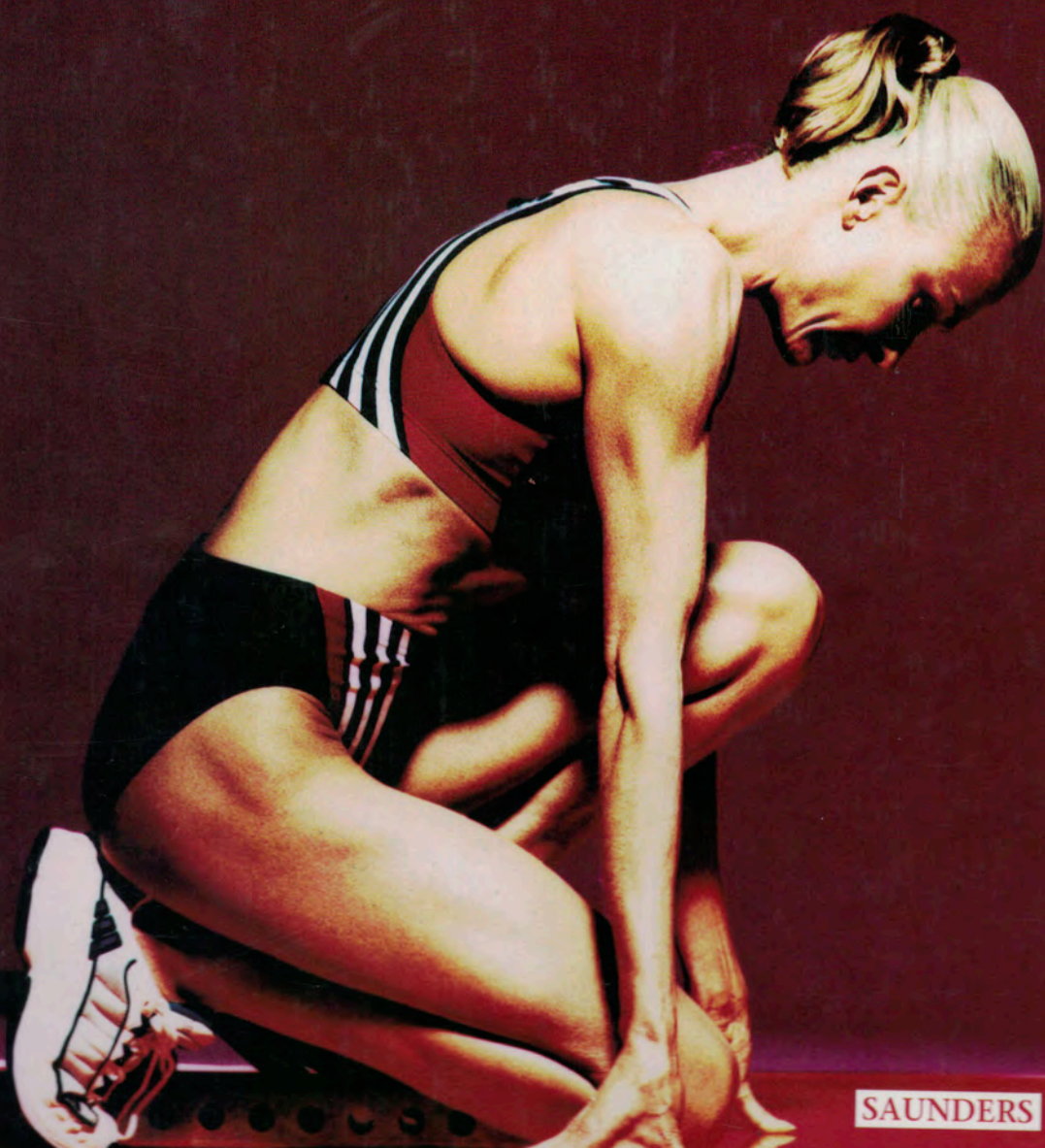


The Female Athlete

Mary Lloyd Ireland and Aurelia Nattiv



SAUNDERS

Section 2 HIGH SCHOOL AND COLLEGIATE

Mary Lloyd Ireland, M.D.

