Med. J. Cairo Univ., Vol. 92, No. 1, Accepted 11/2/2024
DOI: 10.22608/MJCU. 281-294, March 2024
www.medicaljournalofcairouniversity.com

Exploring Etiological Causes of Sudden Unexpected Death in Autopsied Cases of Acute Lung Injury and Associated Acute Myocardial Injury in Egypt between 2009 and 2014: Analysis Study

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Abstract

Background: Sudden unexplained deaths present challenges for forensic pathologists as they do not deal only with traumatic deaths, but also with a wide range of natural deaths. These are mostly sudden, unexpected, clinically unexplained, or otherwise obscure deaths. The cardiovascular disorders being a primary focus is the leading cause of sudden unexpected deaths (SUDs).

Aim of Study: This study aimed to improve management of patients attending emergency department with AMI in acute respiratory failure cases by reviewing the cases of ALI in SUDs and define the etiology and the underlying causes among the Egyptians through conduction of comprehensive analysis of the etiological causes of deaths in cases suffered from massive lung pathology as in cases of ALI and fatal heart pathology as in cases acute myocardial infarction in 80 autopsy cases from anonymous archives of cases of sudden / unexpected death that were admitted to the EFMA in Egypt between 2009 and 2014.

Material and Methods: A comprehensive autopsy analysis was conducted, focusing on the presence of AMI and ALI without histopathological or immunohistochemical assessments.

Results: Among the subjects, 65% exhibited additional lung diseases, with approximately 35% showing signs of ALI. Notably, 60% presented with coronary artery disease, and 40% showed cardiac muscle damage.

Conclusion: The findings suggest a potential association between myocardial damage and ALI in unexpected deaths. This study underscores the importance of routine cardiac evaluation in ALI cases to rule out cardiac involvement. Further research is warranted to understand the complex relationship between AMI and ALI.

Key Words: Sudden unexplained deaths – Acute myocardial infarction – Acute lung injury – Forensic pathology – Autopsy analysis.

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Introduction

SUDDEN unexpected death refers todeaths occurring within 24 hours from onset of symptoms, often in young or apparently healthy people. According to Shepherd **[1]**, the terms “sudden” and “unexpected” are not interchangeable. The former does not necessarily imply the latter, and vice versa **[1].** However, the two often coexist. Acute myocardial infarction (AMI) is the leading cause of sudden unexpected deaths (SUDs), with cardiac causes accounting for up to 56% of such deaths **[2]**. However, the exact incidence of extra-cardiac causes is not well-estimated because sudden death cases are not systematically autopsied **[3].** While cardiac causes are most common (66%), non-cardiac causes make up over 30% of SUDs. These include 12% from respiratory causes, 12% neurological, 3% abdominal, and 4% unexplained **[4].**

Identification of MI as a contributing cause of death is common in patients at autopsy **[5,6].** Immunohistochemical staining is usually required to diagnose early myocardial infarctions that are not yet recognizable on hematoxylin and eosin **[7,8,9].**

Acute lung injuries (ALI), manifesting as acute respiratory distress syndrome (ARDS), likely comprise a significant portion of respiratory SUDs **[10,11]**. According to Fraser, **[12]** and Thille et al. **[13]**, acute lung injury (ALI) resulting from various causes of shock manifests pathologically as diffuse alveolar damage. The clinical presentation of adult respiratory distress syndrome (ARDS) may develop insidiously or over the period of hours or days

after the initiating event. AMI has been suggested to be associated with ALI in approximately 17% of patients and is associated with poor short- and long-term prognosis [14-17]. The prompt and correct diagnosis of AMI in patients with a nonspecific presentation of ALI in the emergency department may improve survival [18,19]. The role of ALI associated with AMI has been studied and may be as important as elevated pressures. However, there is no report that has described pulmonary findings related to possible inflammation in such patients so far [20,21].

Material and Methods

Using an anonymized archives database of sudden unexpected death cases recorded to the Egyptian Forensic Medicine Authority (EFMA), Pathology Department during January 2009 and December 2014, this study employs a cross-sectional retrospective case series design (analytical study). The study started after taken approval from Research Ethics committee for Human and Animal Research at the Faculty of Medicine, Helwan University (FMHU-REC) (approval No: 46-2019). All cases had previously undergone thorough autopsy examinations. Eighty patients in all were carefully inspected, with preserved lung and heart tissue being analyzed. The study, which took place between January 2020 and January 2022, included autopsy results, available reported medical history, and demographic data whenever available.

A- *Case selection:*

Data obtained from the pathology sheet were:

1- Residence: Where Group 1 cases were from urban areas in Egypt governates, Group 2 cases were from rural areas of Egypt governates while Group 3 there were no data available about the residence of these cases (Unavailable).

2- Gender of cases.

3- Age of cases: Group 1cases were from 18-30 years, Group 2 cases were from 31-50 years while Group 3 cases were 51-70 years.

4- Etiological cause of death: Sudden death (SD) which was deaths of such cases reported the sudden death of young (18-35) or apparently healthy persons with unpredictable serious events. Another group was Surgical related cause which was deaths of such cases reported a history of surgery one to four weeks prior to deterioration and death, but not related directly to the surgery or anesthesia complications. In addition, Maternal mortality cause which was deaths of such cases reported a history of abortion or cesarean section delivery one to four weeks prior to deterioration and death. The last group was Trauma-related cause which was deaths of such cases reported a history of receiving trauma (Head injury, firearm injury) one to four weeks prior to deterioration and death.

5- Reported organ failure leading to death: This is what was included in the reports issued by the Forensic Medicine Authority for the causes of death after performing autopsies. Reports attributed deaths due to failure in the function of some organs. The reported primary cause of death was due to either Lung pathology that was recorded as the main pathology that leads to death. Second group Heart pathology which was recorded as the main pathology that leads to death. Third group was General pathology (cardiorespiratory or any other organ failure or anaphylaxis) that was recorded as the main pathology that leads to death.

