



Review paper

Sudden cardiac death: A concern in the sports fraternity

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ABSTRACT

The purpose of this review article is to create awareness and understanding of the phenomenon of sudden cardiac death in the sports fraternity. Causes of sudden cardiac among persons under 35 (<35) years are hypertrophic cardiomyopathy (disease of the myocardium/heart), congenital anomalies of coronary artery (diseases characterized by structural deformities), aortic rupture or tear or rupture of the aorta (Mar fan`s syndrome), myocarditis (inflammation of the myocardium due to a viral infection), mitral valve prolapse (heart valve abnormality), aortic valve stenosis (abnormal narrowing of the valve), sarcodosis (inflammation of various organs of the body) and arrhythmias (irregular heart beat). (Sharma *et al*, 2000) Among persons above 35 (>35) years, sudden cardiac death is caused by coronary heart disease (atherosclerosis), left ventricular dysfunction, myocardial ischemia, presence of cardiac arrhythmias and additional medical problems such as hypertension, peripheral vascular disease, chronic obstructive pulmonary disease and diabetes mellitus. However, hypertrophic cardiomyopathy, mitral valve heart disease and mar fan`s syndrome are causes of sudden cardiac death associated with structural abnormalities (Boker, 1997 and Basso, *et. al*, 2000). Personnel in charge of teams need to go an extra mile in screening sportsmen and sportswomen in their custody in order to have a clear view of their health status before they engage them in any physical activity. It is prudent to note that generally, sudden cardiac death is a rare occurrence. Sporting activities however should not be deemed to cause this phenomenon but rather sports persons may have had an underlying defect before falling victim of sudden cardiac death. Sports personnel should care to advocate or recommend participation in screening for health and legal implications.

Key Words: Sport, Sudden Cardiac Death, Screening,

INTRODUCTION

Sudden death is natural death caused by cardiac arrest (Maron *et al*, 1986). It can also be defined simply as an abrupt loss of heart function (The American Heart Association (2008). Sudden death (cardiac arrest) is a major health problem that has received little publicity compared to heart attack. However, sport or exercise related sudden death has recently captured the attention of the media despite the infrequency of this unfortunate event (.

Kenny *et. al*, (1992) also emphasize that sudden cardiac death among athletes is a rare but tragic occurrence. Sudden death during exercise or sport in athletes has generated a lot of discussion about its risk (Maron *et al* (1996). Most of the cases are related to underlying heart diseases or defects (Maron *et al* 1986). Cardio vascular diseases responsible for sudden unexpected death in highly conditioned athletes are largely related to age of

the patient (American Heart Association, 2008). A competitive athlete is one who participates in an organized team or individual sport. Usually, it requires regular competition against others, as a central component and vigorous training in a systematic way. Emphasis is laid on excellence and eventually, achievement (Mitchel *et. al*, 1988). It is important to note that incidences of sudden death among highly conditioned athletes are low. Just 1 in 200,000 athletes may be at risk of sudden death (Maron *et. al*, 1986). A study published in

1996 by American Family physician revealed that approximately 1 in 50,000 deaths occur among marathon finishers. At this juncture, it is prudent to note that causes of sudden cardiac death should be considered. Age is the variable that most of the researchers have used to identify causes of sudden cardiac death in athletes. The two main age categories used are those athletes under 35 years of age (>35) and athletes above 35 years of age (<35) respectively (Maron *et. al*, 1980).