Participation in high school sports continues to increase. Growth in female sports exceeds that in male sports. According to the National Federation of State High School Associations, for the 1999–2000 season, 3,861,749 males and 2,675,874 females participated in high school athletics, and coed participation totaled 19,289 (Table 2-3). The top 10 high school sports for males and females are listed in Table 2-4. For sports in which both males and females compete, the numbers of participants are as follows: basketball, 541,130 males and 451,600 females; track, 480,791 males and 405,305 females; and soccer, 330,044 males and 270,273 females. The athletics participation survey summary shows that the numbers have consistently grown since recording began in 1971 (Table 2-5). The number of boys participating in 1971 was 3,666,917 and the number of girls, 294,015. The most recent (1999–2000) survey of participants found 3,861,749 boys and 2,675,874 girls.

Growth also may be expressed as a ratio; in 1970, the male:female ratio was 12.5:1, in

Table 2-3. Total Participation by High School Athletes, 1999–2000

MALES	3,861,749	(59%)
FEMALES	2,675,874	(41%)
COED	19,289 ^a	
	6,537,623	

^aCombined sports.

Data compiled by the National Federation of State High School Associations.

Table 2-5. National Federation of State High School Associations 1999–2000 Athletics Participation Summary Survey Totals

YEAR	BOY PARTICIPANTS	GIRL PARTICIPANTS
1971	3,666,917	294,015
1972–73	3,770,621	817,073
1973–74	4,070,125	1,300,169
1975–76	4,109,021	1,645,039
1977–78	4,367,442	2,083,040
1978–79	3,709,512	1,854,400
1979–80	3,517,829	1,750,264
1980–81	3,503,124	1,853,189
1981–82	3,409,081	1,810,671
1982–83	3,355,558	1,779,972
1983–84	3,303,599	1,747,346
1984–85	3,354,284	1,157,884
1985–86	3,344,215	1,807,121
1986–87	3,354,082	1,836,356
1987–88	3,425,777	1,849,684
1988–89	3,416,844	1,839,352
1989–90	3,398,192	1,858,659
1990–91	3,406,355	1,892,316
1991–92	3,429,853	1,940,801
1992–93	3,416,389	1,997,489
1993–94	3,472,967	2,130,315
1994–95	3,536,359	2,240,461
1995–96	3,634,052	2,367,936
1996–97	3,706,225	2,474,043
1997–98	3,763,120	2,570,333
1998–99	3,832,352	2,652,726
99–2000	3,861,749 ^a	2,675,874 ^a

^aTotal does not include a portion of 19,289 participants in combined sports.

1985–1986, 1.9:1, and in 1999–2000, 1.4:1 (Fig. 2-1). Further information regarding a particular state is available from the National Federation of State High School Associations (NFHS, PO Box 20626, Kansas City, Mo 64195; www.nfhs.org). Summaries of athletic participa-

Table 2-4. Top 10 High School Sports, 1998–1999

MALES		FEMALES	
Football	1,002,734	Basketball	451,600
Basketball	541,130	Track & field	405,305
Track & field	480,791	Volleyball	382,755
Baseball	451,701	Fast-pitch softball	343,001
Soccer	330,044	Soccer	270,273
Wrestling	239,105	Tennis	159,740
Cross-country	183,139	Cross-country	154,021
Golf	165,857	Swimming & diving	138,475
Tennis	139,507	Competitive spirit squads	64,319
Swimming & diving	86,640	Field hockey	58,372
	3,620,648 (94%)		2,427,861 (91%)

Data compiled by the National Federation of State High School Associations.

