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SUDDEN CARDIAC DEATH IN 15 TO 39-YEAR-OLD TAIWANESE POPULATION

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ABSTRACT

Background: Sudden cardiac death (SCD) among the young (15 to 39-year-old) population has gained increasing attention in recent years, above all when occurring in young people, remains a major clinical problem. **Objective**: The aim of this study is to examine the effects of age, sex, and season and causes on outpatient SCDs from 2009 to 2010 in Taiwan. Methods: Cross-sectional study.Dates were identified using the International Classification of Disease (ICD) codes of inpatient SCDs recorded by National Health Insurance Research Database (HNIRDs) from 2009 to 2010. **Results**: A total 684 SCD patients were men (70.75%), with a mean age of 30.9 years. The annual incidence of SCD increased by 17.0% from 2009 (3.53 per 100,000 person-years) to 2010 (4.13 per 100,000 person-years). The incidence was higher for men (4.85 to 5.85 per 100,000 person-years) than women (2.18 to 2.37 per 100,000 person-years). After adjusting for sex and age, increased risk of SCD in winter was observed (RR=1.30, 95% CI 0.23-1.43; p=0.01). **Conclusions**: The study posits that the major determinants of SCDs in Taiwan were male, 30 to 39 years old, and winter. Clinical diagnoses of SCDs include cardiovascular diseases of cardiac arrest(n=555, 88.66%), mitral valve prolapse, aortic valve stenosis, acute

myocarditis, and coronary artery aneurysm disease. In relation to these, ECG to a history and physical examination prevention and cardiopulmonary resuscitation (CPR) programs may help reduce the risk of SCD.

KEY WORDS: sudden Cardiac Death (SCD), incidence, young, cardiac arrest, sex distribution.

INTRODUCTION

Sudden cardiac death (SCD) is a major public health problem.[1,2] SCD is a leading cause of death in the US, but the relative public health burden remains unknown.[3]

SCD is one of the major problems in the western world with approximately 70,000 to 100,000 SCD patients in Germany and 450,000 SCD victims in the US. SCD is not caused by a single factor, but is a multi-factorial problem. In 50% of SCD victims, SCD is the first manifestation of heart disease.[4] Over the past few decades, improvements in primary and secondary prevention measures have led to significant declines in cardiac origin.[5–7] In recent prospective studies that used multiple sources from the US, SCD rates have been found to range from 0.50 to 13 per 100,000 people in the general population.[8] In the US, SCD is estimated to occur once every minute; it is the most common and often the first manifestation of coronary heart disease. in the United States.[9] Applying the incidence rates to the European and Asian populations would result in incidence rates of 0.93 to 21.7 per 100,000 people,[10-13] and 2.3 to 10.1 per 100,000 people, respectively.[14-21] In general, the sudden death (SD) risk is higher in males than in females (2–4.3:1.14),[19,22-24] and increases with age.[25] In young adults, the mortality rate for SCD per 100,000 person-years during the study period was 6.7 for males and 1.4 for females, and the incidence of SCD was higher in men than in women.[26]

Aside from being the most common and the typical first manifestation of coronary heart disease, SCD is responsible for 50% to 88% of the mortality from cardiovascular diseases in the US and in other developed countries.[9] Several population-based studies have documented a 15% to 19% decline in the incidence of SCD caused by coronary heart disease since the early 1980s. However, the increasing incidence of coronary heart disease may halt this decline in the future.[27] Continuous surveillance is necessary in clarifying future trends in SCD because of an increasing incidence of diabetes mellitus (2.2 to 13.7 per 100,000 people)

and hypertension (23.0%). The SCD risk factors have also been positively associated with increased SCD risk.[26, 28]

To the research, no study has yet to identify the risk of SCD in the15 to 39-year-old population using the outpatient SCD data recorded by HNIRDs in Taiwan. Although SCD is rare, it is usually fatal and has seen an increase in recent years. Therefore, a retrospective study was conducted to understand the incidence and contributing factors of SCD in Taiwan. We identify the young population, we examined the 15 to 39-year-old population as well as explored the influence of sex, age, seasonal patterns, and associated diseases on the incidence of SCD. Results of the study will be helpful in the development of preventive strategies.

