



The Application of the International Classification of Diseases among Autopsy Cases of Sudden Death in Tripoli, Libya

El-Razik Mashali AA¹, Badr El Dine FMM^{2*}, Elmaguid Ahmed RA³, and Fozi Siala AA⁴

¹Professor of Forensic Medicine & Clinical Toxicology, Alexandria University, Egypt

²Associate Professor of Forensic Medicine & Clinical Toxicology, Alexandria University, Egypt

³Lecturer of Forensic Medicine & Clinical Toxicology, Alexandria University, Egypt

⁴Forensic Medical Examiner, Forensic Medicine Administration, Judicial Expertise & Research Center, Tripoli, Libya

*Corresponding Author: Badr El Dine FMM, Department of Forensic medicine & Clinical Toxicology, Faculty of Medicine, Alexandria University, Champollion Street, El- Khartoum Square, Azarita Medical Campus, Alexandria, Egypt, Tel: +201001988116, E-mail: fatmabadreldine@yahoo.com

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Abstract

Background: Sudden deaths are deemed one of the challenging tasks for forensic pathologists. The objective of this research is to assess the pattern of sudden unexpected deaths in Tripoli, Libya.

Methods: A retrospective study of forensic autopsy cases has been conducted, since the start of January 2011 till the end of December 2015, at the Medico-Legal Department of the Forensic Medicine Administration in Tripoli. The cases of sudden unexpected deaths were investigated in terms of the sociodemographic characteristics, circumstances of death and autopsy findings and classified according to the International Classification of Diseases version 10 (ICD-10).

Results: An aggregate of 13210 forensic autopsies was fulfilled in Tripoli. Two hundred and eleven autopsies were performed on sudden deaths. Males represented the highest percentage (81%). Furthermore, the mean age of the deceased was 39.66 ± 17.53 years, and the highest percentage of cases was in the 5th and 6th decades of life. Most of the deceased were married (67.3%) and belonged to urban regions (66%). The highest percentages of sudden deaths were recorded in winter and spring. Moreover, 60.3% of deaths occurred indoors. The largest percentages of sudden death were among Libyans (62%).

Conclusion: Ischemic heart diseases were on the top of the prevalent autopsy findings. Future strategies are of utmost importance to identify risk factors in target populations.

Keywords: Sudden death; Natural death; Ischemic heart diseases; Libya

List of Abbreviations: COPD: Chronic Obstructive Pulmonary Disease; DM: Diabetes mellitus; ICD-10: International Classification of Diseases version 10; MI: Myocardial Infarction; postmortem MRI: Postmortem magnetic resonance imaging; SIDS: Sudden Infant Death Syndrome; WHO: World Health Organization

Introduction

Sudden unexpected deaths remain a crucial worldwide public health problem and represent a discernible portion of the forensic cases, being even more common than unnatural deaths [1].

Each year, about 300.000 sudden deaths occur in the United States and a nearly similar figure occurs in Europe [2]. The exact incidence is not well established in many developing nations; this could be attributed to the non-recording of cases as well as the fact that, in plenty of instances, not all cases were autopsied [3].

In accordance with the International Classification of Diseases version 10 (ICD- 10), World Health Organization (WHO) defines sudden death as " a death, non-violent, occurring in less than 24 hours from the onset of symptoms. In resuscitated individuals, sudden death is defined as cardiac arrest that occurred within 1 hour of the onset of acute cardiovascular symptoms " [4]. Every unexpected sudden death has an actual or potential medicolegal aspect; as in many cases, the victim was seen alive and apparently well the few hours preceding death. Unwitnessed

death entails cases where death occurred out of the hospital with little medical information available or where the physician has not attended at the time of the terminal event of death. In all these situations, death is usually reported to the authorities for medicolegal investigation. It is not possible to affirm the reason of death from an external examination of the body. Therefore, in all such cases, the synthesis of scene investigation, medical history, autopsy findings, and ancillary studies is imperative to rule out the possibility of death due to foul play [5,6].

Libya is a North African country. According to the last issued statistics in 2016 by WHO, the total population of Libya was around 6,293,000 million inhabitants [7]. Tripoli is the largest city in Libya and the nation's capital and its population is estimated as 2 million (representing almost 30% of the total population of Libya) and the incidence of deaths is approximately 9.5 thousand per year. Although, the Tripoli population is diversely composed of many unique nationalities, it is estimated that over 1.5 million people are Libyans, plus 500 thousand migrants [8].

