Retrospective Study
Sudden death in the southern region of Saudi Arabia: A retrospective study

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Abstract

BACKGROUND

Sudden death is unanticipated, non-violent death taking place within the first 24 h after the onset of symptoms. It is a major public health problem worldwide. Moreover, the effects of living at moderate altitude on mortality are poorly understood.

AIM

In this study, we retrospectively report the frequency and the main causes of sudden deaths in relation to total deaths at Asir Central hospital, 2255 meters above sea level, in the Southern region of Saudi Arabia over a period of 4 years from 2013 to 2016.

METHODS

The medical records of 1821 deaths were examined and showed 353 cases (19.4%) of sudden death.

RESULTS

The highest incidence of sudden death was among the elderly (51%), whereas, the lowest was among children and adolescents (6.5%). With regard to gender, the incidence of sudden death was higher in males (54.4%) compared to 45.6% in females. In this study, we found that the most common direct causes of sudden death were cardiovascular diseases (29.2%), respiratory disease (22.7%), infectious disease (12.2%), cancer (9.4%) and hematological diseases (6.2%). With respect to seasonal variation, the highest incidence was during winter (31.32%) followed by summer (25.8%).

CONCLUSION

The results of this study will definitely help emergency physicians and health care providers to exercise due care to reduce the incidence of sudden death and raise public awareness about impact of sudden death.
**Key Words:** Sudden death, High altitude, Cardiovascular, Gender distribution, Age, Seasonal variation


**Core Tip:** The effects of living at moderate altitude on mortality are poorly understood. Moreover, it has been argued that living at moderate altitudes could be more protective from development of diseases than living at high altitudes. These reported associations of various diseases incidence and mortality with different lifestyles at distinct altitude levels still need further investigation. Indeed, wide scale comparisons between different altitudes as well as sea level will definitely help address the impact of high altitude on various diseases incidence and mortality. This study’s results will help emergency physicians and health care providers to exercise due care to reduce the incidence of sudden death.

**INTRODUCTION**

Sudden death is a non-violent, unpredicted death occurring within the first day from the onset of symptoms. Sudden death occurs in all age groups: infants, children and adolescents, adults and the senior [1, 2]. The risk factors of sudden death consist of hypertension, diabetes mellitus, aging, extremes of body mass index, smoking, sedentary lifestyle, unhealthy diet and stress [3, 4]. In addition, the incidence of sudden death exhibits substantial seasonal variations with the highest peak in winter, followed by fall, spring and summer [5]. Moreover, the etiology of sudden death varies with age, gender, ethnicity and genetics [1, 6, 7]. Thus, history of previous syncope, family history of sudden cardiac death, coronary artery disease, abnormal electrocardiogram with prolongation of QTc or with the Brugada syndrome features, poor left ventricular function or features of
hypertrophic cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy should alert the physician about the risk of sudden cardiac death [8].

Noteworthy, the available data on the effects of high altitude residence on mortality from various diseases seem to be inconsistent possibly due to differences in behavioral factors, ethnicity, genetics and the complex interactions with environmental conditions. The epidemiological data indicate that living at higher altitudes are associated with lower mortality from cardiovascular and digestive diseases, certain types of cancer and stroke. In contrast mortality from respiratory diseases and suicides is somewhat elevated [8-10]. Moreover, the correct diagnosis in cases of sudden death is always a challenging task to achieve without postmortem examination. In the Kingdom of Saudi Arabia, postmortem is ordered only in cases of suspicious death, such as violence. Routine autopsies are not carried out for religious and cultural reasons, thus making the establishment of the etiology of sudden death a hard mission. Inappropriately, there is little research about the frequency, manner and etiology of sudden death in the Kingdom of Saudi Arabia. Only scarce data about sudden death are spotted in the literature. For instance, one from the medicolegal center in Dammam reported unexplained sudden death syndrome of 51 cases [11], The other one was from a university hospital in the Eastern region of Saudi Arabia [12]. Thus, this study aimed at evaluating the incidence and the main underlying causes of sudden death at Asir Central Hospital, 2255 meters above sea level, in the Southern region of Saudi Arabia over a period of four years from 2013 to 2016.

MATERIALS AND METHODS

The medical records of 1821 deaths that occurred at Asir Central Hospital over a period of four years between January, 2013 and December 2016 were retrospectively evaluated. Death was categorized as sudden death when the patient died unpredictably from non-violent causes within 24 h from the onset of symptoms of their ante-mortem clinical presentation. The others were classified as expected death.

