, where basic information and medical history were recorded, (2) vital signs and vision (gross vision only), (3) laboratory, where a dipstick urinalysis was performed (paper cups were distributed at the registration station) and (4) review of medical history and physical examination (*Fig. 1*). Volunteers managed the first three stations, one volunteer serving as a secretary to the physician. A service fee of three dollars per student was billed directly to the school.

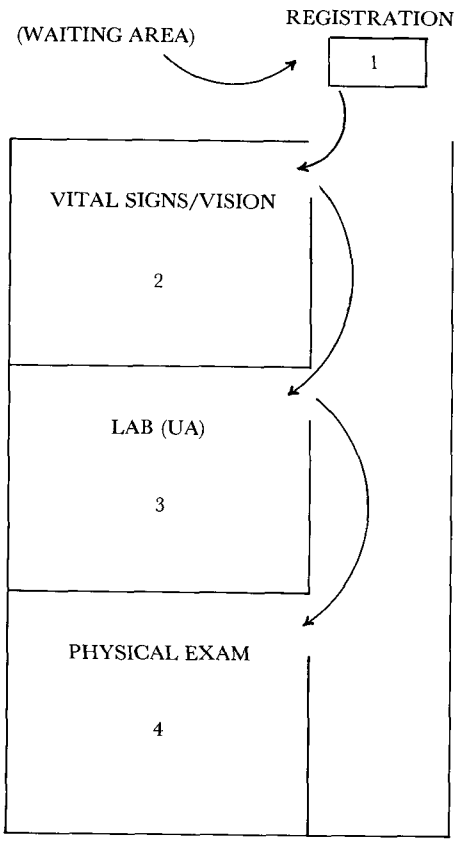

Fig. 1. Diagram of examination work area set-up at the schools (sent to schools in advance). (*UA* = urinalysis.)

Screening criteria

The screening criteria in *Medical Evaluation of the Athlete, A Guide*[7] were used for this study. These criteria are nationally recognized guidelines, which broadly outline contraindications to sports participation and categorize sports into collision, contact, and noncontact types, which were explained to

the schools in advance. A multispecialty physician committee from this institution reviewed and approved these criteria before they were adopted in this study. Some screening decisions had to be based on the individual judgment of the examining physician.

Evaluation forms

A one-page, triplicate sports history and examination form was developed for use in this study in addition to the state athletic card. It featured a directed history and standard examination format consistent with the screening criteria. The completed form indicates findings of the examination, directs the student to any needed follow-up, and specifies sports clearance. The examining physician had three clearance options: clearance *A* permitted unrestricted participation; *B* permitted participation with the stipulation that further evaluation and rehabilitation of a low-risk problem would be completed before competing; *C*, deferred clearance because of detection of a high-risk medical contraindication to participation. Combinations of clearances were possible in an individual depending upon the findings and desired sports participation. The screening physicians did not sign the state athletic cards of students with *C* clearances. The examination results of all students having a major or minor sports risk factor were reviewed with school officials (coaches) at the completion of each screening session. The students, school, and screening physicians each received a copy of the special sports form with the findings, need for follow-up, and sport clearance.

Examination algorithm

A standard physical examination was developed for this study that both fulfilled the screening criteria and was time-efficient. The following ten commands were directed to each youth after review of the medical history:

Move your head up and down . . . now in a large circle
Hands behind your head
Hands behind your back
Slowly bend forward and touch your toes
Hop up and down on one foot . . . now the other
Squat down like a baseball catcher . . . walk toward me like a duck
Stand up so I can listen to your heart
Turn around so I can listen to your lungs
Lie down so I can check your abdomen
(For males) Pull your shorts down so I can check you for hernia and undescended testicle

This checklist identifies sports-related physical findings including those of the spine, skin, and genitalia. The musculoskeletal portion of the examination was performed first so that respiration and heart rate would be accentuated for auscultation of the chest later. Commands were given according to the order on the examination sheet to facilitate recording. Additional examination was performed if necessary.