MATERIALS AND METHODS

Definitions

A total 684people were diagnosed with SCD during 2009-2010. SCD in the young is defined as an unexpected natural death within 24 h after the onset of symptoms in persons aged 15 to 39. All cases wherein death occurred within 24 h from the onset of the underlying cause were considered SCD as long as the cause of death was either of cardiac origin or unknown. SD included sudden cardiac death (SCD), sudden non-cardiac death (SNCD) and unknown SD, which were identified from the NHIRDs from 2009 to 2010 using the ninth revision of the International Classification of Diseases, Clinical Modification (ICD-9-CM) for research population. SCDs included atherosclerotic disease (familial hypercholesterolemia, myocardial infarction, and other acute ischemic heart diseases) (ICD-9-CM 272, 410, 411), cardiomyopathy (dilated cardiomyopathy, obstructive hypertrophic cardiomyopathy, other hypertrophic cardiomyopathy, other cardiomyopathies, and total cardiomyopathy) (ICD-9-CM 425), conduction disorders (Cardiac arrhythmia), unspecified.

Ventricular tachycardia.Ventricular fibrillation and flutter. Total number of conduction disorders.Preexitation syndrome, Other specified conduction disorders) (ICD-9-CM 427,426), and other cardiac causes (cardiac arrest, mitral valve prolapse, aortic valve stenosis, acute myocarditis, myocarditis in diseases classified elsewhere, and coronary artery aneurysm) (ICD-9-CM 424,422,427.5,414). SD with unknown cause (unknown SD) (ICD-9-CM 798.1, 798.2,798.9) and sudden non-cardiac death (SNCD) included epilepsy, pulmonary embolism, non-traumatic cerebral hemorrhage, and asthma (ICD-9-CM 345, 415, 430, 431, 432, 493). Comorbidities included hypertension, hyperlipidemia, diabetes mellitus, acute gastritis, and colitis (ICD-9-CM401,250,535,558).[29] We have excluded congenital cardiac

diseases. This study protocol was approved by the institutional review board (IRB) of China Medical University Hospital (CMUH103-REC1-088).

Statistical analysis

The incidence of SCD, SD, unknown SD and SD of comorbidities were calculated by dividing the number of new cases during 2009-2010 year by the number of people at risk in the population at the beginning of the study. Descriptive data were presented as percentages. Poisson regression models were used to assess the relative risks (RRs) and 95% confidence intervals (CIs) of SCD incidence associated with sex, age, and seasonal variables. The Mantel-Haenszel (M-H) method was used to calculate odds ratios adjusted for confounders (sex and age). p-values <0.05 were considered statistically significant.

RESULTS

Demographic characteristics of SCD, unknown SD, SNCD, SCD and SCD of comorbidities

During the two-year period (2009 to 2010), 684 people from the general population were diagnosed with SCD (incidence rate: 3.83 per 100,000). Men comprised 70.75% (n: 481) of the cases, while women comprised 29.25% (n: 203). 2.37 times more men than women died from SCD, and the average age was 30.9 years. The 30 to 39-year-old group accounted for 60.00% (n: 406) of the cases, with the 20 to 29-year-old and 15 to 19-year-old groups accounting for 28.96% (n: 199) and 11.04% (n: 79), respectively.The major cause of SCD was other cardiac causes (cardiac arrest, mitral and aortic valve prolapse, acute myocarditis, and coronary artery aneurysm) 626(incidence rate: 3.43 per 100000), followed by conduction disorders 39(incidence rate: 0.22 per 100,000), and atherosclerotic diseases 23(incidence rate: 0.12 per 100,000) (Table 1).SD with unknown cause (unknown SD) had an incidence rate of 12.49 per 100,000(n: 2229). SNCD had an incidence rate of 2.92 per 100,000(n: 522).