Table 2-6. 1999–2000 Collegiate Participants (NCAA) by Division, All Sports

MALES		FEMALES	
Division I	85,812	Division I	62,802
Division II	45,288	Division II	29,519
Division III	79,889	Division III	57,865
TOTAL	210,989	TOTAL	150,186

Total numbers include "emerging sports," ie, rowing and squash for men and ice hockey, squash, synchronized, swimming, and water polo for women.

tion by state and numbers of schools and participants for each sport are available from the

National Collegiate Athletic Association (NCAA, PO Box 6222, Indianapolis, Ind 46207; www.ncaa.org). The number of athletes in each state is also available from the NCAA. Information regarding a particular state can also be obtained through the state high school athletic association.

At the collegiate level, the NCAA keeps statistics on the number of competitors in each of 3 divisions. In 1999–2000, the total numbers of participants for all sports were 210,989 males and 150,186 females (Table 2-6).¹⁷ Figure 2-2 presents graphically the growth of participation by males and females since 1989. One can see from this graph that, excluding male partici-

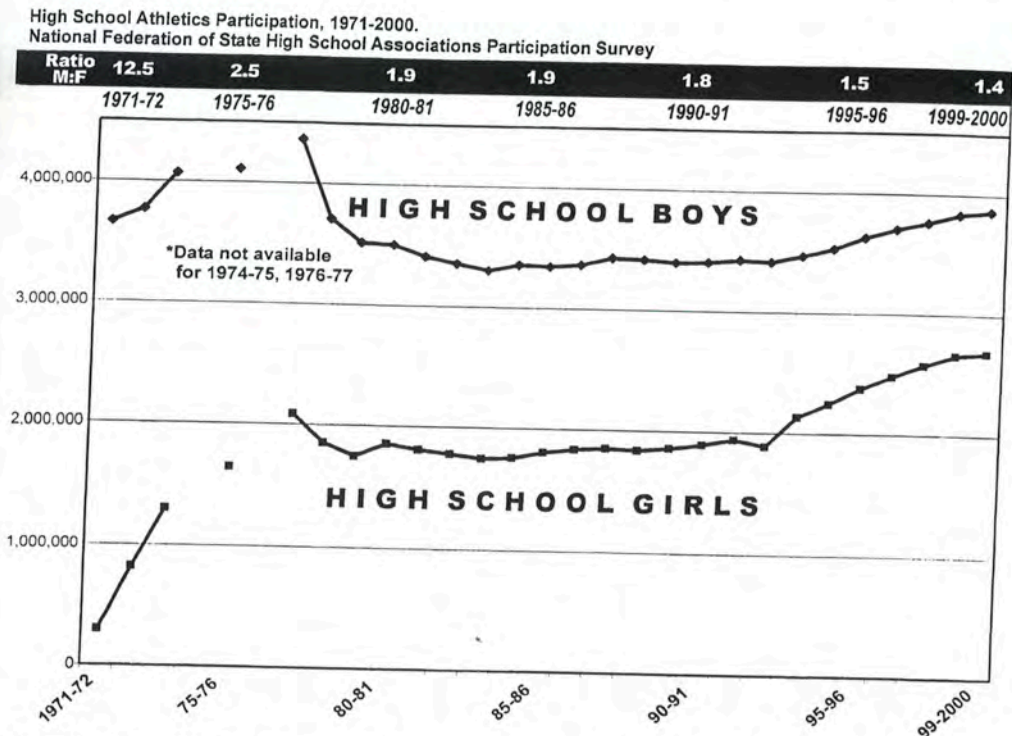


Figure 2-1. High school athletic participation, 1971–2000. (From the National Federation of State High School Associations Participation Survey. Kansas City, Mo.)

men.^{9,12} The decrease in this ratio may indicate changes in the cadet selection pool, improved monitoring of prestress fracture injuries with an open door policy of early intervention, and perhaps better training techniques.

