

# Incidence and Causes of Sudden Cardiac Death in Sport

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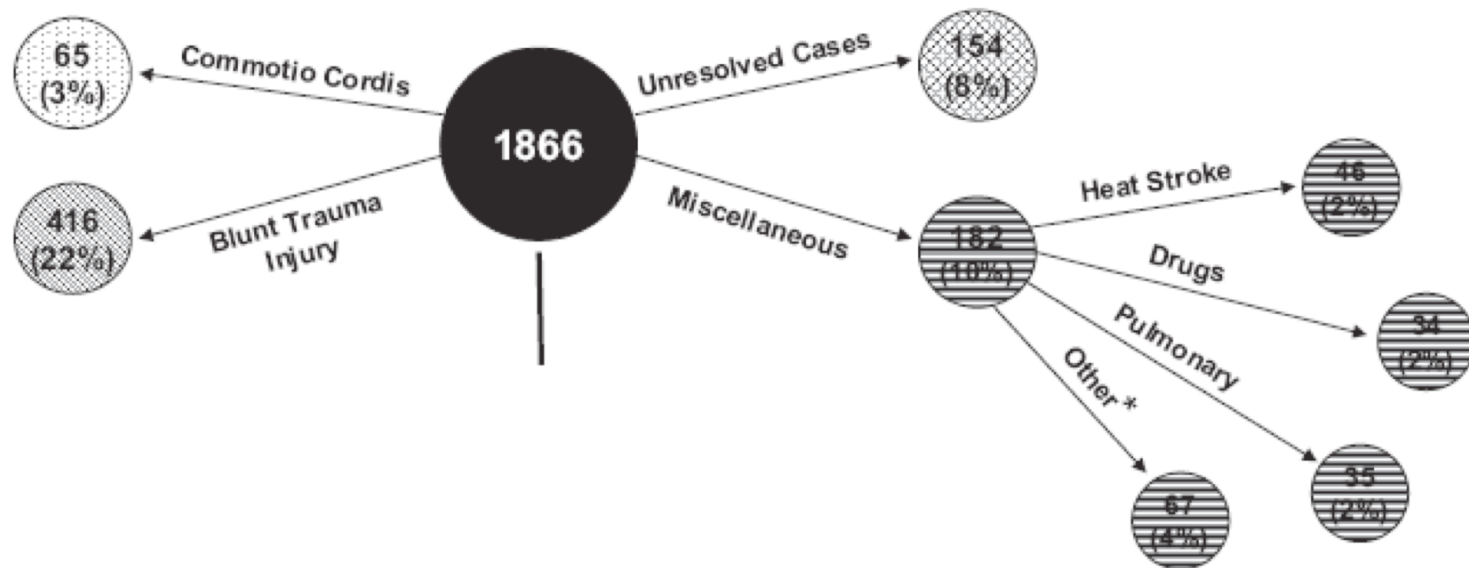
**No Relationships to Disclose**

