



Original Research Article

Sudden and Unexpected Deaths Clinical Presentation, Medical History, Autopsy Findings, and Forensic Determination of Cause of Death

Name of Author: ¹ Dr. Sultan Rajpar, ² Dr. Pushpa Parkash, ³ Dr. Mumtaz Ali, ⁴ Dr. Memon Abrar ul Hasnain, ⁵ Dr. ROMANA MALIK, ⁶ Dr. Mazhar Murtaza	Abstract: Background: Sudden and unexpected death remains an important forensic challenge requiring integration of clinical, medical, pathological, and postmortem evidence. Objective: To assess the clinical presentation, relevant medical history, autopsy findings, and forensic determination of cause of death among cases of sudden and unexpected death. Methodology: It was a descriptive cross-sectional study which was conducted from January to December 2025. A total of 220 eligible cases were taken using consecutive sampling. The clinical records, medico-legal documentation, autopsy reports, histopathology, and toxicological examinations were used for extracting data, which were analyzed using SPSS version 26.0. Results: Of 220 cases, 151 (68.64%) were male and 69 (31.36%) females, while 57 (25.91%) were aged ≥60 years. Sudden collapse occurred in 137 (62.27%) cases and loss of consciousness in 118 (53.64%). Hypertension was documented in 61 (27.73%), diabetes mellitus in 47 (21.36%), ischemic heart disease in 39 (17.73%), and smoking in 76 (34.55%). Significant cardiac pathology was identified in 91 (41.36%) cases. Cardiovascular causes accounted for 91 (41.36%) deaths, followed by respiratory causes in 31 (14.09%) and neurological causes in 27 (12.27%). Coronary artery disease/acute coronary events were the leading specific cause, occurring in 58 (26.36%) cases. Seven (3.18%) deaths remained undetermined or unexplained. Conclusion: Cardiovascular disease was the predominant cause of sudden and unexpected death, highlighting the importance of comprehensive clinical, autopsy, histopathological, and toxicological evaluation for accurate forensic determination.
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INTRODUCTION

Sudden and unexpected death is of great forensic and medical interest since sometimes it may happen without any prior warning and in apparently healthy people. Sudden death is defined in different ways depending on the circumstances of death, and in forensic practice, when the time of death is not certain it is defined as a sudden death as an unexpected natural death occurring shortly after onset of symptoms or within 24 hours [1,2]. Cardiovascular disease (especially coronary artery

disease), neurological disease, respiratory disease, toxicological disease, and other pathological disease are constantly reported as potential causes of sudden death, though others can be involved as well [3,4]. Studies of the victims carried out at autopsy have shown significant differences in the age distribution and underlying disease of the victims, and in many adult series, cardiovascular disease was the predominant cause [5]. Due to the lack of clinical signs or to the vague nature of clinical signs, and to the fact that clinical signs are also poorly

described prior to death, the actual cause depends on systematic integration of circumstantial information, medical history and postmortem examination [1].

Clinically, the prodrome to acute collapse, sudden death, can vary from a state of perfect health to vague symptoms such as chest pain, difficulty breathing, fainting, palpitations, headaches, seizures, or collapse. A thorough medical history can uncover other unrecognized cardiovascular disease, hypertension, diabetes, epilepsy, lung disease, prior medication use, or substance exposure, or a family history of early or sudden death [2,6]. Importantly, however, a lack of a known medical history should not rule out significant underlying disease because sudden death can be the initial clinical sign of an occult disease [7]. Autopsy investigation is therefore an essential part, especially in unconventional circumstances and when clinical diagnosis is not certain. Complete examination should involve external examination, examination of internal organs, systematic cardiac and coronary examination, histopathology and appropriate toxicological examinations [2,8]. These investigations may detect structural disease like coronary atherosclerosis, myocardial infarction, cardiomyopathy, intracranial hemorrhage, pulmonary thromboembolism or other pathological conditions which were not diagnosed while alive [4].

Although advances are made in diagnostic medicine and forensic pathology, some SIDs are still not explained even with conventional autopsy. Some inherited arrhythmia syndromes and other conditions can result in little or no gross anatomical changes and require careful histologic, toxicologic, familial, and (if available) molecular studies [6,9]. It has also been found that using presumed causes as the basis for determining cause of death, without thorough forensic investigations, can lead to wrong conclusions of cause of death [10-12]. Thus, the circumstances of death, the clinical/medical history, autopsy findings, ancillary investigations, and toxicology should all be correlated to arrive at an accurate forensic determination — not just one finding [13,14].