Inclusion criteria:

Age: 18 years old or more.

Cases of sudden death (a death that occurs within 24h of the onset of symptoms) according to WHO definition.

Cases of ALI or serious lung pathology are selected. The microscopic findings of their hearts are reported.

Cases with reported organ failure are either respiratory failure or cardiac failure or both cardiorespiratory failures.

Exclusion criteria:

All cases with putrefaction.

Cases with drug intoxication as reported by toxicological analyses were excluded.

Data collection:

The data were collected from anonymous archives, with available hospital medical records and reports from medicolegal autopsy. Then these collected data was analyzed statistically in accordance with the diagram illustrated in Fig. (1).

Tissues:

The study included preserved blocks of lungs and hearts tissue sections from 80 autopsy of sudden or unexplained death cases with/without evidence of acute myocardial infarction referred to the pathology department of the Medico-legal Administration, Egypt, during the years 2009-2014.

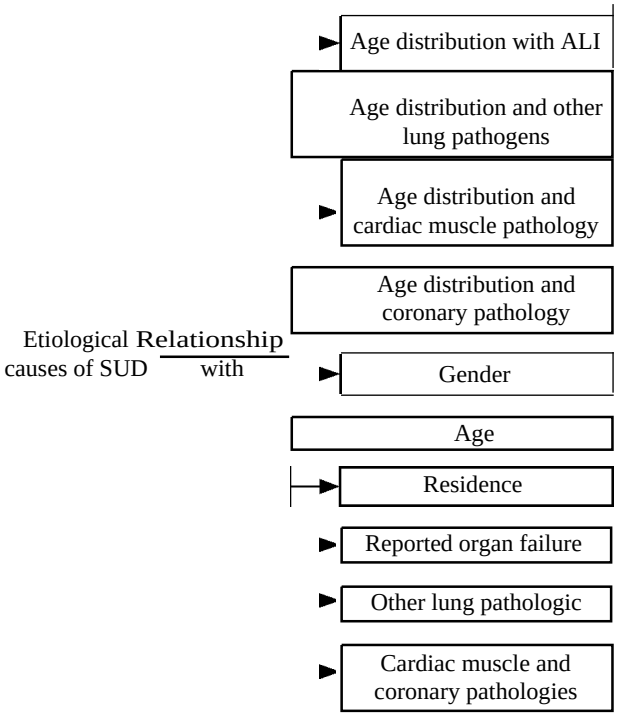

Fig. (1): Illustrate the design of the study.

Heart tissue sections from coronaries and myocardia were taken. Myocardial tissue samples were excised from the left ventricle, ventricular septum, and right ventricle as well as the corresponding coronaries; they were fixed in 10% neutral-buffered formalin and embedded in paraffin. Thin sections were stained with hematoxylin-eosin.

Finally, we selected 73 sections of myocardial tissue from the 80 hematoxylin-eosin-stained sections for immuno-histochemical staining.

Histologic sections were studied via immuno-histo-chemistry with three different antibodies to human cTnT, MB depletion, and caspase 3 3 positive diffuse reaction using a standard avidin-biotin–peroxidase system.

Histopathological Tissue Photographing was done in Histology Department Faculty of Medicine Ain Shams University.

Analytical statistics:

The information was gathered, edited, coded, and then imported into IBM SPSS, a statistical package for social science, version 23. Numbers and percentages were used to represent the qualitative characteristics. The Chi-square test was used to compare groups containing qualitative data. The allowable margin of error was set at 5%, while the confidence interval was set at 95%. As a result, the following *p*-value was deemed significant: $p>0.05$ indicates not significant; $p<0.05$ indicates significant; and $p<0.01$ indicates highly significant.

Results

Of the 80 cases of sudden death that were analyzed, 63.8% (n = 51) were male and 36.3% (n = 29) were female. The subjects' ages ranged from 18 to 70 years old and fell into three different categories.

The data collected from the study and treated documented that, there was no relation between age distribution and ALI group among the studied cases (Table 1). The table illustrates the association between the number and percentage of age distribution in cases of Acute Lung Injury (ALI) within the conducted study, revealing no statistically significant differences among them. The total cohort comprised 27 instances of ALI, with the majority (14 cases) occurring in individuals aged 31-50 years, followed by 7 cases in the 51-70 age group, and 6 cases in the 18-30 age group.

Within the 18-30 age group, all 6 cases (100%) were categorized under diffuse alveolar damage.

In the 31-50 age group, 78.6% (11 cases) were identified as diffuse alveolar damage, while 21.4% (3 cases) exhibited a co-occurrence of diffuse alveolar damage and Eosinophilic lung disease.

Individuals aged 51-70 years displayed 85.7% (6 cases) with diffuse alveolar damage and 14.3% (1 case) with End-stage interstitial lung disease.

It is noteworthy that no statistically significant disparities were observed among the age groups in the study.

Relation between age distribution and other pathologies in lung group among the studied cases (Table 2). The table delineates the correlation between the number and percentage distribution of age groups in cases of various lung pathologies within the conducted study, revealing no statistically significant differences among them. The aggregate number of cases involving other lung pathologies amounted to 49, with the highest incidence observed in the 31-50 age group (21 cases), followed by 15 cases in the 51-70 age group, and 13 cases in the 18-30 age group.

In the 18-30 age group, pulmonary embolism constituted 30.8% (4 cases), while an equivalent percentage of 23.1% (3 cases each) was observed in Junkie pneumopathy and acute pulmonary edema groups. Additionally, a 7.1% occurrence (1 case each) was noted in bronchopneumonia, granuloma, and traumatic pulmonary hemorrhage groups.