In all cases of sudden death, the following data were collected from the medical records: personal information including age, sex, nationality, race and marital status,
history of pre-existing diseases, main complaint(s) on presentation, the findings of clinical examination and investigations, date and diagnosis of death according to death certificates, and time elapsed/passed/Lapsed between the commencement of prodromal symptoms and the onset of death. Cases who reached the hospital dead were excluded from this study. The collected data were tabulated and statistically analyzed using SPSS to examine the effect of age, gender and prodromal symptoms, past medical history and direct cause of death on the incidence of sudden death.

This work has been approved by Research Ethics Committee (REC) of College of Medicine at King Khalid University, Abha, KSA, (REC # 2016-05-01). Moreover, this study was performed in accordance with the ethical standards of the institutional research committee.

RESULTS

The data analysis revealed 353 cases (19.4%) of sudden death out of the studied 1821. The remaining 80.6% were categorized as expected death. The majority of the sudden death cases were Saudi (92.2%, n = 329) whereas, non-Saudi represented 6.8% (n = 24). As regard the distribution of sudden death among different age groups as shown in Figure 1; the peak incidence was among the elderly (51%, n = 180), whereas, it was 17.6% (n = 62), 13.6% (n = 48) and 11.3% (n = 40) among middle-aged adults, infants and young adults respectively. Only 6.5% (n = 23) of the studied sudden death cases were children and adolescents. With regard to gender, as shown in Figure 2, the incidence of sudden death was higher in males (54.4%, n = 192) compared to 45.6% in females (n = 161). In this study, we found that the most common direct causes of sudden death in relation to gender, as shown in Figure 2 and Table (1), were cardiovascular diseases [29.2%; 60 males (16.9%) and 43 females (12.2%)], respiratory disease [22.7%; 37 males (10.5%) and 43 females (12.2%)], infectious disease [12.2%; 18 males (5.1%) and 25 females (7.1%)], cancer [9.4%; 17 males (4.8%) and 16 females (4.5%)], hematological diseases [6.2%; 15 males (4.3%) and 7 females (2%)], including glucose-6-phosphate dehydrogenase (G6PD) deficiency, sickle cell disease. The other causes were diabetes
mellitus [4%: 8 males (2.3%) and 6 females (1.7%)], liver disease [2.6%: 6 males (1.7%) and 3 females (0.9%)], renal disease [3.7%: 8 males (2.3%) and 5 females (1.4%)], congenital anomaly [2.8%: 4 males (1.1%) and 6 females (1.7%)], prematurity [1.4%: 4 males (1.1%) and 1 female (0.3%)], neuropsychiatric diseases [3.7%: 9 males (2.6%) and 4 females (1.1%)], and immunological diseases [2.3%: 3 males (0.9%) and 5 females (1.4%)], including rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE). Noteworthy, the cardiovascular causes consisted of coronary artery diseases [21.8%: 50 males (14.2%) and 27 females (7.7%)], hypertension [2.8%: 7 males (2%) and 3 females (0.3%)], stroke [2%: 5 males (1.4%) and 2 females (0.6%)], cardiogenic shock [0.9%: 2 males (0.6%) and 1 female (0.3%)], and life-threatening arrhythmias [1.7%: 4 males (1.1%) and 2 females (0.6%)]. Also, the respiratory causes consisted of pneumonia [10.8%: 17 males (4.8%) and 21 females (6%)], respiratory failure [1.1%: 1 male (0.3%) and 3 females (0.9%)], asthma [2.7%: 3 males (0.9%) and 5 females (1.4%)], and chronic obstructive pulmonary disease (COPD) [8.5%: 11 males (3.1%) and 18 females (5.4%)].

With respect to seasonal variation, the highest incidence of sudden death was seen in winter (January-March) months (31.82%; \( n = 110 \)) and the lowest was during spring (April-June) (19.3%; \( n = 68 \)), whereas, it was 25.8% (\( n = 91 \)) and 23.8% (\( n = 84 \)) during summer (July-September) and autumn (October-December) respectively (Figure 3). Noteworthy, the highest incidence of expected death was almost equal during summer and winter months (28.5%; \( n = 418 \) and 28.6%; \( n = 420 \) respectively). However, the lowest incidence of expected death was during spring (18.1%; \( n = 266 \)), whereas, it was 24.8% (\( n = 264 \)) during autumn (Figure 3).

