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## Preparticipation Cardiovascular Screening for US Collegiate Student-Athletes

 *Glen C. Pfister, BS; James C. Puffer, MD; Barry J. Maron, MD*

**Context** Sudden death in young competitive athletes due to unsuspected cardiovascular disease has heightened interest in preparticipation screening.

**Objective** To assess screening practices for detecting potentially lethal cardiovascular diseases in college-aged student-athletes.

**Design, Setting, and Participants** A total of 1110 National Collegiate Athletic Association member colleges and universities were surveyed between 1995 and 1997, with 879 (79%) responding to the questionnaire.

**Main Outcome Measures** Information on the administration and scope of the preparticipation screening process was obtained from the team physician or athletic director; preparticipation screening forms were evaluated for content and compared with 12 items recommended by the 1996 American Heart Association (AHA) consensus panel screening guidelines.

**Results** Preparticipation screening was a requirement at 855 (97%) of 879 schools, was performed on campus at 713 schools (81%), and was required annually by 446 schools (51%). Team physicians were responsible for examinations at 603 (85%) of 713 schools with on-campus screening, although 135 of these schools (19%) also approved nurse practitioners and 244 schools (34%) allowed athletic trainers to perform examinations. Of the history and physical examination screening forms analyzed from 625 institutions, only 163 schools (26%) had forms that contained at least 9 of the recommended 12 AHA screening guidelines and were judged to be adequate, whereas 150 (24%) contained 4 or fewer of these parameters and were considered to be inadequate. Smaller Division III schools were more likely than larger Division I schools to have inadequate screening forms (30% vs 14%;  $P < .001$ ). Relevant items that were omitted from more than 40% of the screening forms included history of exertional chest pain, dyspnea, or fatigue; familial heart disease or premature sudden death; and physical stigmata or family history of Marfan syndrome.

**Conclusion** The preparticipation screening process used by many US colleges and universities may have limited potential to detect (or raise the suspicion of) cardiovascular abnormalities capable of causing sudden death in competitive student-athletes.

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The occurrence of unexpected sudden death in student-athletes due to unsuspected cardiovascular disease<sup>1-6</sup> is an uncommon but often highly visible event that has heightened public concern and that of the medical community.<sup>7, 8</sup> Indeed, such catastrophes have stimulated considerable interest in the role of preparticipation screening.<sup>9-12</sup> In this regard, we previously analyzed the status of screening in US high

schools and judged that process to be deficient.<sup>10</sup> Because the status of preparticipation cardiovascular screening available to student-athletes in college is unresolved, we believe it is timely to evaluate the strengths and limitations of this process.

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## METHODS

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We distributed survey questionnaires to the team physician or the athletic director or athletic trainer of the 1110 National Collegiate Athletic Association (NCAA) colleges and universities between 1995 and 1997.<sup>13</sup> In these questionnaires, we solicited detailed information regarding the administration and scope of preparticipation screening, including credentials of team physicians and examiners, and the frequency and site of evaluations.

In a similar fashion, we contacted each institution by telephone to request the most recent version of the approved history and physical examination forms currently in use for preparticipation screening of varsity student-athletes. The content of these forms represents a guide to examiners and is the basis for screening at that institution. Those portions of the screening forms that were relevant to the cardiovascular system were analyzed and items pertaining to the history and physical examination were tabulated by one of us (G.C.P.) and compared with the 12 American Heart Association (AHA) 1996 consensus panel recommendations<sup>9</sup> for preparticipation cardiovascular screening of athletes, which included the following: *family history* of (1) premature sudden death or (2) heart disease in surviving relatives; *personal history* of (3) heart murmur, (4) systemic hypertension, (5) excessive fatigue, (6) exertional syncope, (7) exertional chest pain, or (8) excessive exertional shortness of breath; *physical examination* for (9) heart murmur, (10) femoral pulses, or (11) stigmata of Marfan syndrome; and (12) blood pressure measurement. Proportions were compared with the  $\chi^2$  test.

## RESULTS

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## Characteristics of the Screening Process

Of the 1110 NCAA institutions initially surveyed, 879 (79%) returned the questionnaire including 286 Division I (schools with larger undergraduate enrollments that provide athletic scholarships), 256 Division II (institutions generally intermediate with respect to enrollment and scholarships), and 337 Division III (schools with the smallest enrollments that do not offer athletic scholarships.) A total of 855 (97%) of the 879 schools indicated that formal screening with a personal family history and physical examination was an absolute requirement prior to participation in varsity intercollegiate sports. Most institutions (713/879 [81%]) performed screening examinations in a college health care facility on campus, while the remainder (164/879 [19%]) occurred at off-campus sites administered by nonuniversity health care personnel, with the athlete often having sole discretion for identifying the examining physician.

A designated team physician(s) was usually responsible for performing the evaluations at 603 (85%) of the 713 schools with screening on-campus, either alone or in association with nurse practitioners (n = 135) or athletic trainers (n = 244). Most of the team physicians specialized in orthopedic surgery (n = 451), while the others were most commonly in family practice (n = 348), internal medicine (n = 149), or pediatrics (n = 32). Physicians with formal cardiovascular training conducted examinations in only 33 of the institutions (5%).

Preparticipation screening evaluations were required each year by 446 (51%) of 879 schools, whereas 433 schools (49%) required a screening evaluation only on college entry. Only 58 schools (7%) routinely performed noninvasive testing (either 12-lead or exercise electrocardiograms, chest x-ray, or echocardiogram).