Research Objective

To assess the clinical presentation, relevant medical history, autopsy findings, and forensic determination of the cause of death among cases of sudden and unexpected death.

MATERIALS AND METHODS

Study Design and Setting

A retrospective descriptive cross-sectional study was conducted to assess the clinical presentation, medical history, autopsy findings and cause of death in sudden and unexpected deaths.

Study Population

The study comprised of cases of sudden and unexpected death, where medico legal examination and autopsy had been performed. The available clinical records, medico-legal documentation, autopsy, histopathology and other laboratory investigations were used to obtain data.

Study Duration

This study was conducted for 1 year from January 2025 to December 2025. The inclusion and exclusion criteria were strictly adhered to and all of the cases that were documented and met these criteria were reviewed during the period.

Sample Size Determination

Overall, a total of 220 cases were studied. The sample size was deemed to be sufficient to give a good description of the demographic, clinical, medical, pathological and forensic features of the population of sudden and unexpected deaths. The chosen sample also allowed an evaluation of the major categories of cause of death in relation to relevant clinical and autopsy data.

Sampling Technique

A consecutive sampling technique was used. All cases with the pre-defined eligibility criteria were reviewed sequentially during the study period and eligible cases were added to the sample until the case number required (220 cases) was reached. Consecutive inclusion was used to reduce selection bias based on the investigator's preference and to provide systematic selection of eligible cases from the study population.

Eligibility Criteria

The cases were selected if they were sudden and unexpected deaths during the period of the study with good medico-legal and postmortem documentation for evaluation of the study variables. Men and women aged between the minimum and maximum age limits were included. Cases were excluded if documents for the autopsy were not available, the autopsy was incomplete, or the clinical, medico-legal and pathological information available made it impossible to reach a reliable cause of death.

Clinical Presentation and Medical History

Information from available hospital records, emergency department notes, referral notes, previous medical records and authenticated medico-legal documents was extracted. Demographic data, presenting symptoms, duration and type of symptoms leading up to death, documented abnormalities of vital signs, prior diagnoses, known cardiovascular, respiratory, neurological, metabolic, infectious, or other systemic diseases, medication history, and documented substance exposure were included. Specific attention was paid to symptoms that could be related to sudden deaths, such as chest pain, difficulty breathing, palpitations, loss of consciousness, seizures, change in consciousness, and sudden collapse.

If available, data on past hospitalizations and chronic disease states were also documented.

Circumstances of Death

A systematic review of the available information on the circumstances of death was conducted. This encompassed reported place of death (i.e. hospital, home or other), activity before death, if the death was witnessed, the presence of symptoms prior to death and the approximate time between symptom onset and death (when available). Relevant information recorded in medico-legal reports was compared with the clinical history and post mortem examination findings to substantiate final forensic conclusions.

Forensic Autopsy Examination

External and internal autopsy findings were reviewed and summarized. The findings of the external examinations comprised general physical characteristics, apparent age, body habitus, external injuries, evidence of medical intervention, and other pertinent postmortem examination findings. Internal examination consisted of a systematic evaluation of the major organ systems, focusing on the cardiovascular, respiratory, central nervous, gastrointestinal, hepatobiliary, renal and endocrine systems. The heart was carefully examined for abnormalities of its size and weight, myocardium, valves, coronary arteries and other gross pathological changes. Pathological examination of the lungs, brain and other organs was performed to determine pathological conditions that could account for sudden death. Where traumatic or other significant external findings were noted these were recorded and included within the overall forensic assessment.

Histopathological and Ancillary Investigations

The histopathological examinations of which information was recorded in the autopsy were examined where the samples had been retrieved. The postmortem sampling and microscopic examination were documented, and relevant organs and abnormal-looking tissues were examined. Correlation of gross autopsy findings and available clinical information with histopathological findings was used to identify significant pathological lesions from incidental findings. Ancillary investigations (toxicological and laboratory) were also reviewed when available. The toxicological results were not analysed in isolation, but in the context of circumstances of death, clinical history, autopsy findings and any other relevant evidence provided.