# Sudden Cardiac Death Rates during Exercise

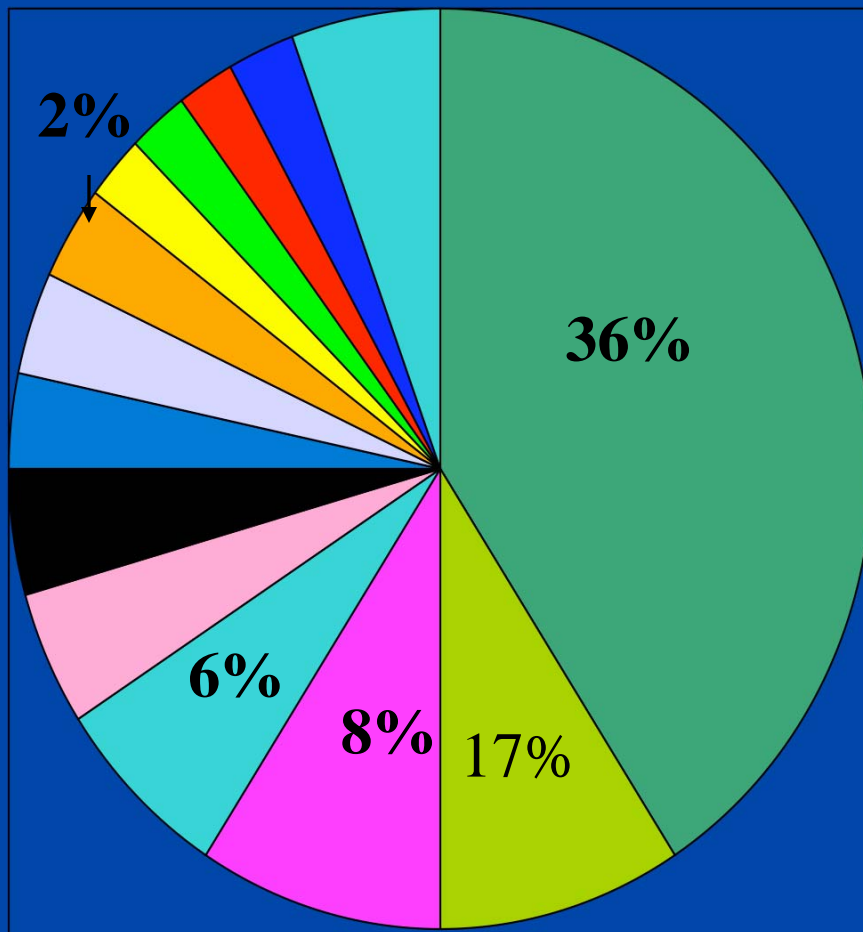
- Maron, et al. *Circulation* 119:1089; 2009
  - US Registry of Sudden Deaths in Athletes
  - 56% of 1866 deaths deemed cardiovascular
  - Mean age 19 years
  - < 100 cases/year ( 2000-2006 period)
  - Incidence 0.61/100,000 ( 2000-2006 period)
- Corrado, et al. *JAMA* 296:1593; 2006
  - 42,386 Italian athletes screened for competition ( 1982-2004)
  - Mean age not provided
  - 55 sudden cardiovascular deaths (1.9/100,000 person –years)
  - Incidence decreased to 0.4/100,000 person-years ( 2003-2004)
  - Rate in women is <1/2 that of men

# Sudden Cardiac Death Rates during Exercise

- Physicians Health Study *New Engl.J. Med* 343:1355;2000
  - 21,481 middle aged men without known cardiovascular disease
  - Incidence: 1 /1.5 million *episodes* of exertion
  - Death rate lower among those who regularly exercise
- Nurses Health Study *JAMA* 295:1399; 2006
  - Middle aged women without known cardiovascular disease
  - Incidence : 1/36.5 million *hours* of exertion
  - Death rate lower among those who regularly exercise