The Forensic Department introduces coroner services to Capital of Libya. The department was authorized to be constructed in the year 1964, and since then, it has been officially in charge of the investigations of violent and sudden unexpected deaths as well as unwitnessed deaths, especially those without an evident cause of death established by the external examination. Almost all cases of suspicious deaths within this region and from other Libyan cities are referred for postmortem examination. The department performs approximately three thousand medico-legal autopsies annually depending upon the jurisdiction.

One of the major difficulties in interpreting epidemiological data on sudden deaths is the lack of standardization in death certificate coding. Although the ICD-10 has been applied in the Arab Gulf area: Saudi Arabia, the United Arab Emirates as well as Jordan, it has not yet been implemented in Libya. International codes allow comparison between different countries and tracking of any changes over time.

Within this framework, there is lack of data pertaining to the incidence of sudden death in Libya. No previous researches were conducted to identify the substantial underlying pathology. Thereby, this study is designed to shed light on the incidence of sudden deaths, the triggering risk factors and the autopsy findings in postmortem examination. In addition, it is the first application of the International Classification of Diseases.

Subjects and Methods

The study is a retrospective, cross-sectional one based on the analysis of all medico-legal reports related to sudden unexpected deaths from the 1st of January 2011 to the end of December 2015.

Cases were compiled from the archives of the Medico-Legal Department of the Forensic Medicine Administration in Tripoli, Libya, after obtaining an official approval.

Selection of Cases

Decedents who had a recorded history compatible with sudden death (defined as a death that occurs within 24 hours of the onset of symptoms).

Criteria of Exclusion

Cases with file missing data, or with a positive toxicological analysis finding as well as cases showing marked putrefaction. Moreover, any deaths related to violence, accidents or suicide were omitted from the study.

The reports were thoroughly reviewed, and the appropriate data was filled in a specially designed data sheet, including:

- **Demographic data of the decedent:** age, sex, marital status, residence, employment status and nationality.
- **Habits data** (Smoking, drug abuse and alcohol) and past medical history.
- **Circumstances of death:** Season, place of death, specific events related to death and the presence of witness.
- **The results of forensic examination were also recorded for each case.**

Autopsies were performed when requested by judicial authorities for unexpected sudden deaths.

External examination of the cadavers as well as internal examination of the organs; specimens, including heart blood, peripheral blood, urine, bile, vitreous humor, stomach contents, kidney, and liver, were assembled from each case at autopsy. The autopsy followed the international recommendations [9].

Gross and microscopic pathological examination was done for specimens taken from studied cadavers; ICD-10 was used to give every case its code.

- Both blood and tissue samples were collected for systemic toxicological analysis according to regular procedures and sent to the Toxicology Section of the Council of Forensic Medicine in Tripoli.

Ethical Considerations

An official approval was obtained from the Ethical Committee of Alexandria's Faculty of Medicine.

Statistical Analysis

The amalgamated data was organized, tabulated and statistically-analyzed using an SPSS software statistical computer package, version 20. Categorical variables are summarized using counts and proportions. A Chi square was used as a test of significance. The level of significance was set at the p value <0.05.

Results

Among the total autopsies (13210) performed during the five-year reference period of the study, sudden unexpected deaths accounted for 1.59% of all forensic autopsy cases (211 cases). The lowest percentage of cases of sudden death (1.25% of autopsied cases) was reported in 2011, while their highest percentage was recorded in 2015 (2.68% of autopsied cases) (Table 1).

The age and sex distribution are displayed in Table 2. Males outnumbered females (81% and 19 % respectively) with a male- to- female ratio of 4.275:1.

The highest percentage of the deceased was married (67.3%), while single, widow/er and divorced cases represented 29.4%, 1.9% and .9% respectively. Also, 36.5% of cases were employed, followed by manual workers (24.6%), then the unemployed (12.8%). Students and housewives represented the least percentage (10.4 % and 10 % respectively). Sixty-six per cent of sudden deaths belonged to the urban community and 34 % of them were from rural areas. Considering nationality, Libyans constituted 63.5% of the cases, while 36.5% were non-Libyans. Most Non-Libyan cases were Africans: Egyptians (7.6%), Chadians (4.7%) and Tunisians (4.3%) with a small percentage from Asian countries (Pakistanis 1.9%), Palestinians 0.9%, Indians 0.9%, Iraqis 0.5%, Syrians 0.5%, Bangladeshis, Thai and Turkish (0.5% each).

Smokers represented about three-quarters of all cases (69%). Substance abuse was reported in about 2% of all cases. Alcohol use disorder was declared in 10 % of cases.

Nearly one third of cases (30.3%) had a history of chronic controlled illnesses. There was no statistically significant relation between the presence of chronic illness and sex, where $X^2=3.458$ and $p=0.063$. On the other hand, there was a statistically significant relation between the type of chronic illness and sex, where $X^2=17.321$ and $p=0.015$ (Table 3).