Forensic Determination of Cause of Death

The final cause of death was assessed using a combination of circumstances of death, clinical and medical history, external and internal autopsy, pathological examination and ancillary investigations. The causes of death were classified based on the last recorded forensic opinion. The largest groups were cardiovascular, respiratory, neurological,

gastrointestinal/hepatobiliary diseases, infectious diseases, toxicological, metabolic and other identifiable pathological causes. All cases in which no specific cause could be determined after a satisfactory investigation were classified as undetermined or unexplained sudden death as appropriate. If more than one pathological abnormality were found the one believed to be the major cause of the fatal event was entered as the main cause of death.

Operational Definition of Sudden and Unexpected Death

This study required that death be sudden and unexpected, meaning that the death was unanticipated or death had occurred in a person who was reported to be in good health or whose known medical condition did not reasonably suggest imminent death. The classification has been developed based on information available on the circumstances of death, clinical history, medico-legal documentation and post-mortem findings.

Data Collection and Quality Assurance

Structured data collection proforma designed based on pre-determined study variables was used to collect data. Original institutional records were used and checked with records available from clinical, autopsy, histopathological, and toxicological documentation to reduce transcription errors and inconsistencies as much as possible. All cases were assigned an ID number for the study and no personally identifiable data was included in the analytical dataset. If any differences were found between records, the finalized autopsy and forensic documentation were used for classification of pathological and cause of death variables.

Statistical Analysis

Entering, coding and analysing data were done in SPSS Statistics version 26.0 (IBM) software. For continuous variables, appropriate tests of normality were used to assess distribution, and they were summarized as mean $\pm$ SD or median (interquartile range), as appropriate. Categorical variables were described in terms of frequencies and percentages. Comparisons were made among the major cause-of-death groups by using appropriate statistical tests for demographic, clinical, medical history and autopsy features. Normally distributed continuous variables were analyzed using an independent-samples t-test and analysis of variance, whereas non-parametric tests were used for variables that were not normally distributed and failed parametric test assumptions. The chi-square test or Fisher's exact test was used to determine the association between categorical variables where appropriate. If sample size and distribution of variables allowed, multivariable logistic regression was conducted to find independent factors associated with major causes of death. Effect estimates were presented along with the corresponding 95% confidence interval. Two-tailed P value < 0.05 was regarded as statistically significant.

RESULTS

Table 1 shows the demographic and circumstantial characteristics of the 220 cases. The largest proportion was aged ≥ 60 years (25.91%), followed by 50–59 years (21.82%), while males predominated (68.64%). Deaths occurred mainly in hospitals (43.64%) and at home (40.45%), and 53.18% of deaths were unwitnessed.

Table 1. Demographic and Circumstantial Characteristics of Study Participants (n=220)

Variable	Frequency (n)	Percentage (%)
Age group		
18–29 years	32	14.55
30–39 years	38	17.27
40–49 years	45	20.45
50–59 years	48	21.82
≥ 60 years	57	25.91
Gender		
Male	151	68.64
Female	69	31.36
Place of death		
Hospital	96	43.64
Home	89	40.45
Workplace/public place	23	10.45
Other/unknown	12	5.45
Death witnessed		
Yes	103	46.82
No	117	53.18
History of sudden collapse		
Yes	137	62.27
No	83	37.73

Figure 1 presents the clinical manifestations preceding sudden and unexpected death. Sudden collapse was the most frequent presentation (62.27%), followed by loss of consciousness (53.64%), dyspnea (32.73%), and chest pain/discomfort (30.45%). No preceding symptoms were documented in 29.09% of cases.