Results

The study group consisted of 2670 student athletes. The average age was 15 years (range, 9–22 years); two thirds were male. Examinations were performed for all types of sports, football being the most common. Of the total, 2382 students (89.2%) had no sports-related risk factors. The remaining 10.8% had sports-related risk factors and were divided into two groups (*Fig. 2*).

A high-risk group of 31 students (1.2% of the total) had medical contraindica-

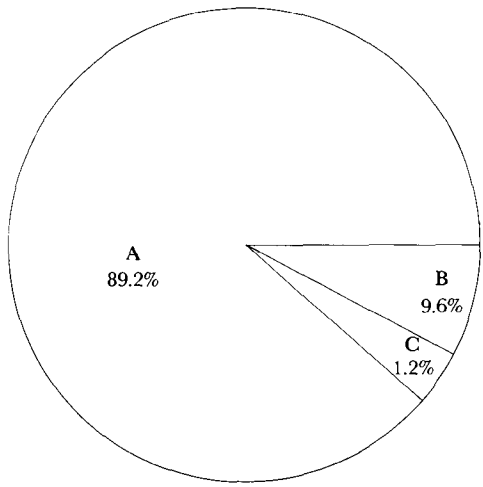

Fig. 2. The screening results among 2670 student athletes included 89.2% who received clearance *A* permitting unrestricted participation. Another 9.6% received clearance *B*, which permitted participation after they had completed further evaluation of a low-risk problem. Medical contraindications to sports participation, clearance *C*, were found in 1.2% (based on AMA sports screening guidelines).

tions to sports participation and were referred to family doctors or consultants of choice for further evaluation. Significant heart murmurs were the most common findings that placed students in this high-risk group. Follow-up inquiry revealed that most of these students were eventually cleared after cardiac examination by their physicians. One student, who had planned to run track, was found to have previously undiagnosed severe mitral insufficiency, which required surgical intervention. Other common findings that placed students in this group were absence of a paired organ and disabling musculoskeletal problems, which jeopardized clearance for collision and contact sports.

Another group of 257 students (9.6% of the total) had lower risk sports-related findings that might have benefitted from further evaluation and rehabilitation prior to participation. Musculoskeletal problems were the most common findings in this group including tight hamstring muscles, patellofemoral syndrome, and ligamentous ankle and knee instabilities. These students were usually required to contact their coach for rehabilitation exercises. Students with heart murmurs considered benign by the examiner but previously undocumented were also placed in this category so that the family doctor could be informed of the finding. Students with proteinuria of 2+ or greater were also placed in this group and a repeat urinalysis by the school nurse or family doctor was required.[8]

Overall, musculoskeletal problems constituted 67% of all identified sports risk factors in this study. Cardiovascular findings were 15% of the total. Only three significant inguinal hernias were diagnosed. Three previously undiagnosed cryptorchid cases were detected. One student was found to have complete unilateral vision loss previously undocumented. In all, 288 students (10.8%) had findings of increased risk for sports participation (*Table*).

The risk-factor detection rates among

Table. Individual risk factors detected among 2670 student sports examinations (male-67%, female-33%) by sex and clearance category (one finding per student)

	Clearance *B* (low risk)		Clearance *C* (high risk)		
	♂	♀	♂	♀	Total
Musculoskeletal					
Tight hamstrings	67	17	0	0	84
Patellofemoral syndrome	5	19	1	1	26
Chronic ankle instability	11	9	0	0	20
Chronic knee instability	8	3	0	1	12
Undocumented scoliosis	3	5	0	0	8
Chronic knee pain	4	2	0	0	6
Osgood-Schlatter's disease	5	0	0	1	6
Recent fracture < 3 mo	5	0	1	0	6
Chronic low back pain	3	1	0	0	4
Postinjury spinal pain	0	1	1	1	3
Leg-length discrepancy	2	1	0	0	3
Recurrent dislocating shoulder	3	0	0	0	3
Acute ankle instability	0	0	1	1	2
Recurrent patellar subluxation	1	1	0	0	2
Other	*	*	†	†	9
Nonmusculoskeletal					
Heart murmurs	25	6	4	3	38
Proteinuria ≥ 2^+	10	10	0	0	20
Exercise-induced asthma	2	3	0	0	5
Undescended testicle	0	—	3	—	3
Inguinal hernia	2	—	1	—	3
Varicocele	3	—	0	—	3
Hypertension	1	1	0	0	2
Hematuria ≥ 2^+	2	0	0	0	2
Blood dyscrasia	1	1	0	0	2
Postinjury visual blur	1	0	1	0	2
Other	*	*	†	†	14