CAUSES OF SUDDEN CARDIAC DEATH IN ATHLETES UNDER 35 YEARS

In most young competitive athletes (less than 35 years of age), sudden death is due to congenital cardiovascular disease (Maron *et. al*, 1996, Basso *et. al*, 2000). Hypertrophic cardiomyopathy appears to be the most common cause of such deaths, accounting for about half of the sudden deaths in young athletes (Sharma *et. al*, 2000, Harris *et. al*, 2006, Nishimura and Ommen, 2007). Other cardiovascular abnormalities that appear to be less frequent but important causes of sudden death in young athletes include congenital coronary artery abnormalities, ruptured aorta (due to cystic medial necrosis), idiopathic left ventricular hypertrophy (a disease marked by marked hypertrophy of the ventricle) and coronary artery atherosclerotic (arterial plague) (Sharma *et. Al*, 2000, Basso *et. al*, 2000, Harris *et. al*, 2001, Basvarajiah, 2007). Diseases that appear to be very uncommon causes of sudden death include myocarditis (inflammation of the heart muscle), mitral valve prolapsed (heart valve abnormality), aortic valve stenosis (abnormal narrowing of valve) and sarcoidosis (chronic inflammation of various organs for example lungs). Cardiovascular disease in young athletes is usually unsuspected during life and most athletes who die suddenly have experienced no cardiac symptom (, Maron, 1993, Estes 1995, Maron *et. al*, 1996,). In only about 25% of those competitive athletes who die suddenly is underlying cardiovascular disease detected or suspected before participation and rarely is the correct diagnosis made (Maron *et. al*, 2007).

Hypertrophic Cardiomyopathy: This condition is also referred to as disease of the heart muscle or myocardium. It is the most common cause of sudden cardiac death in the younger age group (Kenny and Shapin, 1992, Sherry and Boker, 1997). It is a primary disease, which is rare but seems to be genetically transmitted (Maron *et. al*, 1980, Wigle *et. al*, 1995).

Maron *et. al*, (1980) revealed that hypertrophic cardiomyopathy is the most common diagnosis. Results also showed that 14 out of 29 athletes died of sudden death. Usually, a patient experiences a thickened cardiac muscle, specifically the septum (15 mm). The septum is >1.3 times the thickness of the wall without accompanying high blood pressure (Wigle *et. al*, 1995). Another report by Burke *et. al*, (1991) on 34 sports related deaths in young non-conditioned adults revealed that 8 had hypertrophy cardiomyopathy. It is sad to note that all of them died during exercise and yet none had previous symptoms of cardiac disease. Waller (1980) also demonstrated hypertrophic cardiomyopathy (heart disease) in 4 out of 17 autopsies of young athletes by which sudden death in hypertrophic cardiomyopathy occurrence is unclear. However, sudden death and marked hemodynamic changes associated with a reduction in left ventricular volume in the absence of arrhythmias (irregular rhythm of heart beat) may precipitate syncope or sudden death. McKenna *et. al*, (1982) and Sharma *et. al*, (1985) recommended that there should be no competition allowed for patients with hypertrophic cardiomyopathy. Beta blockers and calcium antagonists are used to relieve pain and palpitations.

Congenital Anomalies of Coronary Artery: This condition originates from the wrong aortic sinus leading to sudden death in young athletes (Basso *et. al*, 2000). Van camp and Choi (1984) had earlier revealed that four athletes had an anomalous origin of the left coronary artery. While the exact mechanism by which the coronary artery causes death is not known, Chetlin *et. al*, (1978) in their study revealed that the acute take – off of aberrant artery results in narrowing of the coronary atrium, a condition Corrado *et. al*, (1990) refer to as coronary atherosclerosis, whereby blood cholesterol levels are genetically elevated (Kouchoukos

and Masetti 2007) . This subsequently causes narrowing of blood vessels. An increased stroke volume during exercise may compress the vessel between the aorta and the pulmonary trunk. It is actually difficult to identify it but if it be the case, the patient should be excluded completely from sports. McNamara *et al* (1985) and Corrado *et. al*, (1990) in their Italian series reported 4 out of 22 sudden deaths as secondary to Ischemia heart disease. On the contrary, Waller *et. al*, (1984) did not detect any Ischemic heart disease in athletes less than 30 years of age. Lastly, Noakes and Rose (1984) detected a combination of hypertrophic cardiomyopathy and coronary atherosclerosis at autopsy in three athletes with sudden death (2 young and 1 middle aged). Therefore, Epstein *et.al*, (1985) recommend that coronary angiography (examination of blood vessels) may be required in young patients who wish to engage in competitive sports. In summary, it is necessary to note that congenital anomalous of a coronary artery narrows down to a single artery (left artery) while the coronary atherosclerosis affects all the blood vessels.