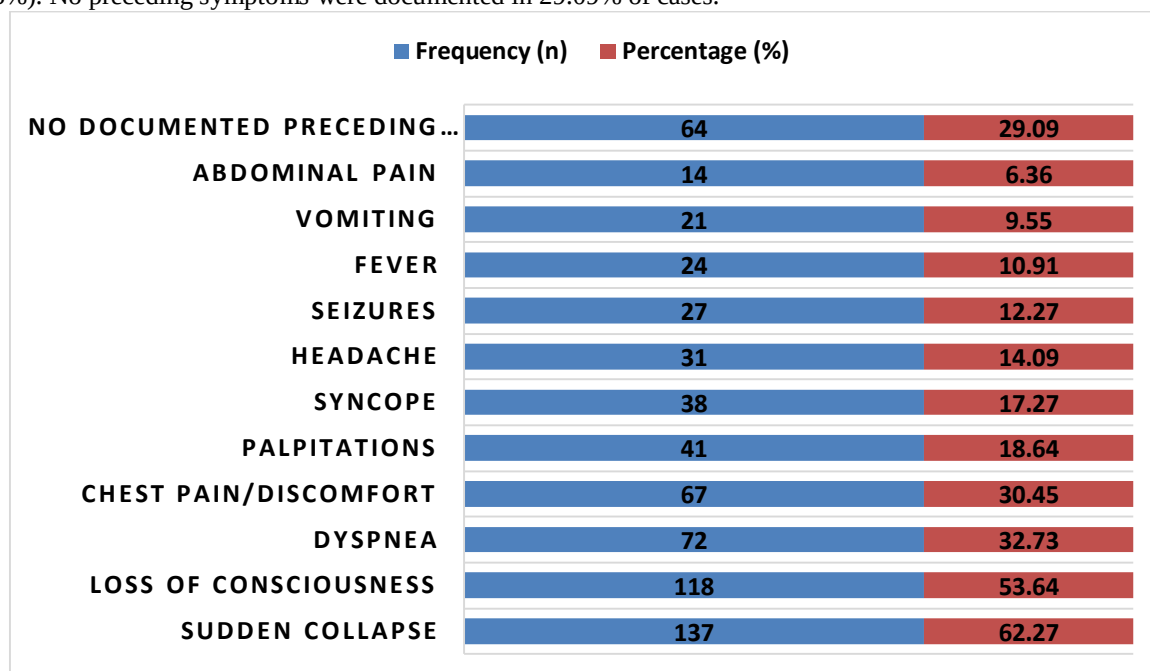


Figure 1. Clinical Presentation Preceding Sudden and Unexpected Death (n=220)

Figure 2 summarizes the relevant medical history of the study population. Nearly half of the cases (44.55%) had no documented previous medical history, whereas hypertension (27.73%), diabetes mellitus (21.36%), and ischemic heart disease (17.73%) were the most frequent comorbidities. Smoking history was documented in 34.55% of cases.