Within the 31-50 age group, bronchopneumonia accounted for 33.3% (7 cases), Junkie pneumopathy for 23.8% (5 cases), granuloma for 19.0% (4 cases), and pulmonary embolism for 14.3% (3 cases). Moreover, an equal percentage of 7.1% (1 case each) was observed in the COPD group and traumatic pulmonary hemorrhage group.

In the 51-70 age group, pulmonary embolism constituted 46.7% (7 cases), while bronchopneumonia, granuloma, Junkie pneumopathy, COPD, and traumatic pulmonary hemorrhage groups each exhibited an equal percentage of 13.3% (2 cases). Notably, no statistically significant differences were identified among the age groups in the study.

Relation between age distribution and cardiac muscle pathology group among the studied cases (Table 3). The table delineates the relationship between the number and percentage distribution of age groups in cases of cardiac muscle pathology within the conducted study, revealing no statistically significant differences among them. The cumulative number of cases involving cardiac muscle pathology amounted to 29, with the highest incidence observed in the 31-50 age group (17 cases), followed by 9 cases in the 18-30 age group, and 3 cases in the 51-70 age group.

In the 18-30 age group, an equal percentage of 33.3% (3 cases each) was identified in the cardiomyopathy and acute myocardial infarction groups, with 22.2% (2 cases) in the myocarditis group, and 11.1% (1 case) in the infective endocarditis group.

Within the 31-50 age group, the majority (41.2%, 7 cases) were attributed to the acute myocardial infarction group, followed by 35.3% (6 cases) in the myocarditis group, 17.6% (3 cases) in the pericardial hemorrhage and pericarditis group, and 5.9% (1 case) in the granulomatous myocarditis group.

For the 51-70 age group, the predominant distribution was observed in the myocarditis group, constituting 66.7% (2 cases), while 33.3% (1 case) was attributed to the cardiomyopathy group. Importantly, no statistically significant differences were detected among the age groups in the study.

Relation between age distribution and coronary pathology group among the studied cases (Table 4). The table presents the distribution of age groups in cases of coronary pathology within the study, revealing no statistically significant differences among them. The total number of coronary pathology cases amounted to 42, with the highest incidence observed in the 51-70 age group (20 cases), followed by 15 cases in the 31-50 age group, and 7 cases in the 18-30 age group.

Within the 18-30 age group, 57.1% (4 cases) were classified under the atherosclerosis group, and 42.9% (3 cases) were attributed to the Acute Coronary Syndrome (ACS) group.

For the 31-50 age group, 53.1% (8 cases) were identified in the atherosclerosis group, 26.7% (8 cases) in the ACS group, 13.3% (2 cases) in the congenital coronary bridging group, and 6.7% (1 case) in the fibromuscular dysplasia group.

The 51-70 age group exhibited a prevalence of 60.0% (12 cases) in the atherosclerosis group, 30.0% (6 cases) in the ACS group, and 10.0% (2 cases) in the congenital coronary bridging group.

There are no statistically significant differences observed among the age groups in the distribution of coronary pathology cases within the study.

Relation between Etiological cause of death with gender among studied cases (Table 5). The presented table elucidates the association between the etiological cause of death and the gender of cases within the study, revealing a statistically significant difference with a p-value of 0.000. The total cohort comprises 80 cases, consisting of 51 males and 29 females.

Among males, the predominant etiological cause of death was sudden death, accounting for 84.2% (32 cases) of instances. In contrast, among females, the most prevalent etiological cause of death was associated with surgical-related conditions, constituting 52.2% (12 cases). The identified statistically significant difference, as denoted by the *p*-value of 0.000, underscores a noteworthy distinction in the distribution of etiological causes of death between genders within the study cohort.

Relation between etiological cause of death with age among studied cases (Table 6). The provided table elucidates the relationship between the etiological cause of death and age among the studied cases, revealing no statistically significant differences. The total number of cases analyzed was 80.

Sudden death emerged as the predominant cause of death in the majority of cases, totaling 38 instances. This distribution was as follows: 18.4% (7 cases) in the 18-30 age group, 42.1% (16 cases) in the 31-50 age group, and 39.5% (15 cases) in the 51-70 age group.

The second most prevalent cause of death was attributed to surgical-related causes, accounting for 23 cases. Within this category, 30.4% (7 cases) were in the 18-30 age group, 43.5% (10 cases) in the 31-

50 age group, and 26.1% (6 cases) in the 51-70 age group.

Maternal mortality causes were identified in 10 cases, with a distribution of 40.0% (4 cases) in the 18-30 age group and 60.0% (6 cases) in the 31-50 age group.

Trauma-related causes accounted for 9 cases, with 22.2% (2 cases) in the 18-30 age group, 33.3% (3 cases) in the 31-50 age group, and 44.4% (4 cases) in the 51-70 age group.

Importantly, no statistically significant differences were observed among the various etiological causes of death across age groups within the studied cases.

Relation between etiological causes of death with residence among studied cases (Table 7). The presented table illustrates the association between the etiological cause of death and the residence of cases within the study, indicating no statistically significant differences. The total number of cases from urban areas amounted to 43, with 52.6% (20 cases) attributed to sudden deaths, 52.2% (12 cases) to surgical-related causes, 60.0% (6 cases) to maternal mortality-related causes, and 55.6% (5 cases) to trauma-related causes.

In contrast, the total number of cases from rural areas totaled 31, with 39.5% (15 cases) as sudden deaths, 43.5% (10 cases) as surgical-related causes, 40.0% (4 cases) as maternal mortality-related causes, and 22.2% (2 cases) as trauma-related causes.

Notably, no statistically significant differences were discerned between the etiological causes of death and the residence of cases within the study.

