

# Medicolegal evaluation of environmental-related mortality

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The mission statement of forensic medicine is recognized and valued for the important and useful contribution to the promotion and protection of the well being of individuals and society. Forensic medicine provides comprehensive services and innovative programs that relate to medicolegal death investigation [1, 2]. Pattern injury recognition, interpretation of injuries, documentation of testimonial and injuries, reporting requirements, and regulations are all vital components of forensic evaluation. Multidisciplinary integration of technologies has been improved in contemporary forensic medicine. Besides, the medicolegal autopsy and histology other techniques and methods, such as molecular-genetic examinations [3, 4], post-mortem CT and MRI imaging [2, 5], post-mortem angiography [6] or corrosive method have been introduced into forensic medical practice. One of the main purposes of forensic post-mortem investigation is to differentiate between natural and violence death cases, and to define the cause of death. Forensic pathologists provide valuable information about the manner of death after the autopsy has been performed.

## Types of manner-of-death

- Natural death is a death that results from a natural disease process. Natural deaths are the cause of the majority of deaths that occur. The post-mortem investigation reveals certain aspects of the death, whether it occurred suddenly or unexpectedly, or if the person was critically ill and had not seen a medical treatment previously.

- Homicide, meaning the killing of a human, where the criminal's intention was to deliberately cause someone's death. Some common examples of murdering include shooting, stabbing, smothering, strangling, hitting with a blunt object and burning.
- Accidental deaths are common to investigate post-mortem in forensic practice. In case, there is a suspect that the accident was deliberate or could have been avoided, a criminal investigation will be conducted.
- Suicide, meaning intentionally taking one's own life. Suicide is neither accidental nor is it classified as death by misadventure simply because the individual has set about on a course of action that would end with their own inevitable death. This would occur by drug overdose, cutting of one's wrists to induce uncontrollable bleeding, or stepping out in front of a moving vehicle.

## Environmental death

Besides the classical four manner of death categories, there are several factors influence fatal natural and violent death cases. Based on the climate change, reports have been published about the concomitant climatic-environmental factors meteorological disasters and environmental pollution, a reasonable number of studies [7–10]. The phenomenon of environmental death has a significant importance in the forensic evaluation of cause of death and manner of death. Climatic factors have direct impacts on fatal outcomes such as in traumatic shock or blunt trauma [11], animal sting anaphylaxis [12, 13], allergic disease [14], hypothermia [15, 16], drowning [17, 18] or lightning [19]. However, the short-term or long-term influence on cardiovascular and respiratory system [20, 21] represents an important challenge for forensic pathologists. Meteorological conditions may influence the traumatic injuries and deaths in motor vehicle accidents too [22].

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## **Meteorological factors, health effects of climate change**

Climate change is potentially the largest global threat to human health ever encountered. Climatic and seasonal triggering factors on human life have received an increasing public and social interest. Patterns of meteorological elements such as temperature and precipitation have been altered due to climate change. In last years physicians and meteorologists pay attention on the relationship between meteorological events and their effects on human health [17, 23]. If the climatic constraints are strong enough, people may adapt with different stress reactions. The adaptability is strongly depends on age, gender, and health status [24]. However, the very strong, extreme, or long-lasting meteorological conditions may result in a serious damage of human health.

All the meteorological parameters have complex biological effects on human bodies [25–27]. The most important meteorological parameters are: air temperature, humidity, wind speed, radiation, atmospheric motions, weather fronts, the air quality and air pollution. Statistical methods are used in growing number of medical science research, because they are capable to explore the complex relationship of the different climatic effects and the human health. Climatic research makes clear that Earth's climate will change in response to the atmospheric greenhouse gas accumulation [23]. Meteorological factors are well-known effect human health status and the rate of fatal cases. Detection and attribution of health effects to climate changes have become a key research challenge [28]. Climatic and seasonal triggering factors have received an increasing attention among risk factors of sudden death [26].