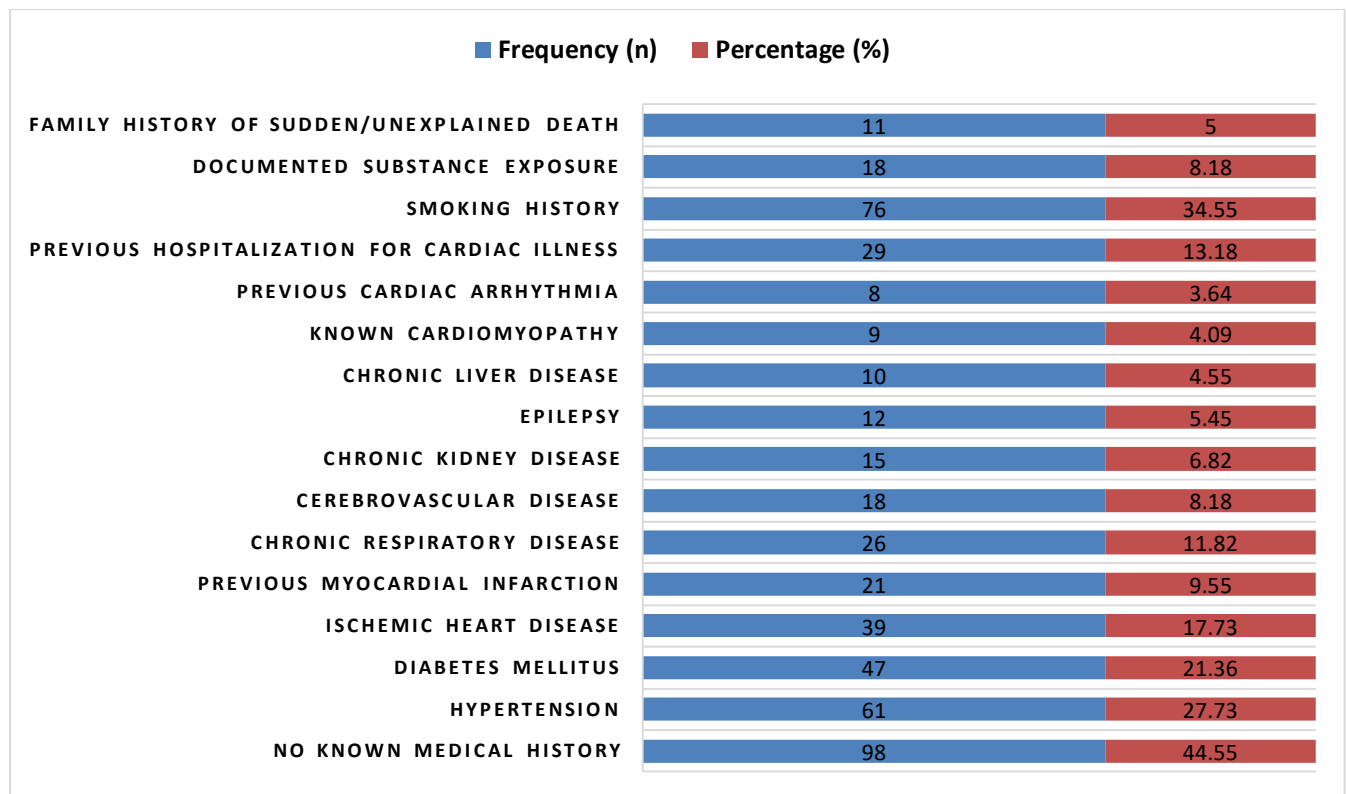


Figure 2. Relevant Medical History Among Sudden and Unexpected Death Cases (n=220)

Table 2 demonstrates the major autopsy findings. Significant cardiac pathology was identified in 41.36% of cases, with coronary atherosclerosis present in 33.64%. Pulmonary edema/congestion (31.36%) and myocardial infarction or scarring (19.09%) were also common, while cerebral hemorrhage was identified in 11.36%.

Table 2. Major External and Internal Autopsy Findings (n=220)

Autopsy finding	Frequency (n)	Percentage (%)
External findings		
No significant external abnormality	146	66.36
Evidence of medical intervention	52	23.64
External injury/trauma	31	14.09
Cyanosis	28	12.73
Froth around mouth/nose	19	8.64
Needle/injection marks	11	5.00
Internal findings		
Significant cardiac pathology	91	41.36
Coronary atherosclerosis	74	33.64
Pulmonary edema/congestion	69	31.36
Myocardial infarction/scarring	42	19.09
Cerebral hemorrhage	25	11.36
Pneumonia	22	10.00
Pulmonary thromboembolism	16	7.27
Cardiomyopathy	14	6.36
Myocarditis	11	5.00
Significant hepatic pathology	9	4.09
Significant renal pathology	8	3.64

Table 3 presents histopathological and toxicological findings. Histopathological examination was performed in 79.09% of cases and demonstrated significant pathology in 58.64%. Toxicological analysis was performed in 43.64% of cases, of which 8.64% had positive toxicological findings.

Table 3. Histopathological and Toxicological Findings (n=220)

Investigation/finding	Frequency (n)	Percentage (%)
Histopathological examination performed	174	79.09
Histopathology showed significant pathology	129	58.64
Myocardial fibrosis	38	17.27
Acute myocardial infarction	31	14.09
Myocarditis	11	5.00
Cardiomyopathic changes	14	6.36
Significant pulmonary pathology	29	13.18
Significant cerebral pathology	21	9.55
Toxicological examination performed	96	43.64
Positive toxicology	19	8.64
Negative toxicology	77	35.00
Toxicology not performed/not indicated	124	56.36

Note: Histopathological categories may overlap where more than one significant microscopic finding was identified. Table 4 shows the final forensic categories of cause of death. Cardiovascular causes were predominant, accounting for 41.36% of deaths, followed by respiratory causes (14.09%) and neurological causes (12.27%). Toxicological causes accounted for 8.18%, while 3.18% remained undetermined or unexplained

Table 4. Final Forensic Determination of Cause of Death (n=220)

Final cause of death	Frequency (n)	Percentage (%)
Cardiovascular causes	91	41.36
Respiratory causes	31	14.09
Neurological causes	27	12.27
Toxicological causes	18	8.18
Infectious causes	15	6.82
Traumatic causes	12	5.45
Gastrointestinal/hepatobiliary causes	8	3.64
Metabolic/systemic causes	6	2.73
Other identifiable causes	5	2.27
Undetermined/unexplained	7	3.18
Total	220	100.00

Table 5 provides the specific forensic causes of death. Coronary artery disease/acute coronary events were the most frequent specific cause (26.36%), followed by cerebral hemorrhage (10.00%) and myocardial infarction (8.64%). Pulmonary thromboembolism and toxicological poisoning/overdose accounted for 7.27% and 8.18%, respectively.