Aortic Rupture (Mar fan's syndrome): This is an autosomal condition in young athletes which subsequently causes sudden cardiac death (Sherry and Boker 1997, Maron *et. al*, 1998). It is a hereditary disorder of connective tissue of blood vessels and heart valves. According to Bailliere's Nurses dictionary (2000), Mar fan's syndrome was discovered by a French pediatrician known as B.J., Mar fan between 1958 – 1942. According to him, it is a hereditary disorder in which there is excessive height with very long digits, a high arched palate, hypertomous and dislocation of the eye lens and heart disease. It occurs commonly in young people. This is supported by Sherry and Boker (1997) whose study revealed that the Mar fan's syndrome is common in athletes whose height advantage is suited for basketball, volleyball and high jump. Usually, the aorta enlarges and eventually ruptures or tears giving rise to aortic rupture. McNamara (1985) recommends that echocardiography is necessary to evaluate the degree of aortic dilatation before a decision is made for sports participation. Sherry and Boker (1995) had a similar opinion where they recommended that an ECG examination should be conducted to determine the presence of aortic root disease. McNamara (1985) advises that patients with Mar fan's syndrome should not be allowed to participate in sports. However, those with aortic dilatation or mitral regurgitation should be limited to activities with low intensity.

Myocarditis: It is a disease which may cause sudden cardiac death but it is rare (Maron *et. al*, (1996) Myocarditis is a condition arising from an acute inflammation of the myocardium (heart). Occasional sudden deaths have been reported due to this condition (Maron *et. al*, 1986, Frouz *et.al*, 2003, Basvarajaiah, 2007) According to Maron *et. al*, (1985) a convalescent period of six months is recommended for competitive athletes.

Mitral Valve Prolapse: This condition is a common disorder. It is estimated to affect 2% to 5% of a given population. However, a sudden cardiac death is rare. For instance, it has been reported in only two athletes with isolated mitral valve prolapse (Corrado *et. al*, 1990, Bharati *et. al*, 1983). In many cases, it is considered a non-invasive condition or illness (benign syndrome) that is not serious although treatment may be sought (Baillierer Nurse's dictionary, 2000). Full participation in sporting activities is allowed except when the following features are noted; history of syncope, disabling chest pain especially if it is worse during exercise, associated Mar fan's syndrome, family history of sudden cardiac death due to mitral valve prolapse and significant mitral regurgitation (Corrado *et al* 1990, Bharati *et al* 1993).

Aortic Valve Stenosis: Kenny and Shapiro (1992) conducted a study which revealed that aortic valve stenosis is an abnormality or condition that is experienced in young athletes. It rarely causes frequent deaths. Aortic valve can be inflamed and is unable to open so that blood flows backwards (regurgitation) into the left ventricles during diastole. Thus the valve between the left ventricle and the valve narrows (Bailliere's Nurses dictionary, 2000).

Sarcoidosis: Sarcoidosis is sometimes referred to as sarcoid heart disease. It is a rare cause of sudden death. However, sarcoidosis was implicated in the death of a professional basketball player (Maron *et al* 1988). Sarcoidosis is a progressive disease that affects parts of the body especially the lymph nodes, lungs, liver, spleen, skin and small bones of the hands and feet (Bailliere's Nurse's dictionary, 2000).

Arrhythmias: According to Baillierer's Nurse's dictionary (2000), arrhythmias occur when there is a variation in the rhythm of the action of the heart. In this case, the heart quickens on inspiration and slows down during expiration of air. In other words the patient experiences irregular and uncoordinated contractions of the muscle fibers. According to Cornado (1990), ventricular arrhythmias with left bundle branch block morphology are the most common clinical manifestations of arrhythmia. He reviewed sudden

death in 22 competitive Italian athletes. The results revealed that right ventricular dysphasia (ARVD) was the most frequent cause of sudden cardiac death. Six of them died during effort or exercise but four had a history of palpitation. As far as athletes participating in activities/exercises/sport is concerned, Zipes (1985)

recommended that those who have no evidence of structural heart disease and whose arrhythmia produces no symptoms and does not appear to be aggravated by exercise, should engage in all competitive sports.