As regard the presenting symptoms, as shown in Table (2), chest pain, dyspnea, fever and disturbed consciousness were the most common presenting symptoms with frequencies of 26.6% (\( n = 94 \)), 18.4% (\( n = 65 \)), 14.7% (\( n = 52 \)) and 11.1% (\( n = 39 \)) respectively. Circulatory collapse stood at 7.7% (\( n = 27 \)), whereas, both cough and abdominal distension were equally represented with 5.4% (\( n = 19 \)) each. Also, nausea and vomiting were 3.4% (\( n = 12 \)), whereas, hemoptysis and hematemesis were almost equally represented with 1.9% (\( n = 7 \)) for the first and 2.3% (\( n = 7 \)) for the second. In addition,
seizures and prematurity were the least presenting symptoms with frequencies of 1.7% 
(n = 4) for the first and 0.7% (n = 5) for the second. Lastly, the initial presenting symptoms 
were not reported in 5 cases (1.4%).

As regard the past history (table-3), cardiovascular, respiratory, infectious, 
kidney diseases and cancer were the most commonly encountered clinical problems with 
frequencies of 23.2% (n = 82), 18.8% (n = 66), 15% (n = 53), 8.2% (n = 29) and 7.7% (n = 27) 
respectively. In addition, hematological disease and diabetes mellitus were almost 
equally represented with 4.5% (n = 16) for the first and 4.3% (n = 15) for the second. 
Moreover, both intestinal and liver diseases were equally represented with 4% (n = 14) 
each. Also, both neuropsychiatric and congenital diseases were equally represented with 
3.4% (n = 12) each. Furthermore, immunological diseases were the least reported in terms 
of past history with frequencies of 2.8% (n = 10). Lastly, there was not reported clinical 
data regarding past medical history 5 cases (0.9%).

**DISCUSSION**

Sudden unexpected death is a public health problem of paramount importance 
worldwide and Saudi Arabia is not an exception. In the present study, we reported that 
sudden unexpected death affected 19.4% of the total deaths at Asir Central hospital in the 
Southern region of Saudi Arabia between 2013 and 2016. The data presented in the 
current study were slightly higher than that of another retrospective study conducted at 
King Fahd University Hospital, Al Khobar, in the Eastern region of Saudi Arabia, which 
reported that the frequency of sudden unexpected death was 17.5% between 2000 and 
2005 [12]. These differences could be plausibly attributed to high altitude hypoxia in Asir 
region, however, this is a research question that indeed needs an in depth investigation. 
In contrast to our data, a previous study reported sudden death incidence of 41% in Canada [13]. Moreover, another study in the United States showed that sudden cardiac 
death accounted for 61% of all deaths [14]. Furthermore, another investigation of State-
wise sudden cardiac death in the United States reported that 63.4% of all cardiac deaths 
were sudden in terms of onset [15].
In the current study, the frequency of sudden unexpected death was higher in males (54.4%; 192 cases) compared to females (45.6%; 161 cases) and this is consistent with the data reported at King Fahd University Hospital in the Eastern region of Saudi Arabia, 56.0% males and 42.2% females \textsuperscript{12} and this is in agreement with international experience \textsuperscript{3,6,14-19}. However, the incidence of sudden unexpected death among Saudi was higher in our study (92.2%) compared to 74.4% Saudis at King Fahd University Hospital in the Eastern region of Saudi Arabia \textsuperscript{14}. On the contrary, the sudden unexpected death was higher among non-Saudi (25.6%) in the Eastern region \textsuperscript{12} compared to 6.8% in the current study. The plausible explanation of such differences could be weather variation between the two regions.

In the present study, sudden death has been calculated in all age groups with the highest percentage was for elderly (51%), followed by middle-aged adults (17.6%), infants (13.6%) and young adults (11.3%). However, the lowest percentage was children and adolescents (6.5%). This pattern of distribution of sudden death in terms of age is in line with data from other countries \textsuperscript{3, 20, 21}. As regard seasonal variation, the highest incidence of sudden death was seen in winter (January-March) months (31.32%; \( n = 110 \)) and it was 23.8% (\( n = 84 \)) and autumn (October-December). This is in partial agreement with the results of Katz et al in the Israeli Negev region who found the peak was in winter (31%) and fall (25%) \textsuperscript{8}. However, in a different study the highest frequency of sudden death was reported in spring (29.6%), followed by summer (25.1%), then fall and winter (22.8% each) \textsuperscript{12}. Again these variations might be plausibly explained based on the weather pattern of every region.