As for seasonal variation, cases of sudden death were equal during winter (32.7%) and spring (32.2%), while they decreased through the summer and autumn seasons (19.9% and 15.2% respectively). There was no statistically significant difference between the season and sex, where $X^2=1.154$ and $p=0.764$.

Death happened mostly at home in 57.3% of cases, followed by at hospital in 30.3%. The least took place in public places and at work (6.6% and 5.7% respectively). There was a statistically significant relation between the place of death and sex, where $X^2=17.296$ and $p=0.001$.

Sudden deaths during sleep contributed to 34.6% of all cases, 30.3% happened during receiving medical treatment, 26.1% happened while performing routine daily activity and 6.2% were associated with physical activity. A significant relation was revealed between the place of death and sex ($X^2=17.296$ and $p=0.001$), as well as between the circumstances of death and sex ($X^2=20.118$ and $p=0.000$).

Table 4 shows the distribution of the studied cases regarding the cause of death.

Table 5 reveals a statistically significant difference between pathological diagnosis and the sex of cases, where $X^2=39.375$ and $p=0.006$.

There was a statistically significant difference between the cardiovascular diagnosis and sex, where $X^2=18.436$ and $p=0.01$. In addition, a history of alcohol use disorder was positive in 33.3% of ischemic heart diseases and in 14.3% of myocardial infarction autopsy cases. Ischemic heart diseases (ICD: I25.10) represented 30.8% of all causes of sudden death and 52.8% of pure cardiovascular, the least was dissecting aneurysm (I71.01) at 0.5% of all autopsy cases (0.8% of cardiovascular etiology).

The most common respiratory pathology was acute bronchopneumonia (ICD: J18.9) in 80.3% of respiratory cases, followed by Tuberculosis (ICD: A15) in 8.5%. A diffuse alveolar hemorrhage (ICD: R04.89) represented the least percentage 1.4%. No statistically significant difference was noticed between respiratory diagnosis and sex, where $X^2=7.359$ and $p=0.118$.

Encephalitis (ICD: G40) and intracranial hemorrhage (ICD: I60) represented 80% of cases with central nervous system pathology. Yet, no statistically significant difference was recorded between central nervous pathology and sex, where $X^2 = 5$ and $p=0.082$.

Acute pancreatitis (ICD: K85) represented 75% of gastrointestinal pathologies (2/3 cases with acute pancreatitis were males with a positive history of alcohol use disorder), while rupture esophageal varices (ICD: I85.01) represented 25% of gastrointestinal cases, (males with positive history of alcoholism). There was no statistically significant difference between gastrointestinal pathology and sex, where $X^2=0.444$ and $p=0.505$.

The cardiac and circulatory failure accounts for more than half of the cases of sudden death (59.7%). Respiratory failure represented 30.8%, 7.1% died from cardiopulmonary failure and only 2.4% died due to failure of brain centers.

There was a statistically significant relation between the cause of death and the age of cases where $X^2=44.25$, $p=0.001$, cardiovascular pathologies were commonly encountered in the age group from 40-59 years. The respiratory, the central nervous and the gastrointestinal systems pathologies mostly affected the age group 20-39 years. The genitourinary and combined systems were more common in cases aged less than 19 years.

A significant relation was revealed between the cause of death and sex, where $X^2=8.88$ $p=0.11$. Males represented 84.6% of cardiovascular cases, 80% of central nervous cases, 75% of gastrointestinal and 74.6% of respiratory cases.

The cardiovascular and respiratory systems were the most frequent affected systems in both urban and rural areas. No statistically significant association was detected between residence and cause of death where $X^2=3.110$, $p=0.683$.

There was a statistically significant relation between the cause of death and the marital state of the cases ($X^2=52.546$, $p\leq 0.001$). The cardiovascular and respiratory systems were more common in married cases (78.9% and 53.5% respectively), while the central nervous, gastrointestinal and genitourinary systems were commonly present in single cases (40%, 75% and 100% respectively).

There was no significant association between the history of smoking and the cause of death, where $X^2=9.35$, $p=0.09$. On the other hand, there was a significant association between the history of substance abuse and the cause of death ($X^2=13.29$, $p=0.02$). Twenty-five per cent of gastrointestinal cases and 2.4% of cardiovascular system cases had a positive history of substance abuse (as taken from families).

There was no statistically significant association between the presence of chronic illness and the cause of death, where $X^2=9.093$ $p=0.1$.

