



SEASONAL PATTERNS OF SUDDEN CARDIAC DEATH ASSOCIATED WITH ISCHEMIC HEART DISEASE IN CONTINENTAL CLIMATE REGIONS

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ABSTRACT

Ischemic heart disease (IHD) remains one of the leading causes of mortality worldwide and is responsible for a substantial proportion of sudden cardiac deaths. Although classical cardiovascular risk factors such as hypertension, dyslipidemia, smoking, and diabetes are well established, increasing attention is being paid to environmental and climatic influences that may modify the course of cardiovascular diseases.

Introduction

Ischemic heart disease (IHD) remains one of the leading causes of mortality worldwide and is responsible for a substantial proportion of sudden cardiac deaths. Although classical cardiovascular risk factors such as hypertension, dyslipidemia, smoking, and diabetes are well established, increasing attention is being paid to environmental and climatic influences that may modify the course of cardiovascular diseases.

Seasonal variations in cardiovascular mortality have been reported in many regions of the world. In countries with a continental climate, characterized by large fluctuations in ambient temperature and atmospheric conditions, the incidence of acute coronary events tends to increase during colder months. Low temperatures can induce peripheral vasoconstriction, elevate systemic vascular resistance, increase blood pressure, and enhance sympathetic nervous system activity. These physiological responses increase myocardial oxygen demand and may precipitate ischemic episodes in individuals with coronary artery disease.

In addition to temperature, other meteorological parameters such as atmospheric pressure, humidity, and rapid temperature fluctuations may also influence cardiovascular outcomes. These environmental factors may contribute to destabilization of coronary circulation and increase the risk of sudden cardiac death.

Despite numerous epidemiological studies describing seasonal patterns in cardiovascular mortality, relatively few investigations have combined epidemiological observations with morphological and forensic analyses. Understanding the structural changes

in myocardial tissue associated with seasonal factors may improve the interpretation of sudden cardiac death in forensic practice.

The aim of this study was to investigate the seasonal characteristics of sudden cardiac death associated with ischemic heart disease and to evaluate the morphological features of myocardial tissue observed during forensic examination.

Materials and Methods

This study was conducted using materials obtained from forensic autopsies performed at the Samarkand branch of the Republican Scientific and Practical Center for Forensic Medicine. Cases of sudden death associated with ischemic heart disease between 2021 and 2025 were included in the analysis.

A total of 42 cases of sudden cardiac death occurring during the winter period were analyzed. Standard forensic autopsy procedures were performed, including macroscopic examination of the heart and histological analysis of myocardial tissue.

Myocardial samples were fixed in 10% neutral buffered formalin and processed using conventional histological techniques. Tissue samples were dehydrated, embedded in paraffin, sectioned, and stained according to standard protocols.

Microscopic evaluation was performed using a NanoZoomer scanning microscope (Hamamatsu Photonics, Japan). Histomorphometric measurements were obtained using NDP.View 2.0 software, allowing the analysis of cardiomyocyte structure, nuclear morphology, and interstitial tissue components.

Statistical analysis was conducted using Microsoft Excel 2021, and results were expressed as mean values with standard deviations.

Results

Analysis of the studied cases demonstrated that sudden cardiac death related to ischemic heart disease most frequently occurred outside hospital settings. Among the examined cases, the majority of deaths occurred at home or in outdoor environments, reflecting the rapid development of fatal cardiac events.

Age distribution analysis revealed that the highest proportion of deaths occurred in individuals between 45 and 74 years of age, indicating that middle-aged and elderly populations represent the most vulnerable groups.

Macroscopic examination of the heart revealed characteristic signs of myocardial remodeling. Increased heart weight and thickening of the left ventricular wall were frequently observed, suggesting long-term hemodynamic stress and chronic ischemic changes.

Histological analysis demonstrated structural alterations in myocardial tissue, including cardiomyocyte hypertrophy, nuclear hyperchromasia, interstitial edema, and perivascular congestion. These findings indicate progressive ischemic-dystrophic changes associated with chronic coronary insufficiency.

Table 1

Distribution of sudden cardiac death cases by age group

Age group (years)	Number of cases	Percentage
35–44	4	9.5%
45–59	17	40.5%
60–74	19	45.2%

75–90	2	4.8%
Total	42	100%

The predominance of cases in the 45–74 age group indicates that chronic ischemic processes and cardiovascular risk factors accumulate over time, increasing susceptibility to fatal cardiac events during periods of environmental stress.

Discussion

The findings of this study support the concept that seasonal environmental factors play an important role in the development of fatal cardiovascular events. Cold exposure may trigger a cascade of physiological responses including vasoconstriction, increased blood pressure, activation of the sympathetic nervous system, and increased blood coagulability.

These mechanisms can significantly increase myocardial workload and oxygen demand. In individuals with coronary artery disease, the imbalance between oxygen supply and demand may lead to acute ischemia and sudden cardiac death.

The morphological changes identified in myocardial tissue reflect long-term adaptive and pathological processes. Cardiomyocyte hypertrophy, interstitial edema, and fibrotic changes are typical signs of chronic ischemic myocardial damage and structural remodeling.

From a forensic perspective, the identification of these morphological patterns is crucial for determining the cause of sudden cardiac death. Integration of environmental and seasonal factors into forensic evaluation may improve diagnostic accuracy and provide a more comprehensive understanding of cardiovascular mortality patterns.

Conclusion

Seasonal environmental conditions, particularly cold temperatures, may significantly influence the occurrence of sudden cardiac death associated with ischemic heart disease. The study demonstrated that winter cases are characterized by structural myocardial remodeling, including cardiomyocyte hypertrophy, interstitial edema, and fibrotic changes.

These findings highlight the importance of considering climatic factors in cardiovascular risk assessment and forensic investigations. Improved understanding of seasonal patterns may contribute to more effective prevention strategies and more accurate determination of sudden cardiac death causes

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