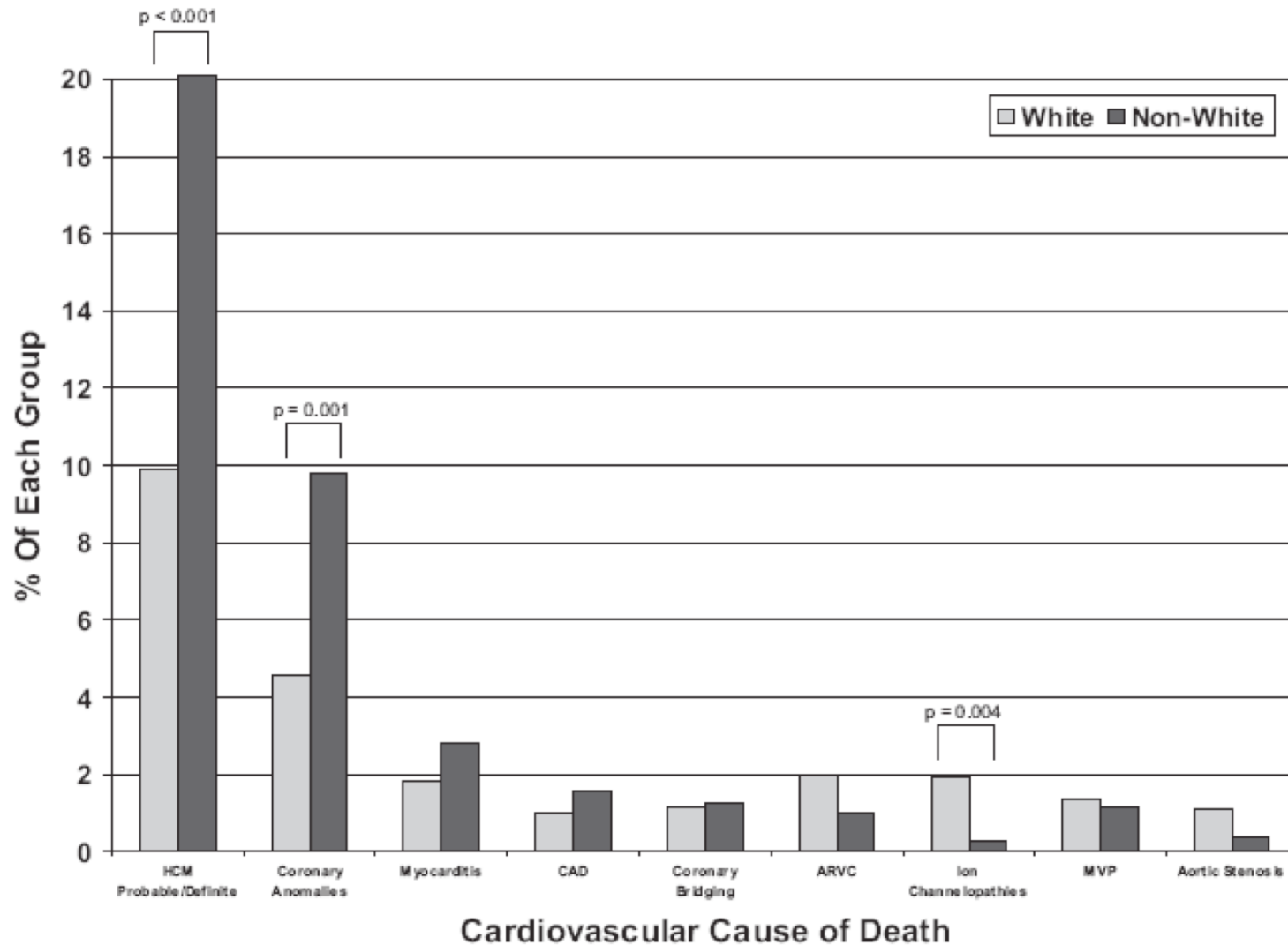
# Cardiovascular Causes of Sudden Cardiac Death in 690 Young Athletes



- HCM
- Coronary anomalies
- LVH/?HCM
- myocarditis
- ARVC
- Ion Channel Dx
- MVP
- LAD bridge
- CAD
- Aortic Rupture
- Aortic Stenosis
- DCM
- WPW
- other