Table 5. Specific Causes of Death Identified at Forensic Examination (n=220)

Specific cause of death	Frequency (n)	Percentage (%)
Coronary artery disease/acute coronary event	58	26.36
Myocardial infarction	19	8.64
Cardiomyopathy	8	3.64
Myocarditis	6	2.73
Pulmonary thromboembolism	16	7.27
Pneumonia/severe pulmonary infection	15	6.82
Cerebral hemorrhage	22	10.00
Other neurological causes	5	2.27
Toxicological poisoning/overdose	18	8.18
Severe systemic infection/sepsis	15	6.82
Traumatic cause	12	5.45
Gastrointestinal/hepatobiliary cause	8	3.64
Metabolic/systemic cause	6	2.73
Other identifiable causes	5	2.27
Undetermined/unexplained	7	3.18
Total	220	100.00

Table 6 demonstrates the association between selected clinical and medical history variables and cardiovascular causes of

death. Age ≥ 50 years, hypertension, diabetes mellitus, ischemic heart disease, previous myocardial infarction, smoking, and preceding chest pain showed significant associations with cardiovascular death, with $p < 0.05$ for these variables.

Table 6. Association Between Selected Clinical/Medical History Variables and Major Cause of Death

Variable	Cardiovascular cause n (%)	Non-cardiovascular cause n (%)	p-value
Male sex	68 (74.73)	83 (64.34)	0.109
Age ≥ 50 years	63 (69.23)	42 (32.56)	< 0.001
Hypertension	38 (41.76)	23 (17.83)	< 0.001
Diabetes mellitus	31 (34.07)	16 (12.40)	< 0.001
Ischemic heart disease	32 (35.16)	7 (5.43)	< 0.001
Previous myocardial infarction	18 (19.78)	3 (2.33)	< 0.001
Smoking history	43 (47.25)	33 (25.58)	0.002
Chest pain before death	42 (46.15)	25 (19.38)	< 0.001
Dyspnea before death	34 (37.36)	38 (29.46)	0.225
Sudden collapse	64 (70.33)	73 (56.59)	0.047

Table 7 presents the multivariable logistic regression analysis for cardiovascular causes of death. Previous ischemic heart disease showed the strongest association (adjusted OR 4.16, 95% CI 1.91–9.08; $p < 0.001$), followed by age ≥ 50 years (OR 2.84, 95% CI 1.63–4.95; $p < 0.001$) and chest pain before death (OR 2.76, 95% CI 1.51–5.05; $p = 0.001$).

Table 7. Multivariable Logistic Regression for Factors Associated with Cardiovascular Cause of Death

Predictor	Adjusted OR	95% CI	p-value
Age ≥ 50 years	2.84	1.63–4.95	< 0.001
Male sex	1.41	0.82–2.43	0.210
Hypertension	2.31	1.25–4.27	0.008
Diabetes mellitus	1.89	0.98–3.64	0.057
Previous ischemic heart disease	4.16	1.91–9.08	< 0.001
Previous myocardial infarction	3.72	1.21–11.43	0.022
Smoking history	1.87	1.05–3.34	0.034
Chest pain before death	2.76	1.51–5.05	0.001

DISCUSSION

This present study describes a thorough forensic evaluation of 220 cases of sudden and unexpected deaths, including clinical presentation, medical history, autopsy findings, ancillary investigations and final cause of death. Males accounted for 68.64% of the cases and individuals aged ≥ 60 years accounted for 25.91% of cases. Common clinical signs were sudden collapse (62.27%) and loss of consciousness (53.64%), while 29.09% developed no apparent pre-existing clinical signs. The pattern places the emphasis on the unpredictable aspect of sudden death and confirms the findings of previous forensic literature, where sudden death often follows a too vague a prodrome. In an autopsy series of 534 sudden adult deaths, Naneix et al. found a strong male predominance (369 males vs. 165 females), similar to that of the present study [15].

Cardiovascular disease was the main terminal cause of death in the current study (41.36%), followed by respiratory disease (14.09%) and neurological disease (12.27%). The specific cause level showed that 26.36% were coronary artery disease/acute coronary events and 8.64% were myocardial infarction. This is in keeping with the known predominance of sudden deaths due to coronary disease. Although cardiomyopathies and primary arrhythmic disorders are important contributors to SCD, coronary heart disease remains the most important underlying disease worldwide, according to

Wong et al. (2019) [16]. Similarly, Naneix et al. (2015) found cardiovascular diseases to be particularly important in sudden adult death, with coronary artery disease significantly more frequent among male victims [15].