Thirty-five per cent of cardiovascular system cases and 57.1% of combined systems cases died during sleep, while cases of other systems died during receiving medical treatment. There was a significant association between the circumstances of death and the cause of death, where $X^2=40.373$, $p=0.004$.

Year	Total number of autopsied cases	Number of sudden death cases	% among autopsy cases
2011	5206	65	1.25 %
2012	1598	35	2.17 %
2013	2978	41	1.36 %
2014	2107	35	1.66 %
2015	1321	35	2.68 %
Total	13210	211	1.59%

Table 1: Distribution of the studied cases of sudden death (n=211) throughout the years of study

Age groups	Male	Female	Total
	No. (%)	No. (%)	No. (%)
<19	17(9.9%)	6(15%)	23(10.9%)
20-39	62(36.3%)	16(40%)	78(37%)
40-59	71(41.5%)	12(30%)	83(39.3%)
60-79	19(11.1%)	6(15%)	25(11.8%)
>80	2(1.2%)	0(0%)	2 (0.9%)
Total	171(100%)	40(100%)	211(100%)
$X^2=2.859$ $p=0.582$			

X^2 : Chi square test

*p value significant when $p<0.05$

Table 2: Distribution of the studied cases of sudden death (n=211) regarding the age groups and sex

Type of chronic illness	Male	Female	Total
	No. (%)	No. (%)	No. (%)
Hypertension	25(14.6%)	5(12.5%)	30(14.2%)
DM	7(4.1%)	6(15%)	13(6.2%)
DM & Hypertension	6(3.6%)	1(2.5%)	7(3.3%)
Other chronic illnesses	7(4.1%)	3(7.5%)	10(4.7%)
DM & others	0(0%)	2(5%)	2(0.9%)
Hypertension & others	1(0.6%)	0(0%)	1(0.5%)
DM, hypertension & others	1(0.6%)	0(0%)	1(0.5%)
None	124(72.5%)	23(57.5%)	147(69.7%)
Total	171(100%)	40(100%)	211(100%)
X²=17.321 p=0.015*			
Diabetes mellitus. Others: epilepsy, pulmonary obstructive disease (asthma and Chronic Obstructive Pulmonary Disease COPD).			

X²: Chi square test

*p value significant when p≤0.05

Table 3: Distribution of the studied cases of sudden death (n=211) regarding the type of chronic illnesses

Cause of death	Sex		Total
	Male	Female	
	No. (%)	No. (%)	No. (%)
Cardiovascular system	104(60.8%)	19(47.5%)	123(58.3%)
Respiratory system	53(31%)	18(45%)	71(33.6%)
Combined system	7(4.1%)	0(0%)	7(3.3%)
Central nervous system	4(2.3%)	1(2.5%)	5(2.4%)
Gastrointestinal system	3(1.8%)	1(2.5%)	4(1.9%)
Genitourinary system	0(0%)	1(2.5%)	1(0.5%)
Total	171(100%)	40(100%)	211(100%)
X²=8.887 p=0.114			

X²: Chi square test

*p value significant when p<0.05

Table 4: Distribution of the studied cases of sudden death (n=211) regarding the cause of death and sex

Pathological diagnosis	ICD-10 Code	Male	Female	Total
		No. (%)	No. (%)	No. (%)
Cardiovascular system				
Ischemic heart disease	I25.10	57(33.3%)	8(20%)	65(30.8%)
Myocardial infarction	I21	22(12.9%)	4(10%)	26(12.3%)
Cardiomyopathy	I42	11(6.4%)	3(7.5%)	14(6.6%)
Pericarditis	I30	9(5.3%)	1(2.5%)	10(4.7%)
Myocarditis	I40	3(1.8%)	0(0%)	3(1.4%)
Rheumatic heart disease	I05-09	2(1.2%)	0(0%)	2(0.9%)
Pulmonary embolism	I26	0(0%)	2(5%)	2(0.9%)
Dissecting aneurysm	I71.01	0(0%)	1(2.5%)	1(0.5%)
Respiratory system				
Acute bronchopneumonia	J18.9	46(26.9%)	11(27.5%)	57(27.0%)
Tuberculosis	A15	3(1.8%)	3(7.5%)	6(2.8%)
Bronchial asthma	J45.21	2(1.2%)	2(5%)	4(1.9%)
COPD	J44.1	2(1.2%)	1(2.5%)	3(1.4%)
Diffuse alveolar hemorrhage	R04.89	0(0%)	1(2.5%)	1(0.5%)
Central nervous system				
Encephalitis	G40	2(1.2%)	0(0%)	2(0.9%)
Intracranial hemorrhage	I61	2(1.2%)	0(0%)	2(0.9%)
DM & DKA	E13.1	0(0%)	1(2.5%)	1(0.5%)