Several studies have demonstrated that cardiovascular mortality has a seasonal distribution [29–33]. The relationship between cold weather and ischemic heart disease mortality is well established [27]. The cold temperature may be an important factor in bringing on the onset of life-threatening cardiac events [26]. The relationship between increasing temperature and mortality has been reported since the early 20th century.

McMichael et al. [23] pointed out that publications estimating via modeling and extrapolation how climate change will affect population health in the future were not extensive. Health outcomes are sensitive to isolated extreme events as very cold temperature, rainfall, heat waves, air pollution and flood. Windstorm damage could be extremely severe, and it is evident that both the frequency and severity of windstorm disasters are increasing. The great windstorms that affected a number of regions in recent years have attracted a great deal of attention throughout the world. Extreme events such as precipitation extremes and severe storms cause hundreds of deaths and injuries annually, and injuries and death are the direct health impacts very often associated with

natural disaster. McGeehin and Mirabelli [24] suggest that the relationship between human health and stressful weather is a complex medical, social and environmental issue. McMichael et al. [23] suggest that the adverse health effects will indicate priorities for planned adaptive strategies. Kovats et al. [28] expect that the detection and attribution of health effects to climate changes have become a key research challenge.

## **Mortality trends**

Regarding to the mortality trends have been detected in the last decades the cardiovascular diseases and traumatic injuries represent a significant public health interest. Based on the international mortality datasets the leading causes of death in the developed countries are in connection with cardiovascular diseases and accidents [3, 34]. Cardiovascular disease was responsible for approximately 30% of death worldwide. It was estimated that the cardiovascular diseases will double from the year 1990 to the year 2020 [35]. Sudden cardiac death describes the unexpected natural death from a cardiac cause within a short time period, generally in one hour from the onset of symptoms, in a person without any prior condition that would appear fatal.

## **Health effects of natural disasters**

The frequency, intensity, and duration of meteorological disasters have also increased since 1920s [36]. Climate disasters, along with extreme meteorological events, heat waves, infectious diseases, water- and food-borne illnesses and air pollution are important components of climate change that impact mortality. Factors associated with greater vulnerability were living in coastal provinces and older age [9]. General experience of great earthquakes and tsunami event that survivors will have acute injuries and infections, and will be in increased risk of chronic illness, such as cardiovascular disease or mental ill.

However, there are publications about the reverse health effects of natural disasters from the US [37], Western Europe [38] and Asia [39]; until recently in Central Europe the societies have not faced many mass fatalities caused by extreme meteorological events. One of the pronounced climate trends of the past two decades is that in moderate latitudes, e.g., in Central Europe, winters are likely to become considerably milder, which may increase the risks of North Atlantic storms to intrude deeper into Western and Central Europe [40]. Reflecting on the event, the storm and the scope of the fatal cases, injuries and material damage, a question was arising, whether the disaster was a coincidence of meteorological conditions and social event.

## CONCLUSIONS

In recent years, there has been growing demand from policy makers in health administration for better understanding of the relationship between meteorological conditions and various adverse health effects and mortality, because the threat to human health is significant. Detection of health effects due to climate change is essential and needs further investigation. It is suggested that the adverse health effects will indicate priorities for planned adaptive strategies. Natural deaths and violent deaths may be influenced by different weather conditions.

The forensic medical investigation and the co-operation between the medical experts and the local authorities or the police are important to discover all the information for differentiation between suicidal, accidental and intentional cases. Data of scene investigation, family history, detailed forensic autopsy, results of laboratory tests, have role in the examination of fatal cases. Further investigation about the characteristics injuries may help the final determination of violent death causes, and more effort should be directed to the effective prevention strategy. Detection of exact cause of death by forensic pathologists has a prominent role in the differentiation between violence and natural death. Characterization of environmental risk factors is important to determine preventative strategies against the global environmental changes. We can conclude that greater attention needs to be placed on the social context of climate change impact, the vulnerability and adaptation.

**Keywords:** Climate change, Environmental death, Forensic medicine, Manner of death, Meteorological conditions

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Klara Törő – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published

## Guarantor

The corresponding author is the guarantor of submission.

## Conflict of Interest

Authors declare no conflict of interest.

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