CAUSES OF SUDDEN CARDIAC DEATH IN ATHLETES ABOVE 35 YEARS

In older or mature athletes (greater than or equal to 35 years of age), sudden death is usually due to coronary artery disease and rarely results from congenital heart disease (Maron *et. al*, 1986). Sheer and Boker (1997) emphasized the fact that in athletes above 35 years of age, the commonest cause of sudden death is coronary artery disease. In this category, the incidence of sudden death during exercise is low (Thompson *et. al*, 1982). However, the incidences increase during vigorous activities (Willich, *et. al*, 1993, Mittleman, *et.al*, 1993). In addition, the prevalence of atherosclerotic coronary artery disease and the incidence of coronary events increase with advancing age (Bethesda Conference, 1994). It is important to note that atherosclerosis is elevated blood cholesterol levels. According to the conference, many patients with coronary artery disease vary greatly in their clinical status. Therefore, consideration should be given to the extent of:

1. Coronary heart disease
2. Left ventricular dysfunction
3. Myocardial Ischemia
4. Additional medical problems e.g. hypertension, peripheral vascular disease, chronic obstructive pulmonary disease, and diabetes mellitus.

In most cases, athletes with coronary heart disease experience reduced maximal oxygen uptake and exercise tolerance (American College of Sports Medicine, 1994). Usually, stroke volume is decreased due to myocardial Ischemia or damage previously, caused by infarction. Patients with angina or a severe pain in the chest have a decreased exercise tolerance because of discomfort which often occurs at a highly reproducible exertion. The heart rate is also decreased, most likely due to enhanced vagal tone as well as other

unknown mechanisms. Subsequently, such patients are reconditioned because their physicians/doctors have restricted their activities. On the contrary, patients from coronary artery disease should be optimistic since it can be managed effectively by engaging in exercise or sporting activities. In the first instance, they show increases in effort tolerance as exercise training reduces sub maximal heart rate. This delays the onset of fatigue. Exercise training in myocardial infarction (heart attack) patients' results in decreased total cholesterol, low density lipoprotein (LCR) and triglycedioles. This implies that exercise increases high density lipoprotein levels (HDL). Depression has also been found to have lessened in post myocardial patients. (Emery *et. al*, 1989). Weight loss associated with exercise helps control risk factors that would lead to cardiac heart disease such as obesity and diabetes (National Obesity Consensus Conference, 1985). Lastly, cardiac rehabilitation programme reduces fatal cardiovascular events and total mortality rate by 20 – 25% (Oldridge *et. al*, 1988).

Frequency of Sudden Cardiac Death: In 1980, a study of joggers from the state of Rhode Island revealed that the risk of sudden cardiac death (SCD) in healthy persons aged between 30 – 65 years was 1 in 15, 240 deaths per year (Thompson *et al* 1982). Another study arrived at 1 in 18, 000 per year to men aged between 25 – 75 years. These figures apply to men with unknown coronary heart disease. The amount of vigorous exercise performed weekly was also correlated with death rates. The conclusion made was that although the number of sudden cardiac deaths increased with vigorous exercise, the overall death rates in athletes who exercise regularly was lower (Siscovick, 1989).

Table 1: Results of an investigation conducted in young high school and College athletes on the incidences or prevalence of sudden cardiac death

Sudden Cardiac Death in College and High school Athletes			
Sport	Participants High School/College	Death High School/Colleges	Est. Death Rate per High School/College
Football (Men)	9,400,000 680,000	53 14	5.61 20.28
Basketball (Men)	5,100,000 260,000	28 9	5.48 34.7
Soccer (Men)	2,100,000 250,000	6 1	2.85 4.06
Wrestling (Men)	2,400,000 100,000	9 0	3.75 0
Baseball (Men)	4,100,000 390,000	5 2	1.22 5.14
Track (men)	4,300,000 270,000	9 1	2.09 3.67
All others (Men)	4,100,000	11	2.7
Totals for (Men)	33,000,00 2,500,00	115 31	6.6 14.5
Women in all Sports	18,000,000 1,200,000	11 3	1.16 2.81

Adapted from Van Camp *et al.* (1995)