Pathological diagnosis	ICD-10 Code	Male	Female	Total
		No. (%)	No. (%)	No. (%)
Gastrointestinal system				
Acute pancreatitis	K85	2(1.2%)	1(2.5%)	3(1.4%)
Rupture esophageal varices	I85.01	1(1.6%)	0(0%)	1(0.5%)
Genitourinary system				
Rupture ovarian cyst	N83.20	0(0%)	1(2.5%)	1(0.5%)
Combined systems				
MI with Bronchopneumonia	I21-J18.9	4(2.3%)	0(0%)	4(1.9%)
SIDS	R95	3(1.8%)	0(0%)	3(1.4%)
Total		171(100%)	40(100%)	211(100%)
X²=39.375 p=0.006*				
<i>COPD = Chronic Obstructive Pulmonary Disease. DKA = Diabetic Ketoacidosis. SIDS = Sudden Infant Death Syndrome.</i>			<i>DM = Diabetes Mellitus. MI = Myocardial Infarction.</i>	

X²: Chi square test

*p value significant when p<0.05

Table 5: Distribution of the studied cases of sudden death (n=211) regarding the pathological diagnosis and sex

Discussion

Sudden death is devastating to families and communities because of the unexpected nature of death and the age of the victim. It is especially troubling because these patients are seemingly healthy compared with their adult counterparts, that is so often responsible for arousing the suspicion of violence [10,11].

The frequency and pattern of sudden unexpected deaths are known to reflect the disease pattern prevalent in any geographic location and thus vary in different parts of the world. Since a multitude of such deaths is unwitnessed, the magnitude of the problem is difficult to ascertain. Contemporary data on sudden death incidence in Libya are lacking. To the best of our knowledge, this is the first study to document the incidence and causes of sudden deaths in Tripoli, Libya, and to introduce the International Classification of Diseases to assign autopsy cases.

The present study reveals that the mean number of sudden deaths was 1.59% of autopsied cases. This was lower than that found by Zanjad and Naresh in Jordan (2015) [5] where the incidence of sudden natural deaths was 8.92%. In another study conducted by Nofal *et al.* (2011) [12] in Saudi Arabia, the incidence was 17.5% of all medico-legal autopsies. The lower number of cases in the current study may be explained by the fact that many cases of sudden deaths in Tripoli are not transferred for forensic examination; therefore the number might represent only the tip of an iceberg.

In contrast, a previous study by Krahn *et al.* (2004) [13] in Canada, reported an incidence of sudden death of 41%; higher rates in developed countries are most probably due to stressful life styles.

In the present study, the lowest percentage of cases was recorded in 2011 (1.25%); that was the time of the Libyan Revolution; the number of cases who died by other causes (especially firearm) was markedly increased with a relative decrease in the number of sudden deaths. The total number of cases returned to the normal average afterwards as routine life returned to normal.

The current study reveals that the most common causes of sudden unexpected deaths were pathologies in the cardiovascular system (58.3%) and respiratory system (33.6%), followed by those in the central nervous system which constituted 2.4% of causes of sudden natural death. This was similar to what was found by Nofal *et al.* (2011) [12] and Pelemo *et al.* (2014) [14].

In the present study, the ages ranged from one year to 85 years with a mean of age 39.66±17.53 years. This agreed with the study made by Pelemo *et al.* (2014) [14] in Nigeria, where the mean age was 43.1±19.5 years.

Eighty-one per cent of the cases in the current study were males. This coincides with various reports which demonstrated that males are at higher risk of non-violent sudden unexpected deaths than females. In a previous study by Azmak (2007) [15], males represented 83.4% of cases and in the study conducted by Ambade (2002) [16], they constituted 79.27%.

This male prevalence that came hand in hand with the predominance of cardiovascular causes of sudden natural death can be explained by the fact that males are more common to be exposed to cardiovascular diseases as the estrogen

hormone in females is a protective factor against acute cardiovascular attacks [11].

Additionally, the culture and the socioeconomic status of the Arab population have a great impact on the health care seeking behavior, where males usually do not complain, tolerate pain and refuse to seek medical treatment till end stages or when the pathological problem became severe or even terminal. These victims could be unaware of their prevailing medical conditions. On the other hand, women seek medical care immediately in response to physical or mental health concerns [17].

Most studied cases were married (67.3%) coinciding with the results reported by Kumar *et al.* (2007) [18] among Malaysians. This is most likely owing to the stressful life style of married individuals. However, other studies reported that marriage is beneficial for an individual health [19,20].