Since 1976 women have made a positive impact on the Corp of Cadets in the United States Military Academy at West Point by being pioneers, athletes, scholars, and leaders. There are well-recognized physiologic differences in age-matched men and women.^{2,4-6,10,11} Experience has demonstrated that women can be successful in a career in the active military. More and more women are participating in rigorous physical activities during childhood and adolescence. This increased activity level is reflected in the improved fitness of female cadet candidates entering our military academies.^{1-3,8,13} During the course of training at West Point women respond to increased physical demands and demonstrate a lower incidence of overuse injuries.

Acknowledgments

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Section 2 HIGH SCHOOL AND COLLEGIATE

Mary Lloyd Ireland, M.D.

Research institutes provide injury rates at the collegiate and high school level. The injury must be defined and reported rates—numerator and denominator made clear. The National Collegiate Athletic Association (NCAA, P. O. Box 6222, Indianapolis, IN 46207, www.ncaa.org) has an injury surveillance system that follows the types and body parts of athletes sustaining injuries in 16 sports. Sixteen percent of member institutions of all 3 divisions are surveyed. Data are compiled from injury reports completed by athletic trainers from participating institutions. The reports indicate the number of injuries per 1000 exposure hours. Injury rates by the type of injury and whether the injury occurred in practice or during a game are shown in Table 3-15. The 2 sports that can be compared by gender are basketball and soccer. There are gender-based differences in the college lacrosse rules, as well as in the apparatus used in gymnastics. The NCAA injury rates by body part are shown in Table 3-16.

Comparison of injuries in different sports and between genders is an important aspect of planning for coverage of events and prevention strategies. One must compare the rates of injury and not the absolute numbers. The information should be assessed carefully to determine the common denominator. The National Center for Catastrophic Sports Injury Research, Chapel Hill, NC, has been recording fatalities and catastrophic and serious injuries in US high schools and colleges. Data on fall sports fatalities and catastrophic and serious injuries in US high school and colleges reported from 1982 to 1996 are listed in Table 3-17.¹⁴ Similar tracking was done for winter sports from 1982 to 1997 (Table 3-18).¹⁴ Spring sports were also followed from 1983 to 1997 (Table 3-19).¹⁴

The numbers of deaths from catastrophic injury in high school and college football are depicted in Figure 3-1. Cheerleading incidents resulted in the highest number of catastrophic injuries in female athletes. With the new injury-reporting and computer packages now available, better documentation of injury types and severity is possible.