Maron, et al . Circulation 119:1085; 2009

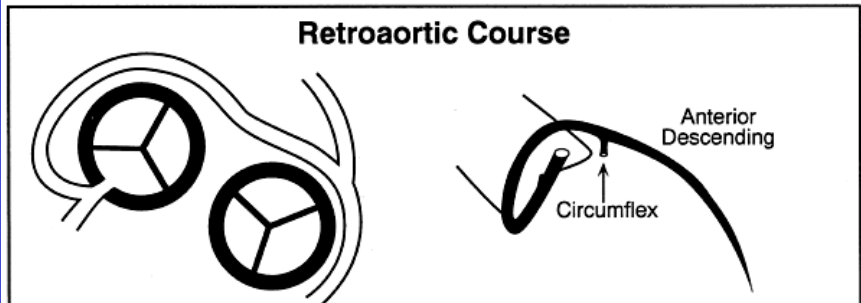
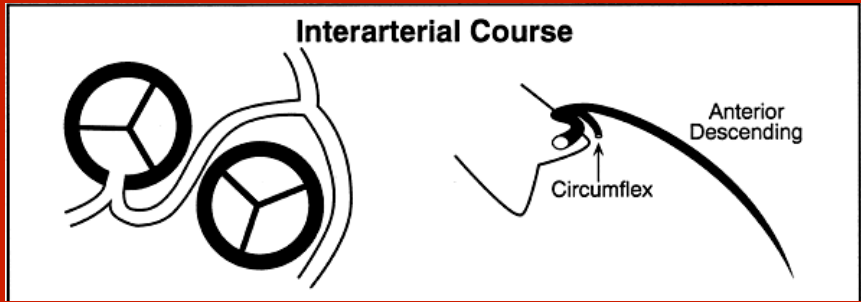
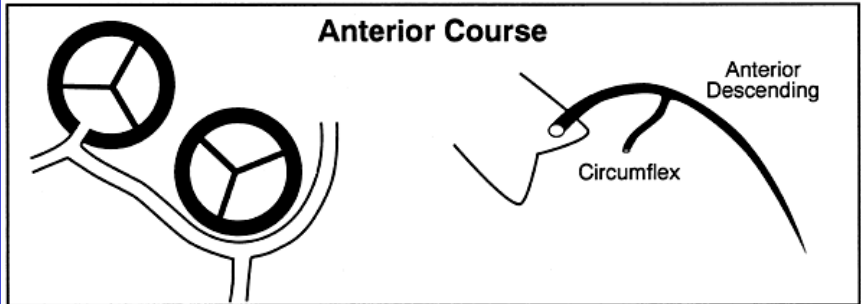
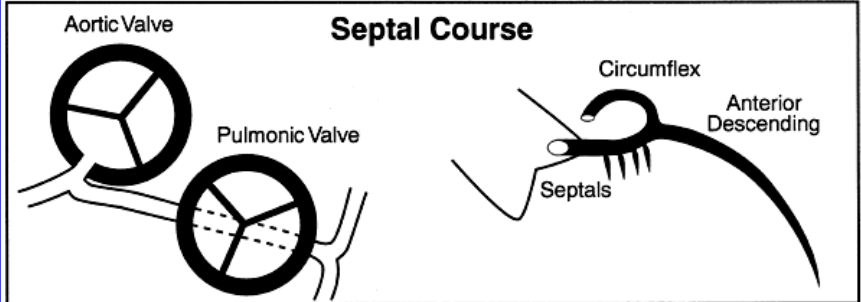
# Cardiovascular Causes of SCD during Sport relative to race/ethnicity