Relation between etiological causes of death with reported organ failure leading to death among studied cases (Table 8). The provided table delineates the relationship between the etiological cause of death and the reported organ failure leading to death in the study, revealing a statistically significant difference with a *p*-value of 0.041. The total number of cases reporting respiratory failure was 55, distributed as follows: 57.9% (22 cases) in the sudden death group, 69.6% (16 cases) in the surgical-related group, 90.0% (9 cases) in the maternal mortality group, and 88.9% (8 cases) in the trauma-related group.

Cases reporting cardiac failure totaled 16, with 34.2% (13 cases) in the sudden death group, 8.7% (2 cases) in the surgical-related group, and 11.1% (1 case) in the trauma-related group.

Additionally, cases reporting cardiorespiratory failure due to general pathology amounted to 9, with 7.9% (3 cases) in the sudden death group, 21.7% (5 cases) in the surgical-related group, and 10.0% (1 case) in the maternal mortality-related group.

The identified statistically significant difference, as indicated by the *p*-value of 0.041, underscores variations in the reported organ failure leading to death across different etiological causes within the study cohort.

Relation between etiological causes of death with other lung pathologies among studied cases (Table 9). The presented table outlines the association between the etiological cause of death and pulmonary histopathologic changes in the study, revealing a statistically significant difference with a *p*-value of 0.000. The total number of pulmonary embolism cases was 14, distributed as follows: 7.7% (2 cases) in the sudden death group, 55.6% (5 cases) in the surgical-related group, 66.7% (4 cases) in the maternal mortality group, and 37.5% (3 cases) in the trauma-related group.

Junkie pneumopathy cases (9 cases; 34.6%) were exclusively found in the sudden death group.

Bronchopneumonia cases numbered 11, with 26.9% (7 cases) in the sudden death group, 33.3% (2 cases) in the maternal mortality group, and 25.0% (2 cases) in the trauma-related group.

Granuloma cases were identified in 7 instances, comprising 23.1% (6 cases) in the sudden death group and 11.1% (1 case) in the surgical-related group.

Acute pulmonary edema cases totaled 3, with 3.8% (1 case) in the sudden death group and 22.2% (2 cases) in the surgical-related group.

Chronic Obstructive Pulmonary Disease (COPD) cases were 2, distributed as 3.8% (1 case) in the sudden death group and 11.1% (1 case) in the surgical-related group.

Traumatic pulmonary hemorrhage cases constituted 37.5% (3 cases) and were exclusively present in the trauma-related group.

The identified statistically significant difference with a *p*-value of 0.000 underscores notable variations in pulmonary histopathologic changes associated with different etiological causes of death within the study cohort.

Relation between etiological causes of death with cardiac muscle pathology among studied cases (Table 10). The provided table delineates the relationship between the etiological cause of death and

cardiac muscle pathology among the studied cases, revealing no statistically significant differences. Notably, various cardiac muscle pathologies were identified in cases that experienced sudden death. The predominant pathology in this group was myocarditis, comprising 33.3% (4 cases).

In both surgical-related and trauma-related etiologies, myocarditis was also the most prevalent pathology, constituting 57.1% (4 cases) and 66.7% (2 cases), respectively.

Conversely, in cases related to maternal mortality, ischemic heart disease, specifically acute myocardial infarction, emerged as the most prevalent cardiac muscle pathology, accounting for 85.7% (6 cases).

The absence of statistically significant differences underscores the diverse cardiac muscle pathologies associated with different etiological causes of death within the studied cases.

Relation between etiological causes of death with coronary pathology among studied cases (Table 11). The presented table outlines the association between the etiological cause of death and coronary pathology among the studied cases, revealing no statistically significant differences. Atherosclerosis emerged as the predominant coronary pathology in cases that experienced sudden death, constituting 54.5% (12 cases), as well as in cases with a surgical-related etiology (66.7%, 8 cases) and a trauma-related etiology (66.7%, 4 cases).

Table (1): Relation between age distribution and ALI group among the studied cases.

	Age (18-30)		Age (31-50)		Age (51-70)		Test value*	*p*-value	Sig.
	No.	%	No.	%	No.	%			
ALI:									
DAD	6	100.0	11	78.6	6	85.7	5.870	0.209	NS
DAD + Eosinophilic lung disease	0	0.0	3	21.4	0	0.0			
End stage Interstitial lung disease	0	0.0	0	0.0	1	14.3			

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (2): Relation between age distribution and other pathologies in lung group among the studied cases.

	Age (18-30)		Age (31-50)		Age (51-70)		Test value*	*p*-value	Sig.
	No.	%	No.	%	No.	%			
Other pathologies:									
Embolism	4	30.8	3	14.3	7	46.7	17.233	0.141	NS
Junkie pneumopathy	3	23.1	5	23.8	1	6.7			
Bronchopneumonia	1	7.7	7	33.3	3	20.0			
Granuloma (T.B & sarcoidosis)	1	7.7	4	19.0	2	13.3			
Acute pulmonary edema	3	23.1	0	0.0	0	0.0			
COPD	0	0.0	1	4.8	1	6.7			
Pulmonary hemorrhage (Traumatic)	1	7.7	1	4.8	1	6.7			

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (3): Relation between age distribution and cardiac muscle pathology group among the studied cases.

	Age (18-30)		Age (31-50)		Age (51-70)		Test value*	*p*-value	Sig.
	No.	%	No.	%	No.	%			
Cardiac muscle pathology:									
Cardiomyopathy	3	33.3	0	0.0	1	33.3	13.268	0.209	NS
IHD (AMI)	3	33.3	7	41.2	0	0.0			
Myocarditis (eosinophilic, neutrophilic, lymphocytic)	2	22.2	6	35.3	2	66.7			
Pericardial Hemorrhage and Pericarditis	0	0.0	3	17.6	0	0.0			
Infective endocarditis	1	11.1	0	0.0	0	0.0			
Granulomatous myocarditis (sarcoidosis)	0	0.0	1	5.9	0	0.0			

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (4): Relation between age distribution and coronary pathology group among the studied cases.