Table 3-15. NCAA Injury Rate by Type of Injury, 1999–2000^a

	CONTUSION		TENDINITIS		LIGAMENT SPRAIN (INCOMPLETE TEAR)		LIGAMENT SPRAIN (COMPLETE TEAR)		MUSCLE- TENDON STRAIN (INCOMPLETE TEAR)		MUSCLE- TENDON STRAIN (COMPLETE TEAR)		FRACTURE		STRESS FRACTURE		CONCUSSION		HEAT EXHAUSTION		INFLAMMATION	
	<i>Practices</i>	<i>Games</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>
Gymnastics-W	0.55	0.96	0.30	0.48	1.66	2.40	0.30	1.44	1.36	1.92	0.05	0.48	0.40	1.44	0.35	0.00	0.10	0.00	0.00	0.00	0.15	0.48
Gymnastics-M	0.41	0.85	1.22	0.00	1.01	1.70	0.20	0.85	1.22	0.85	0.00	0.00	0.20	0.85	0.20	0.00	0.00	0.00	0.00	0.00	0.71	0.00
Basketball-W	0.26	1.03	0.22	0.14	1.54	3.10	0.18	0.62	0.88	0.45	0.02	0.07	0.16	0.79	0.21	0.07	0.22	0.86	0.00	0.00	0.13	0.03
Basketball-M	0.33	1.43	0.14	0.06	1.58	3.26	0.08	0.18	0.55	1.22	0.01	0.03	0.28	0.97	0.11	0.18	0.14	0.58	0.01	0.00	0.09	0.06
Soccer-W	0.34	2.65	0.30	0.26	1.01	4.64	0.16	1.62	1.97	2.72	0.05	0.04	0.13	1.10	0.07	0.07	0.13	1.95	0.07	0.22	0.24	0.18
Soccer-M	0.53	4.80	0.17	0.08	1.15	6.09	0.06	0.31	1.37	3.74	0.01	0.00	0.16	1.09	0.02	0.08	0.03	1.37	0.06	0.00	0.08	0.12
Lacrosse-W	0.37	1.05	0.45	0.23	0.87	1.29	0.08	0.70	1.11	1.64	0.03	0.00	0.13	0.47	0.40	0.00	0.16	0.59	0.03	0.00	0.00	0.23
Lacrosse-M	0.59	2.38	0.07	0.00	0.84	2.22	0.09	0.33	0.72	2.71	0.00	0.00	0.05	0.57	0.01	0.00	0.18	1.64	0.00	0.00	0.05	0.08
Field Hockey-W	0.14	1.51	0.24	0.18	0.60	0.71	0.02	0.09	1.33	0.71	0.02	0.09	0.17	0.80	0.10	0.00	0.05	0.44	0.07	0.00	0.14	0.09
Volleyball-W	0.16	0.17	0.38	0.17	1.06	1.87	0.07	0.26	1.33	0.99	0.02	0.00	0.07	0.09	0.17	0.06	0.09	0.14	0.00	0.00	0.15	0.06
Softball-W	0.43	1.22	0.23	0.16	0.43	0.97	0.05	0.11	0.70	0.77	0.02	0.01	0.14	0.49	0.03	0.00	0.15	0.33	0.00	0.00	0.07	0.07
Spring Football-M	0.86	0.00	0.03	0.00	3.20	0.00	0.48	0.00	2.19	0.00	0.04	0.00	0.59	0.00	0.02	0.00	0.67	0.00	0.02	0.00	0.04	0.00
Wrestling-M	0.44	1.84	0.04	0.10	1.50	9.79	0.13	1.53	1.14	4.49	0.05	0.10	0.18	1.02	0.00	0.00	0.30	1.73	0.00	0.00	0.13	0.31
Football-M	0.44	6.66	0.09	0.16	1.16	14.81	0.14	2.39	1.19	5.59	0.04	0.21	0.21	2.64	0.02	0.07	0.34	4.20	0.16	0.09	0.06	0.25
Ice Hockey-M	0.41	3.21	0.01	0.05	0.32	4.38	0.09	0.51	0.61	1.96	0.03	0.09	0.19	1.58	0.01	0.00	0.11	1.63	0.00	0.00	0.03	0.00
Baseball-M	0.15	1.15	0.24	0.27	0.40	0.96	0.04	0.14	0.57	1.33	0.01	0.04	0.11	0.61	0.02	0.02	0.03	0.29	0.00	0.00	0.06	0.11

^aAll data are shown as rate per 1000 athletic exposures for 1999–2000.

From the NCAA Injury Surveillance System, 1999–2000. NCAA, Indianapolis, Ind.