From the general population, 3,435 were diagnosed with SD (incidence rate: 18.99 per 100,000). Men and women were involved in 71.69% (n: 2462) and 28.33% (n: 973) of the cases. The ratio of male to female incidence was 2.58:1. The average age was 31.2 years. The 30 to 39-year-old group accounted for 56.42% (n: 1938) of the cases, while the 20 to 29-year-old and 15 to 19-year-old groups accounted for 32.78% (n: 1,126) vs 10.80% (n: 371), respectively.

The SCD of comorbidities included hypertension,hyperlipidemia,diabetes mellitus, acute gastritis, and colitis. Men accounted for 70.75% (n: 208) of the cases, while women accounted for 29.25% (n: 86) (incidence rate: 1.65 per 100,000) (Table 1).

The incidences Association of SCD with age group and sex

The annual incidence of SCD increased by 17.0% from 2009 (3.53 per 100,000 person-years) to 2010 (4.13 per 100,000 person-years). The incidence was higher for men (4.85 to 5.85 per 100,000 person-years) than for women (2.18 to 2.37 per 100,000 person-years). In the incidence, the 30 to 39-year-old group (4.96 to 5.71 per 100000 person-years) had the highest incidence, while the 15 to 19-year-old group (1.98 to 2.74 per 100,000 person-years) had the lowest incidence(Table 2).

The incidence of male in 2010 was higher than that of male in 2009 (OR = 1.34, 95% CI 1.12-1.60, p<0.001).The incidence was higher in 2009 15 to 19-year-old group in 2010 than in the 15 to 19-year-old group in 2009 (OR= 1.53, 95% CI 1.24-1.88, p<0.000). The incidence was significantly higher in the 30 to 39-year-old group in 2010 than in the 30 to 39-year-old group in 2009 (OR= 1.35, 95% CI 1.13-1.61, p<0.001). The incidence was significantly higher in the all-year-old group in 2010 than in the all-year-old group in 2009 (OR= 1.29, 95% CI 1.08- 1.54, p<0.006) (Table 2).

Association of SCD with seasonal variation

The incidence of SCD was 1.10, 1.02, 0.89 and 0.82 per 100,000 person-years in winter (December to February), summer (June to August), spring (March to May), and autumn (September to November). The percentage of SCD was highest in the winter and lowest in the summer. Correspondingly, the age-adjusted RR were 1.30 (95% CI -0.23-1.43, p<0.01) in winter, 1.13 (95% CI -0.04-0.15) in summer, and -0.40 (95% CI -0.11- 0.08) in spring, (Table 3).

Table 1. Demographic characteristics of sudden cardiac death, sudden death, and comorbidities, 2009–2010.

Causes of death	ICD-9-CM	15-19 years N (%)	20-29 years N (%)	30-39 years N (%)	Male N (%)	Female N (%)	Total N (%)	incidence*
Sudden cardiac death(SCD)		79(11.04)	199(28.96)	406(60.00)	481(70.75)	203(29.25)	684(100.00)	3.83
Atherosclerotic disease								
(Familiar hypercholesterolaemi. Myocardial infarction. Other acute ischaemic heart diseases.)	272,410, 411	0(0.00)	5(21.74)	18(78.26)	21(91.30)	2(8.70)	23(100.00)	0.12
Cardiomyopathy								
Dilated cardiomyopathy, Obstructive hypertrophic cardiomyopathy, Other hypertrophic ,cardiomyopathy,Other cardiomyopathies ,Total cardiomyopathy)	425	0(0.00)	1(20.00)	2(40.00)	2(40.00)	0(0.00)	5(100.00)	0.01
Conduction disorders								
(Cardiac arrhythmia, unspecified. Ventricular tachycardia. Ventricular fibrillation and flutter. Total number of conduction disorders. Preexitation syndrome , Other specified conduction disorders)	427,426	3(7.69)	11(28.21)	25(64.10)	20(51.28)	19(48.72)	39(100.00)	0.22
Other cardiac causes								
(Cardiac arrest Mitral (valve) prolapse Aortic (valve) stenosis Acute myocarditis Myocarditis in diseases classified	427.5,424, 422,414	77(11.76)	181(29.58)	363(58.66)	443(71.24)	183(28.76)	626(100.00)	3.43