* One each of the following were in clearance *B*: chronic achilles tendinitis, chronic acromioclavicular pain, chronic PIP joint pain, chronic foot pain, undiagnosed leg mass (lipoma), arrythmia, cardiomegaly history, history of brachial plexus stretch (burners), anisotropia, cataract under treatment, diabetes mellitus poorly controlled, chronic rash, and history of anaphylactic reaction to bee stings.

† One each of the following were in clearance *C*: previous cervical fusion, slipped capital femoral epiphysis (new), chronic knee stiffness, acute knee instability, splenomegaly, postoperative laparotomy < 3 months, history of 3 concussions in one year, postinjury headache, postinjury vertigo, undetected visual loss one eye (complete).

screening physicians varied little and were reproducible. The school-based location was generally satisfactory. In a few cases school officials ignored the advance directions, which resulted in chaos. Volunteers and physicians rarely complained of fatigue or loss of control. The special one-page, triplicate preparticipation sports form effectively provided the examination information according to most schools and parents. The format was revised after 650 examinations for clarification of follow-up recommendations. The physical examination algorithm provided a consistent and efficient screening method. On the average, each physician screened 20 students/hr. Volunteers were coaches, school nurses, and occasionally parents.

All schools received copies of the examinations and a school official was briefed on each student found to have

a sports risk factor. We surveyed parents of approximately 5% of the total student study group at one representative school; about 75% of the parents had received copies of the examination at home. The parents we questioned particularly approved of receiving a copy of the examination, having the examinations performed at school with the coaches present, and by sports-oriented physicians who regularly deal with athletic problems. The two main complaints were occasional poor reproduction of hand-written information on the triplicate forms and late arrivals by the physicians.

Discussion

The screening methods of Nicholas,[9] Linder et al,[10] and Tennant et al[11] appeared similar to our study except that they were more complicated. These studies required ancillary medical personnel in addition to physicians. The studies by Nicholas[9] and Linder et al[10] used the same basic screening guidelines as our study.[7] Tennant et al[11] did not define or reference screening guidelines.

The types and percentage of findings requiring further evaluation in Nicholas's study[9] were consistent with our base line data computed in this study. Although the clearance percentages of Tennant et al[11] were similar to our data, they were based on very different findings. More than half of all their findings considered significant to sports participation were in the dental caries or dermatitis groups; types of examiners and medical personnel were not mentioned. The large proportion of musculoskeletal problems diagnosed in both our study and that of Nicholas[9] probably reflects an inherent diagnostic bias by these examiners, most of whom were orthopaedic surgeons. Inherent diagnostic bias was pointed out by Linder et al.[10] This underscores the importance of appropriate screening criteria and astute examiners who have a thorough knowledge of the diagnosis and treatment of sports-related problems.

Heart murmurs represented the most difficult sports clearance situation for our examiners. Shaffer and Rose[12] reported that 85% of young athletes they examined had ejection-type murmurs. Smith[13] emphasized the importance of detection of mitral insufficiency and idiopathic hypertrophic subaortic stenosis (IHSS) since these two cardiac conditions present a major mortality risk to sports participation. The directed history portion of our special sports form sought information regarding weakness or syncope and family history of cardiac-origin sudden death. One documented case of mitral insufficiency was detected by an internal medicine resident in our study. Two cases of suspected IHSS were detected by orthopaedic residents; one was proved to be IHSS. Our examiners were directed to carry out further investigation of all positive findings.