Table 3-16. NCAA Injury Rate by Body Part, 1999–2000^a

	NECK		SHOULDER		WRIST		HAND		LOWER BACK		PELVIS, GROIN		HIPS, UPPER LEG		KNEE		PATELLA		LOWER LEG		ANKLE		FOOT	
	<i>Practices</i>	<i>Games</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>	<i>P</i>	<i>G</i>
Gymnastics-W	0.35	0.48	0.30	0.48	0.15	0.00	0.05	0.00	0.71	0.48	0.30	0.00	0.15	0.96	1.01	4.32	0.15	0.00	0.55	0.48	1.01	2.40	0.25	0.48
Gymnastics-M	0.41	0.00	1.82	0.85	0.20	0.00	0.00	0.00	0.61	0.85	0.00	0.00	0.00	0.85	0.41	1.70	0.00	0.00	0.20	0.00	0.91	1.70	0.20	0.85
Basketball-W	0.03	0.03	0.14	0.41	0.01	0.10	0.01	0.17	0.23	0.21	0.18	0.28	0.43	0.21	0.68	1.97	0.11	0.17	0.25	0.14	1.32	2.14	0.29	0.59
Basketball-M	0.01	0.09	0.09	0.33	0.05	0.30	0.05	0.12	0.24	0.37	0.16	0.46	0.21	0.55	0.48	1.13	0.08	0.15	0.17	0.21	1.28	2.62	0.22	0.64
Soccer-W	0.02	0.29	0.09	0.40	0.02	0.26	0.01	0.11	0.15	0.44	0.53	0.52	1.20	1.77	0.68	3.98	0.06	0.15	0.34	1.33	0.98	3.57	0.19	0.77
Soccer-M	0.01	0.12	0.09	0.66	0.04	0.20	0.02	0.04	0.08	0.43	0.47	1.21	0.72	2.77	0.55	3.24	0.07	0.16	0.32	1.21	0.92	4.37	0.28	1.05
Lacrosse-W	0.05	0.12	0.16	0.47	0.00	0.00	0.03	0.00	0.05	0.35	0.21	0.23	0.50	1.05	0.37	1.88	0.05	0.00	0.53	0.23	0.74	0.35	0.50	0.47
Lacrosse-M	0.04	0.25	0.23	2.22	0.03	0.16	0.03	0.25	0.19	0.41	0.15	0.49	0.46	2.14	0.42	1.23	0.00	0.08	0.11	0.57	0.76	0.82	0.04	0.33
Field Hockey-W	0.02	0.00	0.02	0.00	0.00	0.09	0.07	0.09	0.21	0.18	0.33	0.18	0.67	0.53	0.45	0.98	0.07	0.09	0.29	0.27	0.33	0.62	0.10	0.18
Volleyball-W	0.01	0.06	0.55	0.51	0.05	0.06	0.03	0.00	0.37	0.26	0.20	0.17	0.27	0.09	0.44	0.54	0.10	0.06	0.30	0.09	0.75	1.56	0.16	0.17
Softball-W	0.03	0.07	0.29	0.44	0.07	0.11	0.04	0.21	0.19	0.12	0.09	0.17	0.23	0.38	0.18	0.68	0.09	0.08	0.10	0.32	0.36	0.62	0.10	0.04
Spring Football-M	0.32	0.00	1.13	0.00	0.14	0.00	0.19	0.00	0.35	0.00	0.43	0.00	1.36	0.00	1.85	0.00	0.12	0.00	0.23	0.00	1.50	0.00	0.23	0.00
Wrestling-M	0.43	1.63	0.85	5.51	0.06	0.20	0.05	0.10	0.28	0.71	0.07	0.20	0.11	0.61	1.29	8.06	0.07	0.20	0.07	0.20	0.59	2.04	0.11	0.31
Football-M	0.17	1.63	0.50	5.85	0.05	0.47	0.07	0.68	0.15	0.96	0.29	1.69	0.66	3.10	0.69	9.41	0.05	0.36	0.16	1.71	0.60	8.09	0.16	0.96
Ice Hockey-M	0.04	0.05	0.22	2.28	0.10	0.56	0.00	0.42	0.22	0.42	0.30	1.12	0.14	0.93	0.29	2.75	0.01	0.09	0.05	0.19	1.07	0.09	0.33	
Baseball-M	0.00	0.02	0.39	0.81	0.03	0.20	0.06	0.35	0.10	0.14	0.06	0.15	0.14	0.69	0.11	0.47	0.03	0.07	0.06	0.21	0.25	0.47	0.06	0.16

^aAll data are shown as rate per 1000 athletic exposures for 1999–2000

From the NCAA Injury Surveillance System, 1999–2000. NCAA, Indianapolis, Ind.