Maron, et al . Circulation 119:1085; 2009

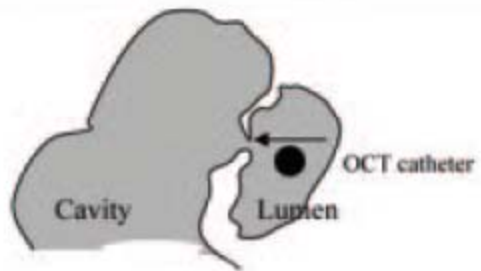
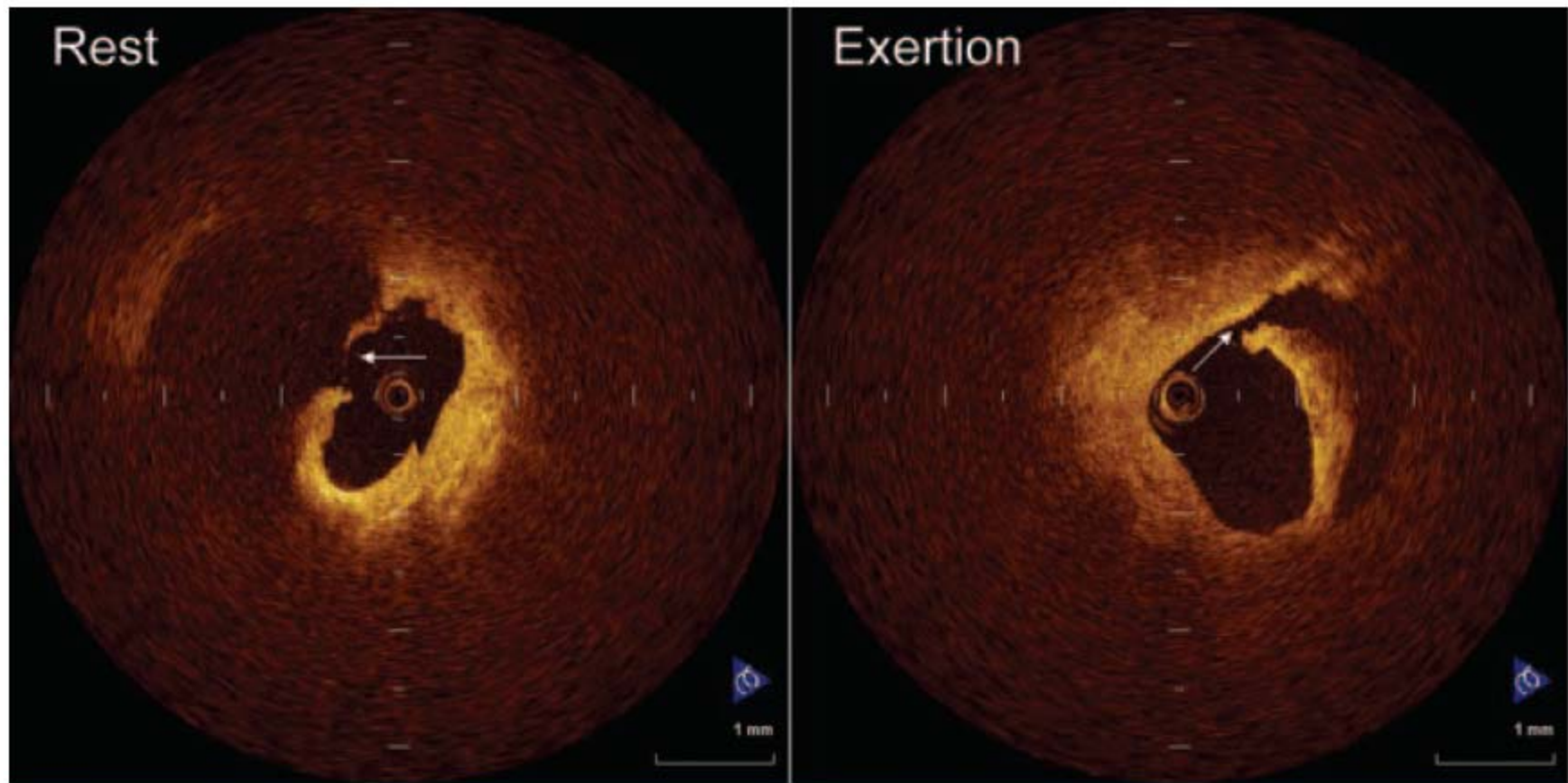
**Cross-Sectional Representation**

**Representative RAO Angiographic Features**



# Exercise and Atherosclerotic Plaque

- **Plaque rupture and thrombosis**
  - **sheer stress**
  - **vasoconstriction**
  - **increased platelet aggregation**
  - **coronary artery twisting and bending**
  - **Plaque rupture occurs at shoulder of lesion where fibrous cap is thicker**