In the present study, cases from urban areas represented nearly one third of all cases, as all cases of sudden death were referred to the Forensic Medicine Administration in Tripoli Morgue at the center of Tripoli. Furthermore, it is well known that urban life is more stressful than rural one.

In the current study, the incidence of sudden death was higher among the employed and manual workers, as they are continuously exposed to work stresses.

Regarding nationality, most of reported cases in the present study were Libyans (62%) which was logic, as despite the multi-nationalities that were present in Libya; most of them left after the Libyan Revolution in 2011.

Considering smoking and drug abuse, smokers represented about nearly two thirds of all cases of sudden death (69.2%), a close percentage was declared by Srivatsa *et al.* (2016) [21]. History of smoking was high among cases of cardiovascular causes of death (64.4%). This could be explained by the fact that cigarette smoking promotes platelet aggregation and catecholamine surges, increasing the likelihood of plaque rupture, coronary vasospasm and thrombus formation which lead to sudden cardiac deaths [22].

Considering the history of smoking among cases of the respiratory system, it was positive in 28.8% of those cases. That is well explained by the effect of smoking on the respiratory system as it causes alterations of surfactant quality, hypertrophy and hyperplasia of mucus secreting glands. Smoking is considered the most important risk factor of chronic obstructive pulmonary disease [23].

Drug abuse was reported in about 2% of all cases, yet no further details concerning toxicological analysis were documented. Alcohol consumption was declared in 10% of all cases, positive history was reported in 75% of gastrointestinal and 11.4% of cardiovascular pathologies.

Seasonal association with cardiac pathology was prevalent in the current study. The high percentage of sudden cardiac deaths was recorded in spring in accordance with the studies conducted by Goerre *et al.* (2007) [24] and Loughnan *et al.* (2008) [25]. The second-high number of cases was encountered in winter, in accordance with the study conducted by Xu *et al.* (2013) [26] in China between the years 2006 and 2010. The winter season was associated with the peak incidence of cardiovascular death. Cold weather triggers cardiac overload provoked by greater coronary resistance, in addition higher levels of inflammation determined by the increased fibrinogen levels, C-reactive proteins and thrombus formation hastening the atherosclerosis, and hence sudden death from acute myocardial infarction [27]. However, no significant relation was found in the current study between the season and sex of the deceased. This could be explained by the small number of females included in the research.

Home was the first encountered place of sudden deaths in the present work, followed by hospital. A significant relation was found between the place of death and sex. All female deaths took place in either hospital or at home. The culture and the socioeconomic status of the Libyan population have a great impact on the health care seeking behavior; where males do not complain, withstand any pain and refuse to seek the appropriate medical treatment till the end stages or when the pathological problem becomes severe or even terminal. Another explanation is that these victims were unaware of their prevailing medical conditions. On the other hand, women seek more medical care in response to either physical or mental health concerns.

Ischemic heart disease (ICD: I25.10) was on the top of the underlying cardiac pathologies (30.8%), with evident myocardial infarction (ICD: I21) in 12.3% of cases. These results were in line with those reported by Nofal *et al.* (2011) [12] and even with the studies concerning developed countries [28,29].

Cardiomyopathy (ICD: I42) was the second leading cause of death in the cardiovascular system which represented 6.6% of the cases of sudden death, followed by pericarditis (ICD: I30) (4.7%), and myocarditis ICD: I40 (1.4%). This agreed with the results achieved by Wisten *et al.* (2002) [30].

In addition, rheumatic heart disease (ICD: I05-09) constituted only 0.9% of cases in accordance with Pelemo *et al.* (2014) [14].

In the current study, no significant association was recorded between the cardiac pathology and sex, in contrary to the results of Papadakis *et al.* (2009) [31] in the United Kingdom. The controversy between both studies may be due to the difference in the sample size. On the other hand, a significant relation was declared in the present study between the cardiac pathology and the age of the deceased. About 75% of cases of ischemic heart diseases (with or without infarction) were detected in the age above 40 years, in accordance with the results of Fragkouli *et al.* (2010) [32].

Regarding the respiratory causes of sudden death, they accounted for 33.6% of cases in the current study. Acute bronchopneumonia (ICD: J18.9) was the most common cause of death in the respiratory system; it represented 27% of cases, which makes it the second leading cause of death in all the studied cases. Pulmonary tuberculosis (TB) ICD: A15 was reported in 2.8% of cases of sudden death. A previous research by Alkhuja *et al.* (2001) [33] concluded that bronchopneumonia is the leading cause of TB - related sudden death TBRSD. Bronchial asthma ICD: J45.21 in this study was 1.9% of all causes of sudden death. A study done by Gullach *et al.* (2015) [34] found that the cause of death in 27% of cases was due to a fatal asthma attack.