## Preparticipation Screening Forms

The most recent versions of the screening history and physical examination forms were obtained from 625 institutions. Of these, 205 (33%) were from NCAA Division I schools, 176 (28%) were from Division II schools, and 244 (39%) were from Division III schools.

The content of the history and physical screening forms pertinent to the cardiovascular system are shown in [Table 1](#). Certain clinically relevant AHA-recommended items were included in only 9% to 52% of these forms: family history of Marfan syndrome, excessive fatigue, prior limitations placed on sports participation, excessive exertional shortness of breath, and exertional chest pain.

Approved physical examination forms also demonstrated important omissions. For example, examination of the femoral pulses (ie, for detection of coarctation of the aorta) and recognition of Marfan stigmata were each included in only 2% of the forms.

Forms arbitrarily regarded as adequate by containing at least 9 of the 12 AHA-recommended items were present for 163 schools (26%),

  
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including 10 institutions with 11 or 12 items ([Figure 1](#)). In contrast, forms arbitrarily judged to be inadequate with 4 or less AHA recommendations came from 150 schools (24%), including 46 with only 0 to 2 items. The remaining 312 schools (50%) used forms that were intermediate by virtue of addressing 5 to 8 AHA recommendations ([Figure 1](#)). Of note, inadequate forms were more frequent in NCAA Division II and Division III schools (49 [28%] and 72 [30%], respectively) and less common (29 [14%]) in Division I ( $P < .001$ ).

## COMMENT

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Sudden death due to cardiovascular disease in trained athletes is most common in high school and college-aged participants.<sup>1-7</sup> High-intensity physical activity may act as a trigger to increase the risk of sudden death in predisposed athletes with underlying cardiovascular disease.<sup>1</sup> These observations have raised awareness of preparticipation

screening in the lay public and physician community<sup>9-12</sup> as a vehicle for detecting cardiovascular abnormalities responsible for these catastrophes, and as a stimulus for withdrawal of selected athletes from competition to reduce risk.<sup>14</sup>

We previously assessed the preparticipation cardiovascular screening process in US high schools by analyzing approved history and physical examination forms as well as designated examiners in each state.<sup>10</sup> In that study, 40% of states either had no screening requirement, no approved examination forms, or forms that were judged inadequate with respect to consensus panel recommendations.<sup>9</sup>

With these observations as a premise, we believed that it was timely to analyze in a similar fashion preparticipation screening in US colleges and universities. We considered the history and physical forms developed by these institutions to constitute the designated guidelines for examiners and thereby represent their specific objectives of cardiovascular screening.

This study shows that, similar to high school athletes, collegiate student-athletes may be exposed to a flawed preparticipation cardiovascular screening process that reduces the reasonable expectation of detecting pertinent cardiovascular abnormalities in some athletes. When AHA consensus panel recommendations<sup>9</sup> were used as the "gold standard" for comparison, about 25% of the NCAA schools were considered to have inadequate screening forms. Indeed, the forms of a substantial number of institutions omitted items that are crucial to the cardiovascular evaluation, such as exertional dyspnea and chest pain, prior limitation from competitive sports, excessive fatigue, or family history of Marfan syndrome.

  
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Of the colleges surveyed, 85% used a designated team physician(s) as the approved examiner to perform preparticipation evaluations. Nevertheless, the majority (75%) of these team physicians were orthopedic surgeons, clinicians who are often not as familiar with cardiovascular evaluations as are primary care physicians or trained cardiovascular subspecialists. A substantial proportion of institutions surveyed also permit nurse practitioners and athletic trainers to perform preparticipation examinations, alone or in association with physicians; these observations emphasize the importance of establishing minimum standards of expertise for nonphysician (and physician) clinicians performing screening examinations.

Nevertheless, when performed optimally, preparticipation screening with customary history and physical examination<sup>9</sup> has the potential to identify cardiovascular abnormalities such as hypertrophic cardiomyopathy, Marfan syndrome, some cases of arrhythmogenic right ventricular dysplasia, dilated cardiomyopathy, and atherosclerotic coronary artery disease.<sup>15, 16</sup> Marfan syndrome and systemic hypertension are identifiable from physical examination,<sup>16, 17</sup> as are diseases with a systolic heart murmur (eg, aortic valvular stenosis and obstructive hypertrophic cardiomyopathy).<sup>9, 18</sup>

Schools in NCAA Division I, which generally have the largest intercollegiate sports programs, award athletic scholarships, and place a priority on athletic achievement, were more likely to have comprehensive screening evaluations than Division II and III schools, which have generally smaller enrollments and intercollegiate sports programs and are permitted no or limited numbers of athletic scholarships.

While it is customary for preparticipation screening in US colleges and universities to consist of only standard history and physical examination, noninvasive tests such as the 12-lead electrocardiogram and echocardiogram could increase the likelihood of identifying important cardiovascular abnormalities, particularly hypertrophic cardiomyopathy.<sup>18</sup> However, such screening tests are costly and impractical for most schools, particularly when considering the infrequency of sudden cardiac death for student-athletes (about 1 per 200,000 per academic year).<sup>2, 19</sup>

Our observations should represent an impetus for change and improvement in the preparticipation cardiovascular screening process for college-aged athletes. We expect that improved screening would ultimately increase the potential for more frequent detection of certain cardiovascular lesions associated with sudden death in collegiate athletes.

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