Sport	No. (%)	Age, y	Cause of Death, n (%)		
			Trauma Injury	Commotio Cordis	CV Diseases†
Football	565 (30)	17±4	140 (25)	12 (2)	281 (50)
Basketball	405 (22)	17±4	4 (1.0)	0	349 (86)
Soccer	115 (6)	16±4	11 (10)	4 (4)	80 (70)
Baseball	111 (6)	16±4	16 (14)	30 (27)	54 (49)
Motor vehicle racing‡	104 (6)	28±8	97 (93)	0	5 (5)
Track and field	96 (5)	17±4	25 (26)	0	61 (64)
Wrestling	69 (4)	22±8	7 (10)	1 (1.4)	37 (54)
Boxing	56 (3)	25±6	42 (75)	0	11 (1.8)
Swimming§	46 (2)	17±4	0	0	35 (76)
Cross country	38 (2)	17±4	0	0	29 (76)
Hockey	29 (1.5)	18±5	4 (14)	7 (24)	11 (38)
Horse riding	27 (1.4)	27±8	24 (89)	0	2 (7)
Softball	22 (1.2)	19±6	3 (14)	1 (5)	12 (55)
Marathon	20 (1.1)	28±7	0	0	13 (65)
Lacrosse	19 (1.0)	18±2	1 (5)	8 (42)	9 (47)
Skiing¶	19 (1.0)	25±8	15 (79)	0	1 (5)
Triathlon	17 (0.9)	32±5	3 (18)	0	8 (47)
Rugby	16 (0.9)	21±3	3 (19)	0	7 (44)
Martial arts	15 (0.8)	23±7	5 (33)	2 (13)	2 (13)
Others#	14 (0.8)	26±9	3 (21)	0	5 (36)
Rowing	11 (0.6)	22±6	0	0	9 (82)
Cycling	10 (0.5)	29±8	7 (70)	0	3 (30)
Tennis	10 (0.5)	19±4	0	0	8 (80)
Volleyball	10 (0.5)	18±5	0	0	10 (100)
Gymnastics	9 (0.5)	15±3	4 (44)	0	3 (33)
Surfing	9 (0.5)	23±8	2 (22)	0	1 (11)
Figure skating	2 (0.1)	24±6	0	0	1 (50)
Golf	2 (0.1)	18±0.7	0	0	2 (100)
Totals	1866	19±6	416	65	1049