Considering the causes of sudden natural death in the central nervous system, they represented 2.4% of cases in the present study. As for infectious diseases, encephalitis ICD: G40 was the cause of death in 0.9% of cases of sudden death. This is partially in accordance with the study of Ugiagbe *et al.* (2012) [35] where the common CNS lesions encountered were meningoencephalitis which occurred in 45% of cases. Intracerebral hemorrhage ICD: I61 represents 0.9% of causes of sudden death in contrast with those reported by Pelemo *et al.* (2014) [14].

Regarding the gastrointestinal causes of sudden death (1.9% of cases), acute pancreatitis ICD: K85 was detected in three cases (1.4%) (2/3 of the cases was males and had a positive history of alcohol use disorder). This was in partial agreement with the study conducted by Tsokos and Braun (2007) [36] in Germany where the frequency of cases of acute pancreatitis that presented as sudden death were 0.44% over the 5-year period of the study.

Conclusion

In conclusion, in the present study, affection of the cardiovascular system was the most common cause of sudden death, especially Ischemic heart diseases, followed by the respiratory system diseases (bronchopneumonia).

The research at hand represents the first step to apply the International Classification of Diseases as a tool to classify the different pathologies of sudden death. In the future, it will be of utmost importance to implement ICD 10 in all medical reports as well as death certificates all over the country to achieve accurate and universally comparable mortality statistics.

The results merit additional studies to find the magnitude of sudden deaths among the Arab countries population.

Limitations

The current study however has some limitations; the history of the deceased is vital and is an indispensable part of the investigation, as insufficient or irrelevant data can hinder the forensic examiner, and consequently alter the final diagnosis.

In the Forensic Medicine Administration of Libya, there is still a lack of data documentation in the medicolegal reports as the history concerning the treating medications is eventually important and can point to a particular disease linked with sudden death. Despite the fact that; the procedure of forensic autopsy follows the international guidelines, there are still some weak points recorded. Although assessment of heart weight and measurement is crucial to diagnose heart diseases, it is not yet a routine part of the postmortem examination.

Ethical Approval and Consent to Participate

Cases were compiled from the archives of the Medico-Legal Department of the Forensic Medicine Administration in Tripoli, Libya after obtaining an official approval.

An official approval was obtained from the Ethical committee of Alexandria faculty of medicine, Egypt.

References

1. Yang KM, Lee SY, Kim YS, Seo JS, Lee YS, et al. (2009) Guidelines for forensic assessment of natural unexpected cardiovascular death. *Basic Appl Pathol* 1: 155-63.