	Age (18-30)		Age (31-50)		Age (51-70)		Test value*	*p*-value	Sig.
	No.	%	No.	%	No.	%			
Coronary pathology:									
ACS (thrombus, hemorrhage in atheroma,	3	42.9	4	26.7%	6	30.0%	3.182	0.786	NS
ruptured atheroma)v	4	57.1	8	53.3%	12	60.0%			
Atherosclerosis	0	0.0	2	13.3%	2	10.0%			
Congenital coronary bridging	0	0.0	1	6.7%	0	0.0%			
Fibromuscular dysplasia									

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (5): Relation between Etiological cause of death with gender among studied cases.

	Etiological cause of death								Test value	*p*-value	Sig.
	SD		Surgical related		Maternal mortality related		Trauma related				
	No.	%	No.	%	No.	%	No.	%			
Gender:							1	11.1			
Female	6	15.8	12	52.2	10	100.0	8	88.9	29.455	0.000	HS
Male	32	84.2	11	47.8	0	0.0					

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (6): Relation between etiological cause of death with age among studied cases.

	Etiological cause of death								Test value	*p*-value	Sig.
	SD		Surgical related		Maternal mortality related		Trauma related				
	No.	%	No.	%	No.	%	No.	%			
Age:											
18-30	7	18.4	7	30.4	4	40.0	2	22.2	7.353	0.289	NS
31-50	16	42.1	10	43.5	6	60.0	3	33.3			
51-70	15	39.5	6	26.1	0	0.0	4	44.4			

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (7): Relation between etiological causes of death with residence among studied cases.

	Etiological cause of death								Test value	*p*-value	Sig.
	SD		Surgical related		Maternal mortality related		Trauma related				
	No.	%	No.	%	No.	%	No.	%			
Residence:											
Un available	3	7.9	1	4.3	0	0.0	2	22.2	4.537	0.604	NS
Urban	20	52.6	12	52.2	6	60.0	5	55.6			
Rural	15	39.5	10	43.5	4	40.0	2	22.2			

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (8): Relation between etiological causes of death with reported organ failure leading to death among studied cases.

	Etiological cause of death								Test value	*p*-value	Sig.
	SD		Surgical related		Maternal mortality related		Trauma related				
	No.	%	No.	%	No.	%	No.	%			
Reported organ failure eading to death:											
Respiratory Failure	22	57.9	16	69.6	9	90.0	8	88.9	13.159	0.041	S
Cardiac Failure	13	34.2	2	8.7	0	0.0	1	11.1			
Cardiorespiratory Failure (General Pathology)	3	7.9	5	21.7	1	10.0	0	0.0			

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (9): Relation between etiological causes of death with other pathologies among studied cases.

	Etiological cause of death								Test value*	*p*-value	Sig.
	SD		Surgical related		Maternal mortality related		Trauma related				
	No.	%	No.	%	No.	%	No.	%			
Other pathologies:											
Embolism	2	7.7	5	55.6	4	66.7	3	37.5	45.482	0.000	HS
Junkie pneumopathy	9	34.6	0	0.0	0	0.0	0	0.0			
Bronchopneumonia	7	26.9	0	0.0	2	33.3	2	25.0			
Granuloma (T.B & sarcoidosis)	6	23.1	1	11.1	0	0.0	0	0.0			
Acute pulmonary edema	1	3.8	2	22.2	0	0.0	0	0.0			
COPD	1	3.8	1	11.1	0	0.0	0	0.0			
Pulmonary hemorrhage (Traumatic)	0	0.0	0	0.0	0	0.0	3	37.5			

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (10): Relation between etiological causes of death with cardiac muscle pathology among studied cases.

	Etiological cause of death								Test value	*p*-value	Sig.
	SD		Surgical related		Maternal mortality related		Trauma related				
	No.	%	No.	%	No.	%	No.	%			
Cardiac muscle pathology:											
Cardiomyopathy	2	16.7	1	14.3	1	14.3	0	0.0	18.666	0.229	NS
IHD (AMI)	2	16.7	2	28.6	6	85.7	0	0.0			
Myocarditis (eosinophilic, neutrophilic, lymphocytic)	4	33.3	4	57.1	0	0.0	2	66.7			
Pericardial Hemorrhage and Pericarditis	2	16.7	0	0.0	0	0.0	1	33.3			
Infective endocarditis	1	8.3	0	0.0	0	0.0	0	0.0			
Granulomatous myocarditis (sarcoidosis)	1	8.3	0	0.0	0	0.0	0	0.0			

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Table (11): Relation between etiological causes of death with coronary pathology among studied cases.

	Etiological cause of death								Test value	*p*-value	Sig.
	SD		Surgical related		Maternal mortality related		Trauma related				
	No.	%	No.	%	No.	%	No.	%			
Coronary pathology:											
ACS (thrombus, hemorrhage in atheroma, ruptured atheroma)	5	22.7	4	33.3	2	100	2	33.3 66.7	9.594	0.384	NS
Atherosclerosis	12	54.5	8	66.7	0	0.0	4	0.0			
Congenital coronary bridging	4	18.2	0	0.0	0	0.0	0	0.0			
Fibromuscular dysplasia	1	4.5	0	0.0	0	0.0	0				

p-value >0.05: Nonsignificant (NS). *p*-value <0.01: Highly significant (HS).
p-value <0.05: Significant (S). *: Chi-square test.

Discussion

The current study revealed a statistically significant difference in pulmonary histopathologic changes between genders, with a *p*-value of 0.005. Notably, the percentage of males was elevated in the group with other lung pathologies, while the female percentage was increased in the Acute Lung Injury (ALI) group.