In line with previous studies, the most common past medical history was cardiovascular diseases including coronary artery disease, hypertension and stroke 23.2% (\( n = 82 \)) \textsuperscript{3, 12, 14, 15, 17, 18, 21-24}. However, as regard the presenting symptoms, in our study, chest pain, dyspnea, fever and disturbed consciousness were the most common presenting symptoms with frequencies of 26.6% (\( n = 94 \)), 18.4% (\( n = 65 \)), 14.7% (\( n = 52 \)) and 11.1% (\( n = 39 \)) respectively. This finding was to some extent different from the findings of another where the most frequent initial presentations were dyspnoea, fever
and prematurity followed by circulatory collapse angina and cough [12]. Moreover, previous studies found that syncope was the main presentation in cases of sudden death [25]. These discrepancies may be related to the different variables in the studied population. However, chest pain, dyspnea and fever represent the cardinal symptoms of cardiovascular and respiratory diseases, which were the two most common reasons of sudden death reported in our study.

The data presented in our study also indicated that the single most significant direct cause of sudden death was cardiovascular diseases (29.2%), which is in agreement with the previously reported findings [3, 4, 6, 12, 17, 18, 20, 22, 23]. In addition, the next most frequent causes were respiratory disease, infectious disease, cancer and haematological diseases, among others.

It has been previously demonstrated that residence at high altitude diminishes incidence of several types of cancer and related mortality [26-29]. Although environmental variation could be considered as one of the plausible explanations of regional differences in terms of incidence and mortality rates from various diseases, careful consideration of all possible confounders, such as ethnicity, genetics, urbanization, industrialization, sociocultural and socioeconomic status and adaptation to environmental stressors as well as lifestyle behaviors, is extremely difficult. Moreover, it has been argued that living at moderate altitudes could be more protective from development of diseases than high altitudes. These reported correlation of various diseases incidence and mortality with diverse lifestyles at different altitude levels still need further verification by future studies. It is noteworthy that one of the limitations of this study is the lack of real data about the causes of death from other hospitals in Saudi Arabia at the sea level. Such data from various altitude would have made this study more productive and it’s our hope that we can conduct wide scale comparisons between different altitudes as well as sea level as this will definitely help address the impact of high altitude on various diseases incidence and mortality.

CONCLUSION
This aim of this study was evaluating the incidence and the main underlying causes of sudden death at Asir Central Hospital, 2255 meters above sea level, in the Southern region of Saudi Arabia over a period of four years from 2013 to 2016. We found the frequency of sudden death was highest among the elderly and middle-aged adults followed by infants and also in winter and autumn. The most important presenting symptoms prior to death were chest pain, dyspnea and fever. Hence, it is highly recommended that health care staff in particular emergency physicians exercise due care while managing patients presenting with these initial presenting symptoms, particularly elderly patients, middle-aged adults and infants.

**ARTICLE HIGHLIGHTS**

*Research background*

Sudden death is unanticipated, non-violent death taking place within the first 24 h after the onset of symptoms. It is a major public health problem worldwide. Moreover, the effects of living at moderate altitude on mortality are poorly understood.

*Research motivation*

The effects of living at moderate altitude on mortality are poorly understood. Moreover, it has been argued that living at moderate altitudes could be more protective from development of diseases than living at high altitudes. These reported correlation of various diseases incidence and mortality with diverse lifestyles at different altitude levels still need further investigation.

*Research objectives*

Reporting the frequency and the etiology of sudden death at Asir Central hospital, 2255 meters above sea level, in the Southern region of Saudi Arabia over a period of 4 years from 2013 to 2016.

*Research methods*
The medical records of 1821 deaths that occurred at Asir Central Hospital over a period of four years between January, 2013 and December 2016 were retrospectively evaluated. Death was classified into sudden and expected categories. Death was considered sudden when the patient died unpredictably within 24 h from the onset of their ante-mortem clinical presentation. The others were classified as expected death.

**Research results**

The frequency of sudden death was highest among the elderly and middle-aged adults followed by infants and also in winter and autumn. The most important presenting symptoms prior to death were chest pain, dyspnea and fever.

**Research conclusions**

It is highly recommended that health care staff, in particular emergency physicians exercise due care while managing patients presenting with these initial presenting symptoms, particularly elderly patients, middle-aged adults and infants.

**Research perspectives**

Indeed, wide scale comparisons between different altitudes as well as sea level will definitely help address the impact of high altitude on various diseases incidence and mortality.
Figure Legends

Figure 1: Age distribution of sudden death cases at Asir Central Hospital between 2013-2016.

Figure 2: Gender distribution of sudden death cases at Asir Central Hospital between 2013-2016.

Figure 3: Seasonal variation of sudden death cases at Asir Central Hospital between 2013-2016.