The cardiovascular contribution is further supported by the clinical and medical history findings. Hypertension was recorded in 27.73%, diabetes mellitus 21.36%, previous myocardial infarction 9.55%, smoking 34.55% of all cases. Age ≥ 50 years, hypertension, diabetes, ischemic heart disease, previous myocardial infarction, smoking, chest pain and sudden collapse were significantly associated with cardiovascular death. Age ≥ 50 years (OR 2.84, 95% CI 1.63–4.95; $p < 0.001$) and previous ischemic heart disease (OR 4.16, 95% CI 1.91–9.08; $p < 0.001$) were the most important independent factors associated with cardiovascular death in multivariable analysis. A biological plausibility and a consistency with evidence that established cardiovascular disease and conventional cardiovascular risk factors are important causes of sudden cardiac death [16] underlie these findings.

Pathological evidence from the autopsies was an important source of information for the clinical associations. In 41.36% significant cardiac pathology was found, 33.64% had coronary atherosclerosis, 31.36% had pulmonary edema/congestion, and 19.09%

had myocardial infarction or myocardial scarring. Pulmonary thromboembolism was found in 7.27% and cerebral hemorrhage in 11.36%. The cardiovascular predominance is similar to the large forensic series from the prior study [15] and to Nichols and Chew (2012), who studied 175 sudden unexpected deaths in hospitalized adults, who found the most common cause to be cardiac arrhythmia (33%) and pulmonary thromboembolism (15%) [17]. These differences may be due to differences in the study populations, including the differences between hospital-based and wider medico-legal study populations.

The present study validated the diagnosis with histopathology and toxicological studies. Histopathological examination was performed in 79.09% of cases, with significant pathology being found in 58.64% of these, myocardial fibrosis in 17.27%, acute myocardial infarction in 14.09%, significant pulmonary pathology in 13.18% and significant cerebral pathology in 9.55%. Toxicology was done in 43.64% of which 8.64% were positive. The study findings confirms the view that sudden death investigation should not be based solely on gross autopsy examination. In a systematic cardiac examination, in addition to appropriate histology and toxicology, Basso et al. (2017) have recommended the use of these tests as a crucial element of the investigation of forensic cardiac death [18] and Daş et al. (2022) have shown the diagnostic value of histopathology of the heart in the investigation of forensic cardiac death [19].

Last, 3.18% of cases could not be determined or explained despite forensic investigation. This is a small percentage, but important to note as a diagnostic shortcoming of traditional autopsy. Sessa et al. (2021) highlighted the need for a "structured approach" that combines approaches that include circumstances, thorough autopsy, histology, toxicology, and, if applicable, molecular approach to the investigation of unexplained sudden death [20]. Likewise, the APHRS/HRS consensus suggests that in the case of sudden unexplained death, a multidisciplinary investigation should be conducted as inherited arrhythmia syndromes may have little or no structural abnormality at autopsy.

Strengths and Limitations

The integrated forensic approach of this study, which included clinical presentation, medical history, circumstances of death, external and internal examination of the body, histopathology, toxicology and final forensic determination of cause of death in 220 cases of sudden and unexpected death, is the major strength of this study. Using consecutive sampling and systematic review of medico-legal and post-mortem records decreased investigator bias in the selection of cases and ensured a detailed characterization of the major causes of death. The study was, however, retrospective and performed at a single tertiary-care center and may

not be generalizable to other populations and areas. The analysis was also subject to the limitations due to the incompleteness and inaccuracies of the existing clinical and medico-legal records, which could lead to information bias, especially for symptoms and previous medical histories. In addition, molecular research and a thorough analysis of genetic disorders was not commonly available, potentially explaining why some cases were reported as undetermined or unexplained.

CONCLUSION

Sudden and unexpected death in this study was primarily due to cardiovascular disease (41.36%) of which coronary artery disease/acute coronary events made up 26.36% of specific causes. Older age, hypertension, diabetes, and ischemic heart disease, previous myocardial infarction, smoking, chest pain and sudden collapse were significantly associated with cardiovascular death, with previous ischemic heart disease being the most significant independent predictor. The results highlight the need for comprehensive autopsy, which includes clinical history, circumstances of death, histopathology, toxicological and systematic autopsy, to make a correct forensic determination of cause of death.

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