These findings align with Naneix et al. *[22]*, who studied the gender distribution in autopsies of 534 cases of sudden adult death, reporting 69.1% males and 30.9% females with no statistically significant difference between them *[22]*.

Among the 27 cases suffering from ALI in the present study, Diffuse Alveolar Damage (DAD) was identified in 23 cases. The distribution of DAD cases across age groups was 100% in the age group of 18-30 years, 78.6% in the age group of 31-50 years, and 85.7% in the age group of 51-70 years. No significant relationship was observed between age and ALI cases, including those with DAD, DAD with Eosinophilic Lung Disease, and End Stage Interstitial Lung Disease.

These findings resonate with prior studies, which indicated a higher prevalence of DAD in individuals over 50 years of age *[23,24]*. Additionally, cases with DAD and Eosinophilic Lung Disease were primarily in the age range of 31-50 years, consistent with the literature on acute eosinophilic lung disease, which reported a mean age of 53 years *[25]*. End Stage Interstitial Lung Disease was observed in one case (14.3%) in the age group of 51–70 years, in line with studies characterizing Interstitial Pulmonary Fibrosis as predominantly affecting adults over 60 years *[26]*.

No statistically significant relationship was found between the age of the studied cases and other lung pathologies, including Embolism, Junkie Pneumopathy, Bronchopneumonia, Granuloma, Acute Pulmonary Edema, Chronic Obstructive Pulmonary Disease (COPD), and Pulmonary Hemorrhage. Embolism, however, was identified as a lung pathology occurring in both the 18-30 and 51-70 age groups, consistent with the increased incidence of pulmonary embolism in older populations, attributed to various risk factors such as venous stasis, hypercoagulability, and venous endothelial injury *[27,28]*.

The study revealed a higher prevalence of male cases (63.8%) compared to females (37.3%), potentially attributed to increased male participation in stressful events and physically demanding work, as well as a higher incidence of injuries resulting from violence among males. This observation aligns with Sanchez et al. *[29]*, whose cohort study of 789 consecutive cases of sudden non-violent deaths demonstrated a predominance of males (77.19%) across all age ranges.

Similarly, Soeiro et al. *[24]* found a higher proportion of male patients (67.4%) in their study of 218 autopsies on patients with acute respiratory failure who did not have a prior diagnosis of acute myocardial infarction. Moss and Mannino *[30]* reported continuously higher annual mortality rates for acute respiratory distress syndrome (ARDS) in men compared to women in their analysis of deaths between 1979 and 1996.

In the current study, sudden death was the predominant cause of death in males (84.2%), while females predominantly succumbed to surgical-related conditions and maternal mortality (52.2% and 100%, respectively). A statistically significant dif-

ference was observed between the gender of cases and the etiological cause of death, with males more commonly experiencing trauma-related fatalities and females exhibiting a higher incidence of maternal mortality.

These findings are consistent with Sessa et al. *[31]*, who highlighted a greater risk of sudden death in males, increasing with age. Additionally, Fnon et al. *[32]* reported a significant gender difference in the incidence of coronary atherosclerosis, with males representing 89.52% of cases and a male-to-female ratio of 9:1.

The age distribution of individuals included in the study spanned from 18 to 70 years, with 20 cases (25.0%) in the 18-30 age group, 45 cases (56.3%) in the 31-50 age group, and 15 cases (18.8%) in the 51-70 age group. This finding aligns with previous research by Sanchez et al. *[29]*, Soeiro et al. *[21]*, and Fnon et al. *[32]*, which reported similar age ranges in studies related to sudden deaths, acute respiratory failure, and sudden cardiac death, respectively.

The analysis of acute lung injury (ALI) cases revealed no statistically significant differences in age distribution. Diffuse alveolar damage (DAD) was consistently present across all age groups, constituting 100% in the 18-30 age group, 78.6% in the 31-50 age group, and 85.7% in the 51-70 age group. This observation is consistent with findings by Saha et al. *[33]* who noted a higher incidence of autopsied acute respiratory distress syndrome (ARDS) in the younger age group.

In the current study, primary organ failure leading to death was investigated, revealing that (68%) of cases were attributed to reported respiratory failure, (20.0%) to cardiac failure, and (11.3%) to cardiorespiratory failure due to general pathology. Notably, respiratory failure was reported in (81.6%) of cases with other pathologies, surpassing the percentage in the Acute Lung Injury (ALI) group (55.6%). Cardiac failure was noted in (18.5%) of ALI cases and (14.3%) in cases with other lung pathologies.

These findings are consistent with the observations of Cheung et al. *[34]*, who highlighted the recognition of massive extrapulmonary trauma and shock as causes of unexplained respiratory failure during wars in the second half of the 20th century. Moreover, Jentzer et al. *[35]* emphasized the association of acute respiratory failure with a higher incidence of end-organ failure and cardiac arrest, acknowledging multiorgan failure as a significant contributor to morbidity and mortality in medical and cardiac ICU patients.

The study documented that shock presenting with rapidly onset dyspnea was accompanied by the development of diffuse chest infiltrations over hours to days. Once Acute Respiratory Distress Syndrome (ARDS) initiated, the mortality rate increased, aligning with the findings of Cheung et al. *[34]* and De Hemptinne et al. *[36]*.

These results underscore the critical impact of respiratory, cardiac, and cardiorespiratory failures on mortality, especially in the context of shock and traumatic events. The study contributes to the understanding of organ failure dynamics, emphasizing the significance of prompt recognition and intervention in managing critically ill patients.