elsewhere Coronary artery aneurysm)								
Sudden death with unknown cause (unknown SD)	798	243(10.90)	768(34.46)	1218(54.64)	1608(72.14)	621(27.86)	2229(100.00)	12.49
Sudden noncardiac death (SNCD)								
(Epilepsy.Pulmonary embolism.Nontraumatic cerebral hemorrhage. Asthma)	345,415, 430,431, 432,493	52(9.96)	156(29.89)	314(60.15)	370(70.88)	152(29.12)	522(100.00)	2.92
Sudden death (SD)†	798.1,798.2,798.9	371(10.80)	1126(32.78)	1938(56.42)	2462(71.69)	973(28.33)	3435(100.00)	18.99
Comorbiditie‡								
(hypertension hyperlipidemia, Diabetes mellitus, Acute gastritis and colitis.)	401,250, 535,558	10(3.40)	76(25.85)	208(70.75)	208(70.75)	86(29.25)	294(100.00)	1.65

*Incidence rates are per 100,000 person-years during 2009-2010.

†Sudden death (SD) include Sudden cardiac death (SCD), unknown SD, and Sudden noncardiac death (SNCD).

‡Comorbidities include hypertension**, hyperlipidemia, diabetes mellitus, acute gastritis and colitis.**

Table 2. Incidence rate* of sudden cardiac death, sudden death 2009–2010, by year, age and sex group.

Variable	2010 n(Incidence rate)	2009 n(Incidence rate)	Odds ratios (ORs)†	95% confidence intervals (CIs)	*p* value
Sex					
Male	264(5.58)	220(4.85)	1.34	1.12-1.60	0.001
Female	104(2.37)	96(2.18)	1.11	0.90-1.37	0.311
Age					
15-19	44(2.74)	32(1.98)	1.53	1.24-1.88	0.000
20-29	106(3.05)	96(2.71)	1.18	0.97-1.43	0.093
30-39	218(5.71)	188(4.96)	1.35	1.13-1.61	0.001
Total	368(4.13)	316(3.53)	1.29	1.08-1.54	0.006

* Incidence rate (per 100,000 person-years) is the number of new cases of SCD divided by the size of the population at risk in each year.

* Data are represented as the number of the incidence and the rate in the parenthesis.

†The Mantel-Haenszel (M-H) method was used to calculate odds ratios adjusted for confounders (sex and age).

Table 3. Incidence rate* of sudden cardiac death, 2009-2010, by months and season

Months	n	Season	Total/Months	Incidence Rate	RR (95%CI)†	*p*-value
3	54	Spring	0.30	0.89	-0.40(-0.11~-0.08)	0.69
4	55		0.31			
5	50		0.28			
6	53	Summer	0.30	1.02	1.13(-0.04~-0.15)	0.26
7	60		0.34			
8	69		0.39			
9	46	Autumn	0.26	0.82	1(reference)	_
10	53		0.30			
11	47		0.26			
12	59	Winter	0.33	1.10	1.30(-0.23~1.43)	0.01
1	70		0.43			
2	62		0.35			

*Incidence rates are per 100,000 person-years during 2009-2010.

†The relative risks (95% Confidence Intervals, CI) are derived from Poission regression model adjusted for sex and age.

DISCUSSION

In this study, the annual year incidence of SCD was 3.53 to 4.13 per 100,000 person-years in Taiwan. The present analyses demonstrate marked variations in the occurrence of SCD, with peaks in the 30 to 39-year-old groups, in males, and during the winter months. Clinical

diagnoses of SCDs include cardiovascular diseases of cardiac arres, mitral valve prolapse, aortic valve stenosis, acute myocarditis, and coronary artery aneurysm disease. Our findings provide strong evidence of an ongoing epidemiological transition in Taiwan, where treatable cardiac causes the major of cardiac arrest were responsible for the SCD. Such evidence would be helpful in the development of preventive strategies.