In the table above, death rates were described as the number of deaths per million athletes per year. Out of 160 total deaths among college athletes, 146 were males while 14 were females. Among high school athletes, 126 were males while 34 were females (greater than college athletes). Further results revealed that cardiac abnormalities were present in 72% of athletes with hypertrophic cardiomyopathy (HCM), predominant (51%), followed by coronary artery anomalies (16%), heat stroke (13) and exertion rhabdomyolysis with sickle cell (7). Football recorded the highest number of deaths (67), followed by basketball (37). More occurrences or incidences of sudden cardiac death among males over females were noted. Van Camp *et al.*, (1995) did not reveal the reasons why the scenario was unexplained. Perhaps further research should be conducted to find out why the incidences of sudden cardiac death in male athletes are incidentally higher than in female athletes. Opie (1975) and Northconte (1984) revealed that sudden deaths occur one hour (1hour) on the onset of symptoms. The results showed that 21 deaths were dominated by the game of rugby and referees. However, 18 of the deaths were attributed to cardiac

heart disease. This was supported by Thompson *et al.*, (1979), whose study revealed that out of 18 deaths among joggers, 13 had been caused by coronary heart disease. Perhaps, at this juncture, it is prudent to show symptoms that confirm or that may lead to sudden cardiac death. They also emphasized that those who died from coronary artery disease were significantly older than those dying from structural cardiovascular abnormalities. The following is a list of symptoms that can alert one of abnormalities of the heart that would lead to sudden cardiac death;

Prodromal Symptoms

- Chest pain/angina,
- Increasing fatigue,
- Indigestion/heart burn/gastro intestinal symptoms,
- Excessive breathlessness,
- Ear or neck pain,
- Vague malaise,
- Upper respiratory tract infection,
- Dizziness/palpation
- Severe headache

Table 2: Sudden Death Occurrences in United States

Coronary artery diseases		Others					
		Hypertrophy Destructive cardiomyopathy	Coronary artery anomalies	Myocarditis	Conduction Disorders	Ruptured Aorta	VHD
No. of subjects	110	149	8	3	4	1	3
Males	109	14	8	3	4	1	3
Females	1	2	0	0	0	0	0

Mean age (SD) year(s) 40(91)

← 19(62) →

VHD – Valvular heart disease

Northconte (1984)

From the above table of 145 cases, 51 were associated with running, 32 with rugby football and American football, 9 with basketball, 4 with tennis and 13 with

various other pursuits. Northconte (1984) also noted that sudden death in women is extremely rare.

RECOMMENDATION

Patients with coronary heart disease require a complete medical history. Physical examination and exercise test prior to embarking on an exercise program is necessary. In other words, pre-participation screening is mandatory (American Colleges of Sports Medicine, 1995). Any abnormalities should be fully investigated. In case of patients with unstable angina, severe aortic stenosis, uncontrolled cardiac arrhythmias or decompensate congestive heart failure, exercises should be postponed (Maron *et. al*, 1985). Many patients should begin with a supervised exercise program that is specifically designed for their needs and based on the severity of their symptoms. Patients

should be re-evaluated over 2 – 3 months after beginning an exercise program. (Fletcher *et. al*, 1990). As a general rule, 20 – 60 minutes of intermittent (minimum of 10 minutes) exercise is sufficient. Large muscle group aerobic activity is appropriate 3 to 5 days a week. The activity should be performed at 55% maximum heart rate. Those patients who are quite unfit can start at a lower intensity level of 40% of maximum heart rate. Progression is slow and gradual with monitoring of symptoms as intensity and duration of activities is increased (American College of Sports Medicine, 1994).

CONCLUSION

Despite difficulties in adequate or accurate statistical published figures of many cases of deaths, the activities were not sufficiently vigorous to constitute death. The determination of true incidences of sudden death in sport is hindered by inadequate registration and investigation of each case. For instance, Opie (1975) estimated rugby football players as 1 in 50,000 and 1 referee in 3,000 referees. Although exercise provides some protection against development or progression of coronary artery heart disease in athletes, it will not provide immunity. In actual fact,

intensive physical exertion depresses the immune system. It also causes transient increase in risk during periods of activity. This is supported by Siscovick (1982) whose study revealed that regular vigorous exercise protects against primary cardiac arrest. However, if cardiac arrest occurs, it is more likely to take place during exercise training. Lastly, athletes who exercise have a reduced likelihood of developing arteriosclerosis and a lower risk of sudden cardiac death.

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