Similarly, the examination of other lung pathologies showed no statistically significant age-related differences. Cases of acute pulmonary edema (APE), bronchopneumonia, and junkie pneumopathy were distributed across various age groups, with specific occurrences noted, such as 46.7% of APE cases in the 51-70 age group, 33.3% of bronchopneumonia cases in the 31-50 age group, and 23.8% of junkie pneumopathy cases in the 31-50 age group. Bělohlávek et al. *[27]* reported a similar pattern with most cases of APE occurring in individuals aged 60 to 70 years.

The analysis of cardiac muscle pathology and coronary pathology cases indicated no statistically significant age-related differences. Notably, acute myocardial infarction (AMI) was prevalent in the 31-50 age group (41.2%), while myocarditis was more commonly observed in the 51-70 age group (66.7%). Additionally, atherosclerosis cases were most frequently found in the 51-70 age group (60.0%). These findings resonate with the observations of Fnon et al. *[32]*, highlighting age-specific trends in deaths related to ischemic heart disease and coronary atherosclerosis.

The study revealed that most cases originated from urban areas, comprising 53.8% (43 cases), while 38.8% (31 cases) were from rural areas. Data on the residence of 7.5% (6 cases) were not available for analysis. Regrettably, there were no comparable studies identified in the existing literature to provide contextual insights or comparisons for this specific dataset.

In the study pulmonary embolism was recorded in (28.6%) in cases that died from serious pathology in lungs other than ALI. This is in accordance with Sessa et al. *[31]* who stated that the most important cause of death in the case of non-cardiac SD (nc SD) involving the respiratory system is acute pulmonary embolism (APE).

Bronchopneumonia cases in this study were the second most record (22.4%) of cases that died from massive pathology in lungs other than ALI. The study aligns with previous research findings, as indicated by Smith et al. *[37]*, which asserted that severe pneumonia stands as a recognized natural cause of non-cardiac sudden death (nc-SD). This condition can arise from both viral and bacterial agents, leading to diverse diseases such as myocardial ischemia, maladaptive responses to hypoxia, sepsis-related cardiomyopathy, and other associated phenomena *[37]*.

In the current study, cases of "Junkie pneumopathy" constituted 18.4% of individuals who succumbed to extensive lung pathology other than Acute Lung Injury (ALI).

In the present study, cases involving granulomas accounted for 14.3% of individuals who succumbed to lung pathology distinct from Acute Lung Injury (ALI). According to Shah et al. *[38]*, granulomatous inflammation typically features the development of identifiable granulomas, consisting of clusters of epithelioid histiocytes surrounded by a peripheral ring of lymphocytes and plasma cells. The spectrum of granulomatous inflammation can vary, ranging from well-formed granulomas to more diffuse aggregates of histiocytes interspersed with other inflammatory cells.

In the current study, cases of acute pulmonary edema constituted 6.1% of individuals who succumbed to lung pathology other than Acute Lung Injury (ALI).

In the studied cases, traumatic pulmonary hemorrhage accounted for 6.1% of individuals who died from lung pathology other than Acute Lung Injury (ALI). Notably, Abdul Raoof et al. *[39]* reported that traumatic lesions to the chest comprised 22% of all cases of mechanical trauma subjected to autopsy. Moreover, the lung was identified as the most affected thoracic organ, involved in 30% of autopsied traumatic cases.

In the studied cases, Chronic Obstructive Pulmonary Disease (COPD) cases constituted 4.1% of individuals who died from lung pathology other than Acute Lung Injury (ALI). Consistent with this, Karoli & Rebrov *[40]* asserted that individuals with chronic obstructive pulmonary disease face a cardiovascular mortality risk that is 2-3 times higher than that of the general population.

In the present study, ischemic heart disease, specifically acute myocardial infarction, was identified in 34.5% of cases. This observation aligns with the recognition by Fnon et al. *[32]* that sudden cardiac death represents a significant global public health concern.

Additionally, infectious cardiac muscle pathologies, encompassing myocarditis, pericarditis, and infective endocarditis, were diagnosed in 34.5%, 10.3%, and 3.4% of cases, respectively, within the cohort that succumbed to inflammatory cardiac muscle pathology. The definition of myocarditis by Caforio et al. *[41]* as an inflammatory disorder of the myocardium, characterized by immunocompetent cell infiltration and non-ischemic degeneration of cardiac myocytes, underpins the interpretation of these findings.

Cardiomyopathy, identified in 13.8% of cases within the cardiac muscle pathology category, concurs with the findings of Naneix et al. *[22]*. Their study reported cardiomyopathy as the cause of death in 15.5% of cases, with specific subtypes such as arrhythmogenic cardiomyopathy, dilated cardiomyopathy, hypertrophic cardiomyopathy, and undetermined cardiomyopathy contributing to this outcome.

Granulomatous myocarditis, specifically Sarcoidosis, was detected in 3.4% of cases within the cardiac muscle pathology group. Birnie et al. *[42]* highlighted giant cell myocarditis (GCM) and cardiac sarcoidosis (CS) as distinct causes of inflammatory cardiomyopathy, each presenting with heart failure and arrhythmias.

This reflects a departure from previous notions considering them as the same disease; they are now recognized as two separate entities.

In the current study, atherosclerosis was identified in 57.1% of cases among individuals who succumbed to coronary pathology, aligning with the findings reported by Fnon et al. *[32]*. Their examination of sudden cardiac death cases within Egyptian forensic departments from January 2010 to December 2014 corroborated the high prevalence of atherosclerosis in such cases.

Furthermore, the acute coronary syndrome (ACS) group, comprising thrombus, hemorrhage in atheroma, and ruptured atheroma, was detected in 31.0% of cases within the cohort experiencing coronary pathology. This observation corresponds with the results of Fnon et al. *[32]*, who reported that acute coronary events were present in 27.61% of cases with atherosclerosis, with thrombosis being the most frequently identified acute event.