In this study, 481 (70.75%) of the cases involved males and 203 (29.25%) involved females of SCD. The male-to-female ratio was 2.37:1.[14,19,30.31] Thus, given that the latter predominantly affects males, SCD is perceived as a male problem.[21,22] Similar to overall SCD, SCD in this study is more common in males than in females (mean age range: 24 to 32 years). Studies on the incidence and causes of SCD in the young (1–40 years) are often restricted to male athletes.[32-34] The age group with the highest incidence was the 30 to 39-year-old group, while the 15 to 19-year-old group had the lowest incidence. Previous studies have shown that SCD incidence increases with age.[34,35]

Our study confirmed that the incidence was at its lowest and highest in September and in January, respectively. The literature describes the relationship between cold weather and SCD.[36,37] which likely contributes to the number of deaths occurring in winter. A seasonal trend in cardiovascular diseases was observed in the current study, with the highest incidence occurring during the colder winter months. The same finding has been observed in many countries.[38-40] The implications of this finding are important for testing the relative importance of the proposed mechanisms. Furthermore, understanding the influence of seasonal patterns and other factors is essential in implementing effective public health measures. These could result in increased blood pressure through increased heart rate and peripheral vascular resistance. The seasonal variability of CVDs was clearly demonstrated by the epidemiological data, which showed mostly a peak in winter months. Many theories explain the possible reasons underlying the development of a disease in winter more than in other times of the year. Many biological aspects are also known to contribute to the development of disorders. This finding may have important implications, and the risk of cardiovascular diseases appears to be the greatest during the winter months. The knowledge of the role of environmental and biological factors could be used to improve prevention measures and educational strategies, especially in people with a risk of diseases. People should be informed of the increased risk of cardiovascular diseases during the cold seasons; they should also be educated about the importance of having regular physical activities and

dressing warmly in the winter.[37-40] Low temperature has a hazardous effect on blood pressure and may alter the ratio of myocardial oxygen supply to demand; increase ventricular wall stress, cardiac work and oxygen requirements; as well as reduce mechanical efficiency and coronary blood flow.[37,39,40] For the effective prevention of SCD across Taiwan, such variations must be considered when developing programs to reduce risk. Multiple studies on screening have shown that adding an ECG to a history and physical examination is more sensitive than history and physical examination alone in identifying those who are potentially at risk for SCD.[41]

In this study, the annual year incidence of SCD was 3.53 to 4.13 per 100,000 person-years, which is most likely because of the increasing number of cardiac arrest (n=555,88.66%) in the age groups.[42] The activation of the sympathetic nervous system and secretion of catecholamine are increased in response to cold temperatures. In this study, we observed that clinical diagnoses of SCD major causes of cardiac arrest. In cardiac rehabilitation programs, cardiac arrests occur at a rate of 1 in 12 000 to 15 000, and during stress testing, cardiac arrest occurs at a rate of 1 per 2000, at least 6 times greater than the general incidence of sudden cardiac death for patients known to have heart disease.[42] When the blood flow to the heart is stopped due to narrow or obstructed coronary arteries, a heart attack occurs. This may lead to a cardiogenic shock and cardiac arrest. The survival rate after bystander cardiopulmonary resuscitation (CPR) was 2.6-fold higher than the rate for those where no treatment was given until the ambulance arrived.[43]

The SCD of comorbidities included hypertension, hyperlipidemia,diabetes mellitus, acute gastritis, and colitis. (incidence rate: 1.65 per 100,000). The number of SCD risk factors (hypertension and diabetes) was positively associated with increased SCD risk.[44,45] Patients who have been identified to have the highest risk require the most immediate anti-chronic disease therapeutic intervention.

There are some limitations in using the Health Insurance Database in this study. First, claims data were used, which indicated that only those who visited a medical institution were enrolled. NHI database-registered cases of SCD and SD are not linked to death certificate data; therefore, we could not confirm the incidence of SCD and SD using only the relevant data from medical records. We could only confirm the cases of SCD and SD from the NHI database. Second, this database does not document job (athletes), family status and lifestyle.

The lack of such valuable information makes it difficult to evaluate the respective influences of these factors.

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