2. Sans S, Puigdefábregas A, Paluzie G, Monterde D, Balaguer-Vintró I (2004) Increasing trends of acute myocardial infarction in Spain: the MONICA-Catalonia Study. *Eur Heart J* 26: 505-15.
3. de la Grandmaison GL (2006) Is there progress in the autopsy diagnosis of sudden unexpected death in adults? *Forensic Sci Int* 156: 138-44.
4. WHO (2011) International statistical classification of diseases and related health problems. 10th revision. Geneva, Switzerland.
5. Zanjad NP, Nanadkar SD (2006) Study of Sudden Unexpected Deaths in Medico-Legal autopsies. *JIAFM* 28: 27-30.
6. Saukko P, Knight B (2015) *Knight's Forensic Pathology*. 4th (Edn.) CRC press, London, 515-52.
7. <http://www.who.int/countries/lby/en/>
8. Osama Kh Ali, Hashim N, Rostam K, Jusoh H (2011) Population Growth in the Region of Tripoli, Libya. *AJBAS* 5: 1609-15.
9. Adams V (2008) Guidelines for reports by autopsy pathologists. Humana, Totowa, USA.
10. Sampson BA, Adams VI, Hirsch CS (2006) Sudden and unexpected death from natural causes in adults. In: Spitz WU. *Medicolegal Investigation of Death: Guidelines for the Application of Pathology to Crime Investigation*. 4th (Edn.) Charles C. Thomas, Publisher, USA.
11. Ingles J, Semsarian C (2007) Sudden cardiac death in the young: a clinical genetic approach. *Intern Med J* 37: 32-37.
12. Nofal HK, Abdulmohsen MF, Khamis AH (2011) Incidence and causes of sudden death in a university hospital in eastern Saudi Arabia. *EMHJ* 17: 665-70.
13. Krahn AD, Connolly SJ, Roberts RS, Gent M (2004) Diminishing proportional risk of sudden death with advancing age: implications for prevention of sudden death. *Am Heart J* 147: 837-40.
14. Pelemo OE, Sabageh D, Komolafe AO, Sabageh AO, Odesanmi WO (2014) An autopsy review of sudden unexpected natural deaths in a suburban Nigerian population. *Popul Health Metr* 12: 26.
15. Azmak AD (2007) Sudden natural deaths in Edirne, Turkey, from 1984 to 2005. *Med Sci Law* 47: 147-55.
16. Ambade VN (2002) Study of natural deaths in Nagpur Region. *MLAM* 14:11-4.
17. Morentin B, Audicana C (2011) Population-based study of out-of-hospital sudden cardiovascular death: incidence and causes of death in middle-aged adults. *Rev Esp Cardiol* 64: 28-34.
18. Kumar V, San KP, Idwan A, Shah N, Hajar S, et al. (2007) A study of sudden natural deaths in medico legal autopsies in University Malaya Medical Centre (UMMC), Kuala Lumpur. *J Forensic Leg Med* 14: 151-4.
19. Waite LJ, Lehrer EL (2003) The Benefits from Marriage and Religion in the United States: A Comparative Analysis. *Popul Dev Rev* 29: 255-76.
20. Ryan LH, Wan WH, Smith J (2014) Spousal social support and strain: impacts on health in older couples. *J Behav Med* 37:1108-17.
21. Srivatsa UN, Swaminathan K, Munavarah K, Amsterdam E, Shantaraman K (2016) Sudden cardiac death in South India: Incidence, risk factors and pathology. *Indian Pacing Electrophysiol J* 16: 121-5.
22. Adabag AS, Luepker RV, Roger VL, Gersh BJ (2010) Sudden cardiac death: epidemiology and risk factors. *Nat Rev Cardiol* 7: 216-25.
23. Bodduluri S, Newell JD, Hoffman EA, Reinhardt JM (2013) Registration Based Lung Mechanical Analysis of Chronic Obstructive Pulmonary Disease (COPD) Using a Supervised Machine Learning Framework. *Acad Radiol* 20: 527-36.
24. Goerre S, Egli C, Gerber S, Defila C, Minder C, et al. (2007) Impact of weather and climate on the incidence of acute coronary syndromes. *Int J Cardiol* 118: 36-40.
25. Loughnan ME, Nicholls N, Tapper NJ (2008) Demographic, seasonal, and spatial differences in acute myocardial infarction admissions to hospital in Melbourne Australia. *Int J Health Geogr* 7: 42.
26. Xu B, Liu H, Su N, Kong G, Bao X, et al. (2013) Association between winter season and risk of death from cardiovascular diseases: a study in more than half a million inpatients in Beijing, China. *BMC Cardiovas Disord* 13: 93.
27. Bhaskaran K, Hajat S, Haines A, Herrett E, Wilkinson P, et al. (2009) Effects of ambient temperature on the incidence of myocardial infarction. *Heart* 95:1760-9.
28. Chugh SS, Reinier K, Teodorescu C, Evanado A, Kehr E, et al. (2008) Epidemiology of Sudden Cardiac Death: Clinical and Research Implications. *Prog Cardiovasc Dis* 51: 213-28.
29. Maas AH, Appelman YE (2010) Gender differences in coronary heart disease. *Neth Heart J* 18: 598-602.
30. Wisten A, Forsberg H, Krantz P, Messner T (2002) Sudden cardiac death in 15-35-year old in Sweden during 1992-99. *J Intern Med* 252: 529-36.
31. Papadakis M, Sharma S, Cox S, Sheppard MN, Panoulas VF, et al. (2009). The magnitude of sudden cardiac death in the young: a death certificate-based review in England and Wales. *Europace* 11: 1353-8.
32. Fragkouli K, Vougiouklakis T (2010) Sudden cardiac death: An 11-year postmortem analysis in the region of Epirus, Greece. *Pathol Res Pract* 206: 690-4.
33. Alkhuja S, Miller A (2001) Tuberculosis and sudden death: a case report and review. *Heart Lung* 30: 388-91.
34. Gullach AJ, Risgaard B, Lynge TH, Jabbari R, Glinge C, et al. (2015) Sudden death in young persons with uncontrolled asthma - a nationwide cohort study in Denmark. *BMC Pulm Med* 15: 35.
35. Ugiagbe EE, Ugiagbe RA (2012) Causes of sudden natural death: A medico-legal autopsy study of medical cases in an African referral center. *East Afr Med J* 89: 332-8.
36. Tsokos M, Braun C (2007). Acute pancreatitis presenting as sudden, unexpected death: an autopsy-based study of 27 cases. *Am J Forensic Med Pathol* 28: 267-70.