Congenital coronary bridging was observed in 9.5% of cases within the coronary pathology group.

Hostiuc et al. **[43]** emphasized the prevalence of congenital coronary bridging, reporting an overall occurrence of at least 19%, which rises to 42% when considering autopsy studies exclusively.

Fibromuscular dysplasia (FMD) was identified in 2.4% of cases within the coronary pathology group. Kim et al. **[44]** characterized coronary FMD as a rare cause of sudden cardiac death, representing a nonatherosclerotic contributor to ischemic heart disease.

In conclusion: The study revealed a significant association between etiological cause of death and pulmonary/coronary histopathological changes. Respiratory failure was identified as the predominant organ failure precipitating death, emphasizing the critical impact of lung injuries on mortality. No age-related differences were discerned in ALI, other lung pathologies, cardiac muscle pathologies, or coronary pathologies across groups. The findings contribute to understanding the linkage between acute lung and myocardial injuries in sudden death.

In summary, while this study provides initial evidence on the association between acute lung and myocardial injuries in sudden death scenarios, larger-scale research is warranted to establish more robust linkage patterns and prognostic indicators to guide clinical decision-making.

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استكشاف الأسباب الأولية للوفاة المفاجئة غير المبررة في حالات التشريح الطبى لحالات إصابات الرئة الحادة والإصابة المرتبطة باحتشاء عضلة القلب الحاد فى مصر بين عامى ٢٠٠٩ و٢٠١٤ : دراسة تحليلية

أجريت هذه الدراسة على حالات الموت المفاجئ غير المبرر المسجلة بأرشيف مصلحه الطب الشرعى المصرية، حيث قام الطبيب الشرعى بتشريح اعضاء الجسم بالعين المجردة وميكروسكوبيا وعمل مقاطع من انسجه الاعضاء (العينات) وتم حفظها فى فورمالين ١٠٪.

وخلال هذه الدراسة تم عمل ربط لنتائج التشريح مع التقارير السريرية الواردة من المستشفى في حالات اصابه الرئة واحتشاء عضله القلب مع الاخذ فى الاعتبار معرفه النوع والسن ومنطقة الإقامة ومعرفة مسببات الوفاة (مفاجئة، بعد عمليات جراحية، وفيات أمهات، بعد التعرض لإصابة) وكذلك معرفة الخلل او الفشل فى الأعضاء الحيوية المدون بتقارير مصلحة الطب الشرعى المصرية كلما كان ذلك ممكنا للقيام على الاسباب الحقيقية للوفاة.

الاهداف: هدفت هذه الدراسة إلى العمل على خفض معدل حدوث الوفيات بين المرضى الذين يفدون إلى الطوارئ بدون أعراض محدده نتيجة تزامن وارتباط حدوث احتشاء عضله القلب مع حالات اصابات الرئة الحادة مما قد يرفع من نسب بقائهم على قيد الحياة نتيجة التدخل الفورى والسريع في التعامل مع تلك الحالات عن طريق تحديد وتجميع ومراجعه عينات الوفاة المفاجئة غير المبرره نتيجة اصابات الرئة الحادة مع تعيين اسباب حدوثها كلما كان ذلك متاحا وكذلك تصنيف الاسباب الأساسية لإصابات الرئة الحادة ومعدلات حدوثها.

طريقةالدراسة: اختيار الحالات والصفة التشريحية:

تم العمل في هذه الدراسة على فحص قوالب من أنسجة القلب والرئة ميكروسكوبيا لحالات الموت مفاجئ الغيرمبرر لحالات مجهولة أرشيفياً لعدد ٨٠ حالة تشريح وأدخلت الى مصلحة الطب الشرعى المصرية فى الفترة بين يناير ٢٠٠٩ وديسمبر٢٠١٤، وتم تسجيل السن والنوع والسكن كلما كان ممكنا ونتائج اداء الصفة التشريحية للحالات.

خواص اختيار الحالات: قوالب مأخوذة من أنسجة القلب والرئة للبالغين من سن ١٨ وحتى ٧٠ عام. وكذلك حالات اصابات الرئة الحادة بها تقارير ميكروسكوبيه للقلب.

النتائج والتوصيات: وكانت من اهم نتائج هذا العمل انه لم يتم العثور على علاقة ذات دلالة إحصائية أو ارتباط بين ALI وAMI عند فحص الحالات باستخدام E & HE ، بينما كانت هناك علاقة ذات دلالة إحصائية بين ALI و AMI عند فحص الحالات بواسطة دلالات الأنسجة القلبية المناعية.

لذا توصى هذه الدراسة بالمزيد من الأبحاث عن ALI وعلاقتها بالتغييرات التي تحدث فى القلب سواء الأشخاص الذين تم علاجهم او الذين توفوا وخضعوا لأداء الصفة التشريحية بعد الوفاة من اجل الوقوف على المزيد من التفسيرات لأسباب الفسيولوجياالباثولوجيا التى قد تحدث بالإضافة للوقوف على المسببات لأسباب الوفاة.

كما ان هناك حاجة إلى المزيد من الدراسات حول العلاقات ذات دلالات احصائية وآليات الارتباط بين حدوث احتشاء عضلة القلبمع الإصابات الرئوية الحادة فى مصر مع التأكيد على استخدام الصبغات المناعية والتى تمكنت من كشف العلاقة بين حدوث الوفاة الفجائية لأسباب قلبية مصاحبة للإصابة الرئوية الحادة فى هذه الدراسة.

كما ننصح بالمزيد من الدراسات الاكلينيكية للتوصية باستراتيجيات التعامل معإصابات الرئة الحادة لأنها غير كافية فى هذا الوقت خاصة عندما ترتبط بتأثر القلب لتقليل معدل الوفيات بين هؤلاء المرضى.