Table 3-18. Winter Sports Fatalities and Catastrophic and Serious Injuries, US High Schools and Colleges, 1982–1997

SPORT	TOTAL NUMBER OF PARTICIPANTS (PERCENT MALE/FEMALE)	TOTAL FATALITIES (AND RATE PER 100,000 PARTICIPANTS)		TOTAL DIRECT INJURIES (AND RATE PER 100,000 PARTICIPANTS)		TOTAL DIRECT FATALITIES AND INJURIES (AND RATE PER 100,000 PARTICIPANTS)
		DIRECT ^a	INDIRECT ^a	NONFATAL ^a	SERIOUS ^a	
High School						
Basketball	13,878,343 (56/44)	0	54 (0.39)	2 (0.01)	5 (0.04)	7 (0.05)
Gymnastics	486,597 (14/86)	1 (0.21)	0	7 (1.44)	4 (0.82)	12 (2.46)
Ice hockey	354,135 (98/2)	2 (0.56)	2 (0.56)	4 (1.13)	5 (1.41)	11 (3.11)
Swimming	2,556,181 (46/54)	0	4 (0.16)	4 (0.16)	3 (0.12)	7 (0.27)
Wrestling	3,556,640 (99/1)	2 (0.06)	13 (0.37)	20 (0.56)	11 (0.31)	33 (0.93)
Total	20,831,896 (62/38)	5 (0.02)	73 (0.35)	37 (0.18)	28 (0.13)	70 (0.34)
College						
Basketball	367,225 (54/46)	0	12 (3.27)	1 (0.27)	2 (0.54)	3 (0.81)
Gymnastics	34,543 (33/67)	0	0	5 (14.49)	1 (2.90)	6 (17.39)
Ice hockey	60,603 (96/4)	0	1 (1.65)	4 (6.60)	3 (4.95)	7 (11.55)
Swimming	234,566 (50/50)	0	4 (1.70)	1 (0.43)	0	1 (0.43)
Wrestling	108,673 (100/0)	0	0	1 (0.92)	0	1 (0.92)
Total	805,610 (61/39)	0	17 (2.11)	12 (1.49)	6 (0.74)	18 (2.23)
Overall	21,637,506	5 (0.02)	90 (0.42)	49 (0.23)	34 (0.16)	88 (0.41)

^aSee Table 3-17 footnotes for definitions.

From Cantu RC, Mueller FO: Fatalities and catastrophic injuries in high school and college sports, 1982–1997: Lessons in improving safety. Physician Sports Med 27(8): 35–49, 1999, with permission.

Table 3-19. Spring Sports Fatalities and Catastrophic and Serious Injuries, US High Schools and Colleges, 1983–1997

SPORT	TOTAL NUMBER OF PARTICIPANTS (PERCENT MALE/FEMALE)	TOTAL FATALITIES (AND RATE PER 100,000 PARTICIPANTS)		TOTAL DIRECT INJURIES (AND RATE PER 100,000 PARTICIPANTS)		TOTAL DIRECT FATALITIES AND INJURIES (AND RATE PER 100,000 PARTICIPANTS)
		DIRECT ^a	INDIRECT ^a	NONFATAL ^a	SERIOUS ^a	
High School						
Baseball	6,279,333 (99/1)	6 (0.10)	7 (0.11)	11 (0.18)	11 (0.18)	28 (0.45)
Lacrosse	442,785 (66/34)	1 (0.23)	2 (0.45)	0	0	1 (0.23)
Track and field	12,684,649 (56/44)	16 (0.13)	19 (0.15)	10 (0.08)	13 (0.10)	39 (0.31)
Tennis	3,951,505 (51/49)	0	1 (0.03)	0	0	0
Total	23,358,272 (67/33)	23 (0.10)	29 (0.12)	21 (0.09)	24 (0.10)	68 (0.29)
College						
Baseball	319,679 (100/0)	2 (0.63)	2 (0.63)	1 (0.31)	1 (0.31)	4 (1.25)
Lacrosse	121,114 (61/39)	0	1 (0.83)	2 (1.65)	2 (1.65)	4 (3.30)
Track and field	836,624 (60/40)	2 (0.24)	1 (0.12)	2 (0.24)	3 (0.36)	7 (0.84)
Tennis	227,035 (51/49)	0	2 (0.88)	0	0	0
Total	1,504,452 (67/33)	4 (0.27)	6 (0.40)	5 (0.33)	6 (0.40)	15 (1.0)
Overall	24,862,724	27 (0.11)	35 (0.14)	26 (0.10)	30 (0.12)	83 (0.33)