The detection rate of hypertension in our study appears low compared to results from specific blood pressure screening studies by Fixler et al[14] and Strong.[15] However, these investigators caution against the overzealous interpretation of elevated blood pressure in otherwise normal youths since few show objective stress-testing evidence for restriction of their sports participation.[16] The follow-up requirements of our study were consistent with Strong's[15] recommendations.

Although "heart and hernia" screening has been the traditional sine qua non of sports physicals, this study indicates that these risk factors make up only 15% of all sports-related findings. Undescended testicles represent a risk

factor of equal or more importance than hernias on the genitourinary examination. There were equal incidences of these conditions, three each in this series.

The only laboratory study performed in this study was dipstick urinalysis, which is considered adequate for screening purposes.[8] Our previous anecdotal experience with several thousand complete blood counts of young athletes during sports physicals indicated that this expensive test is not necessary for a screening preparticipation evaluation.

We are aware of one death, that of a student athlete we examined preseason. Autopsy reports revealed that a (silent) cerebral aneurysm had ruptured during a collision sport competition in this individual who had no history of symptoms. The presymptomatic diagnosis of this type of tragedy continues to elude us.

The minimal service fee charged in this study was used to cover the cost of the special sports form, urine dipsticks, and physician remuneration. This fee was well accepted by the schools and parents and was generally considered a very low cost for this service. We discovered in retrospect that some schools had added costs to the examination fee without informing us. We now request advance knowledge and justification for any additional fees by the schools. We also speak with school officials one day in advance to assure that they understand their role and responsibilities. The school nurse, coaches, and parents were encouraged to participate since their involvement would aid in assuring follow-up care. The charges and organization were consistent with other published recommendations[17] in addition to the reviewed studies.

The injury rate of any sports team depends upon many factors in addition to the preseason examination such as coaching decisions, conditioning, parental attitudes, player compliance, officiating, type of sport, and playing conditions. Consequently, the effectiveness of our approach to preseason injury detection and prevention was difficult to assess. Students who were identified as having medical contraindications to sports participation received immediate benefit from these evaluations. We believe our emphasis on parent and school involvement during examinations, review of results with school officials (coaches), distribution of copies of results, and required follow-up and rehabilitation created an increased awareness of the need to reduce the injury rate during the season.

Conclusion

On the basis of this study, approximately 11% of young athletes have sports risk factors identifiable during a preparticipation examination that need further evaluation prior to competition. Most of these risk factors are treatable musculoskeletal conditions requiring rehabilitation. This study indicated that between 1% and 2% of young athletes have findings considered high-risk medical contraindications to playing certain sports, with heart murmurs being the most frequent. The organization, screening criteria, special sports examination form, and examination algorithm provided a uniform and quality-oriented preparticipation examination. The approach involved the school officials and parents in the screening process and helped make the sports examinations effective, convenient, and inexpensive.

References

1. Michener JA. Sports in America. New York: Random House Inc, 1976.
2. Garrick JG, Requa RK. Injuries in high

school sports. Pediatrics 1978; **61:** 465–469.
3. DeHaven KE. Athletic injuries in adolescents. Pediatr Ann 1978; **7:** 704–714.
4. Official Handbook 1978–1979: National Federation of State High School Associations; Elgin, Illinois, The National Federation; 1978.
5. Garrick JG. Sports medicine. Pediatr Clin North Am 1977; **24:** 737–747.
6. Shaffer TE, Slager RF, Lutz EE, Turner HS, Wolfert KC. Preseason preparation; screening and conditioning. Ohio State Med J 1977; **73:** 305–318.
7. American Medical Association; Medical Evaluation of the Athlete, A Guide. Chicago: American Medical Association, 1977.
8. Ryan AJ, West CD, Shapiro FL, Swartz CD. Proteinuria in the athlete. The Physician and Sports Medicine 1978; **6:** 45.
9. Nicholas JA. Determining fitness for preparticipation in sports. Muscle and Bone 1982; **1:** 4.
10. Linder CW, DuRant RH, Seklecki RM, Strong WB. Preparticipation health screening of young athletes. Am J Sports Med 1981; **9:** 187.
11. Tennant FS, Sorenson K, Day CM. Benefits of preparticipation sports examinations. J Fam Pract 1981; **13:** 287.
12. Shaffer TE, Rose KD. Cardiac evaluation for participation in school sports. JAMA 1974; **228:** 398.
13. Smith NJ. Medical issues in sports medicine. Pediatrics in Review 1981; **2:** 229.
14. Fixler DE, Laird WP, Fitzgerald V, Stead S, Adams R. Hypertension screening in schools; results of the Dallas study. Pediatrics 1979; **63:** 32–36.
15. Strong WB. Hypertension and sports. Pediatrics 1979; **64:** 693–695.
16. Fixler DE, Laird WP, Browne R, Fitzgerald V, Wilson S, Vance R. Response of hypertensive adolescents to dynamic and isometric exercise stress. Pediatrics 1979; **64:** 579–583.
17. Walton J, Kemp E, Sittner L. Athletic physicals (a report for the South Dakota Chapter of the American Academy of Family Physicians). South Dakota J Med 1977; **30:** 19.

