

# Incidence and Etiology of Sudden Cardiac Arrest and Death in High School Athletes in the United States

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## Abstract

**Objective:** To determine the incidence and etiology of sudden cardiac arrest and death (SCA/D) in US high school athletes.

**Patients and Methods:** A prospective media database of SCA/D was queried for cases aged 14 to 18 years from 7 states over 6 school years (September 1, 2007, to August 30, 2013). Event details were investigated to determine participation on a high school athletic team, sex, sport, and occurrence during school-sponsored activity or exertion. National sports participation numbers were used and a conversion factor was applied to account for multisport athletes. Autopsy reports were reviewed and cause of death was adjudicated by an expert panel.

**Results:** A total of 16,390,409 million athlete-seasons representing 6,974,640 athlete-years (AY) were examined, encompassing 36% of the total US high school athlete population. A total of 104 cases of SCA/D were identified (35 SCA with survival and 69 sudden cardiac deaths [SCDs]). The rate of SCD was 1:101,082 AY and of SCA/D 1:67,064 AY. Eighty-eight percent (92) of events occurred in male athletes. The rate of SCA/D in male athletes was 1:44,832 AY and in female athletes 1:237,510 AY (incidence rate ratio, 5.3; 95% CI, 2.9-10.6;  $P < .001$ ). Men's basketball was the highest risk sport with an SCA/D incidence of 1:37,087 AY followed by men's football at 1:86,494 AY. Men's basketball and football athletes accounted for 57% (39) of deaths. Eighty percent of SCDs (55 of 69) were exertional and 55% (38 of 69) occurred while playing for a school-sponsored team. Autopsy reports were obtained in 73% (50) of cases. The most common findings of autopsy were idiopathic left ventricular hypertrophy or possible cardiomyopathy (13 of 50 [26%]), autopsy-negative sudden unexplained death (9 of 50 [18%]), hypertrophic cardiomyopathy (7 of 50 [14%]), and myocarditis (7 of 50 [14%]).

**Conclusion:** The rate of SCA/D in male high school athletes was 1:44,832 AY, with almost half due to possible or confirmed cardiomyopathy disease. It is likely that many cases were not identified because of reliance on media reports, and these numbers represent a minimum estimate.

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Sudden cardiac arrest (SCA) and sudden cardiac death (SCD) in a young athlete are tragic, affecting the athlete, family, and broader community. Some characterize SCD in athletes as a rare but highly publicized occurrence, whereas others argue that SCD occurs more frequently.<sup>1,2</sup> Current assessments of the incidence of SCD in college athletes place the risk between 1 death in 43,000 athlete-years (1:43,000 AY) and 1:67,000 AY, with a higher risk reported in male athletes

(1:38,000 AY), African Americans (1:21,000 AY), and male basketball athletes (1:9000 AY).<sup>1,3,4</sup>

In contrast, estimates of SCD in high school athletes vary considerably, with reports<sup>5-11</sup> ranging from 1:46,000 to 1:919,000 AY (Table 1). It has been hypothesized that sudden cardiac arrest/death (SCA/D) is more common in college than in high school athletes; however, differences may also be attributed to study methodology such as the

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**TABLE 1. Incidence Studies of SCA and SCD in US High School Athletes<sup>a</sup>**

Reference, year	Study design; population	Case identification	Denominator	Exertional SCD or all SCDs?	SCD or all SCA/Ds?	Study years	Age range (y); no. of cases	Annual incidence
Van Camp et al, <sup>7</sup> 1995	Retrospective cohort; high school and college athletes	National Center for Catastrophic Sports Injury Research and media reports	Data from the NFHS <sup>b</sup>	Exertional	SCD	1983-1993	13-24; N=160	High school Overall 1:213,000 Male 1:152,000 Female 1:861,000
Maron et al, <sup>11</sup> 1998	Retrospective cohort; Minnesota high school athletes	Catastrophic insurance claims	Minnesota State High School League statistics <sup>c</sup>	Exertional only during the school-sponsored sport	SCD	1985-1997	16-17; N=3	High school Overall 1:217,000 Male 1:129,000 Female 0
Drezner et al, <sup>6</sup> 2009	Cross-sectional survey; high school athletes	Survey of 1710 high schools with AEDs	Reported number of student athletes	All cases occurring on the school campus	SCA + SCD	2006-2007	14-17; N=14	High school 1:23,000 (SCA + SCD) 1:64,000 (SCD)
Maron et al, <sup>8</sup> 2013	Retrospective cohort; Minnesota high school athletes	US National Registry of Sudden Death in Athletes	Minnesota State High School League statistics <sup>c</sup>	All	SCD	1986-2011	12-18; N=13	High school Overall 1:150,000 Male 1:83,000 Female 0
Roberts and Stovitz, <sup>5</sup> 2013	Retrospective cohort; Minnesota high school athletes	Catastrophic insurance claims	Minnesota State High School League statistics <sup>d</sup>	Exertional only during the school-sponsored sport	SCD	1993-2012	12-19; N=4	High school 1:417,000 (1993-2012) 1:919,000 (2003-2012) Female 0
Toresdahl et al, <sup>9</sup> 2014	Prospective observational; high school athletes	2149 high schools monitored for SCA events on the school campus	Reported number of students and student-athletes	All cases occurring on the school campus	SCA + SCD	2009-2011	14-18; N=44	Student-athlete Overall 1:88,000 Male 1:58,000 Female 1:323,000
Drezner et al, <sup>10</sup> 2014	Retrospective cohort; Minnesota high school athletes	Public media reports	Minnesota State High School League statistics <sup>e</sup>	All	SCA + SCD	2003-2012	14-18; N=13	High school Overall 1:71,000 Female 0 Male, basketball 1:21,000

<sup>a</sup>AED = automated external defibrillator; CA = sudden cardiac arrest; NFHS = National Federation of State High School Associations; SCD = sudden cardiac death.

<sup>b</sup>Estimated using a conversion factor of 1.9 to account for multisport athletes "based on discussions with representatives from the national organizations"<sup>7,p642</sup>

<sup>c</sup>Estimated using a conversion factor of 2.3 to account for multisport athletes.

<sup>d</sup>Sum of unduplicated athletes from 1993-1994 through 2011-2012 school-years.

<sup>e</sup>Sum of unduplicated athletes from 2003-2004 through 2011-2012 school-years.

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