^aSee Table 3-17 footnotes for definitions.

From Cantu RC, Mueller FO: Fatalities and catastrophic injuries in high school and college sports, 1982–1977: Lessons in improving safety. Physician Sports Med. 27(8): 35–49, 1999, with permission.

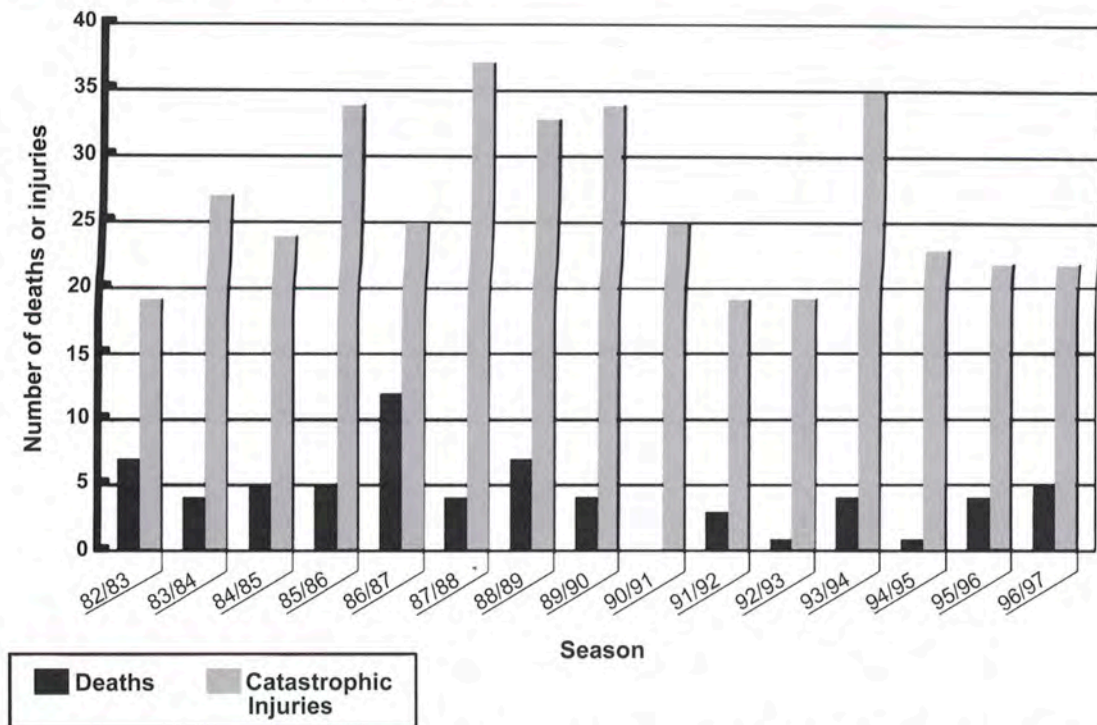


Figure 3-1. Deaths and catastrophic injuries in US high school and college football, 1982–1997. (From Cantu RC, Mueller FO: Fatalities and catastrophic injuries in high school and college sports, 1982–1997: Lessons in improving safety. *Physician Sportsmed* 27 (8): 35–49, 1999, with permission.)

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