Date of Exam ____/____/____
School Official ____
Exam Doctor ____

Cleveland Clinic Foundation

PREPARTICIPATION SPORTS EXAM

A B C
Contact: Coach ☐
School Nurse ☐
Family Doctor ☐

THIS IS NOT A SUBSTITUTE FOR A REGULAR PHYSICAL EXAM PERFORMED BY YOUR FAMILY DOCTOR

Name: ____ **Grade** ____ **Age** ____ **Birthdate** ____/____/____
School ____ **Sport** ____ **Sex:** ____
Parents ____ **Address** ____ **Phone:** ____
Family Doctor ____ **Address** ____ **Phone:** ____

HISTORY: Answer **No** or **Yes** with *details and dates. Use reverse side if necessary.*

I. Have you ever sustained **an injury** which prevented you from playing sports for **more than one day and** have you **had** any injuries **such as** (circle): skull fracture - **brain surgery** **concussion** - knocked out, **neck pain**/injury - arm/finger **numbness, back pain**/injury - leg/toe numbness, heatstroke/fainting - exhaustion, broken bone - **fracture,** joint **dislocation** - out of place, **deep bruise** - muscle pull, ligament **sprains,** tender kneecap/shin, **trick knee** - catching/locking,

____
____

II. Do you have a history of **and/or** take medicine (specify) for any medical problems **such as** (circle): **asthma** - allergy - wheezing - short of breath, heart **murmur**/palpitation - rheumatic fever - **high blood pressure,** diabetes - high/low **sugar,** fainting - **seizure,** yellow jaundice - **hepatitis,** severe influenza/cold - **mononucleosis** - weakness, **anemia** - bruise easily - bleeding - sickle cell, loss of eyesight, hearing, testicle, kidney, etc., **hernia** - rupture - bulging, skin disease - boils - **rash,** or other?

____
____

III. Are you allergic to any medicine such as (circle) penicillin, iodine, novocaine or other?

____

IV. Any family history of medically unexplained or cardiac caused sudden death under age 50?

____

BP____/____ **P**____ **Ht**____ **Wt**____ **Gross Vision:** R____ L____ **; Pupils:** R____ L **LAB:** UA____

EXAM:

1. Upper Extr: AC jts ____
   Symm ____
   ROM ____
2. Spine: Neck ____
   Fwd Bend ____
   Curve ____
3. Lower Extr: Gait ____
   1-Hop ____
   Duck ____
   Symm ____
   ROM ____
4. Heart: ____
5. Lungs: ____
6. Skin: ____
7. Abdo: Spleen ____
   Liver ____
8. GU: Hernia ____
   Testicles ____
9. Other: ____
   ____
   ____

IMPRESSION:

☐ Satisfactory Exam
☐ Recommend further evaluation/rehabilitation regarding: ____
Contact your: School Nurse — Coach — Family Doctor

CLEARANCE:

A — Cleared for: Collision — Contact — Noncontact sports
B — Cleared for: Collision — Contact — Noncontact sports after completing eval/rehab
C — NOT cleared for: Collision — Contact — Noncontact sports due to: ____
____

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