Sport	No. (%)	Age, y	Male, n (%)	Female, n (%)	Race, n			Survivors, n (%)	Cause of Death, n (%)		
					White	Black	Other*		Trauma Injury	Commotio Cordis	CV Diseases†
Football	565 (30)	17±4	564 (99.8)	1 (0.2)	280	205	80	13 (2)	140 (25)	12 (2)	281 (50)
Basketball	405 (22)	17±4	364 (90)	41 (10)	142	243	20	30 (7)	4 (1.0)	0	349 (86)
Soccer	115 (6)	16±4	93 (81)	22 (19)	81	14	20	7 (6)	11 (10)	4 (4)	80 (70)
Baseball	111 (6)	16±4	111 (100)	0	95	5	11	14 (13)	16 (14)	30 (27)	54 (49)
Motor vehicle racing‡	104 (6)	28±8	103 (99)	1 (1)	102	0	2	0	97 (93)	0	5 (5)
Track and field	96 (5)	17±4	74 (77)	22 (23)	62	22	12	3 (3)	25 (26)	0	61 (64)
Wrestling	69 (4)	22±8	69 (100)	0	56	4	9	2 (3)	7 (10)	1 (1.4)	37 (54)
Boxing	56 (3)	25±6	55 (98)	1 (2)	21	19	16	0	42 (75)	0	11 (1.8)
Swimming§	46 (2)	17±4	30 (65)	16 (35)	43	1	2	1 (2)	0	0	35 (76)
Cross country	38 (2)	17±4	29 (76)	9 (24)	30	6	2	2 (5)	0	0	29 (76)
Hockey	29 (1.5)	18±5	29 (100)	0	28	1	0	3 (10)	4 (14)	7 (24)	11 (38)
Horse riding	27 (1.4)	27±8	17 (63)	10 (37)	21	1	5	0	24 (89)	0	2 (7)
Softball	22 (1.2)	19±6	6 (27)	16 (73)	19	0	3	2 (9)	3 (14)	1 (5)	12 (55)
Marathon	20 (1.1)	28±7	15 (75)	5 (25)	16	0	4	3 (15)	0	0	13 (65)
Lacrosse	19 (1.0)	18±2	19 (100)	0	18	1	0	2 (11)	1 (5)	8 (42)	9 (47)
Skiing¶	19 (1.0)	25±8	14 (74)	5 (26)	19	0	0	0	15 (79)	0	1 (5)
Triathlon	17 (0.9)	32±5	15 (88)	2 (12)	16	0	1	0	3 (18)	0	8 (47)
Rugby	16 (0.9)	21±3	16 (100)	0	13	2	1	0	3 (19)	0	7 (44)
Martial arts	15 (0.8)	23±7	14 (93)	1 (7)	12	3	0	0	5 (33)	2 (13)	2 (13)
Others#	14 (0.8)	26±9	12 (86)	2 (14)	14	0	0	2 (14)	3 (21)	0	5 (36)
Rowing	11 (0.6)	22±6	8 (73)	3 (27)	10	0	1	0	0	0	9 (82)
Cycling	10 (0.5)	29±8	8 (80)	2 (20)	7	2	1	0	7 (70)	0	3 (30)
Tennis	10 (0.5)	19±4	8 (80)	2 (20)	8	0	2	0	0	0	8 (80)
Volleyball	10 (0.5)	18±5	1 (10)	9 (90)	5	3	2	1 (10)	0	0	10 (100)
Gymnastics	9 (0.5)	15±3	5 (56)	4 (44)	6	0	3	0	4 (44)	0	3 (33)
Surfing	9 (0.5)	23±8	9 (100)	0	7	0	2	0	2 (22)	0	1 (11)
Figure skating	2 (0.1)	24±6	2 (100)	0	2	0	0	0	0	0	1 (50)
Golf	2 (0.1)	18±0.7	2 (100)	0	2	0	0	0	0	0	2 (100)
Totals	1866	19±6	1692	174	1135	532	199	85	416	65	1049

# U.S. Marathons

- 340 marathons in 2007
- 403,000 finishing times
- Men
  - 69% >35 years
  - 6% > 60 years
- Women
  - 55% > 35 years
  - 3% > 60 years
- Rate of sudden cardiac death:
  - 0.8-1.1 per 100,000 participants

Sources; marathonguide.com;  
Roberts, et al. J Am Coll Cardiol 46:1373; 2005  
Redelmeier, et al. Br Med J 335:1275; 2007

# Summary

- The rate of sudden cardiac death during exercise and sport is low
- It is higher in men than women
- Hypertrophic cardiomyopathy, coronary artery anomalies, and myocarditis are the most common causes in those < 40 years
- Coronary artery disease is the most common cause in those >40 years
- The cause of sudden death differs among types of sport



# Adverse Effects of Exercise

- **Cardiovascular**
- **Musculoskeletal Injuries**
- **Metabolic Abnormalities**
- **Anemia**
- **Rhabdomyolysis**
- **Hazards/Collisions**

# Adverse Effects of Exercise

- **Metabolic Abnormalities**
  - fluid
  - electrolytes
  - hypothermia
  - hyperthermia
  - hypoglycemia ( diabetics)
  - exercise - induced asthma
- **Hyperadrenergic state**