

Climate Change and Stroke: An Analysis of Epidemiological Data with Special Reference to Croatia, the European Union, and the United States

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Abstract

Stroke is the second leading cause of global mortality and the third leading cause of disability, with 11.9 million new cases and 7.3 million deaths reported worldwide in 2021, a 44% rise compared with 1990. Climate change is accelerating the frequency, intensity and duration of heatwaves, and Croatia occupies a particularly vulnerable position at the intersection of a Mediterranean/sub-Mediterranean climate, an ageing population and cerebrovascular mortality already above the European Union average. This narrative review, conducted according to SANRA criteria, aimed to synthesize epidemiological evidence linking heatwaves to stroke incidence and mortality, with special reference to Croatia, the European Union and the United States. PubMed, Scopus, Web of Science and institutional reports from WHO Europe, the CDC, ECDC, IPCC, Eurostat, DHMZ and HZJZ were searched for the period 2014–2025; peer-reviewed original studies, systematic reviews, meta-analyses and reference-body reports in English or Croatian were included, while non-peer-reviewed conference abstracts and studies lacking a defined temperature exposure or cerebrovascular outcome were excluded. Each 1°C rise in mean daily temperature was associated with a 1–2% increase in ischemic stroke incidence, with heatwaves showing a lag effect of one to four days and tropical nights acting as an independent risk factor. Between 2022 and 2024, more than 181,000 heat-related deaths were recorded across 32 European countries, with the highest mortality rates in Greece, Bulgaria and Italy, while the United States recorded record-breaking heat-related emergency department visits in summer 2023. Croatia's standardized cardiovascular mortality (572.8 per 100,000) significantly exceeds the EU average, with heat-related excess cerebrovascular mortality observed both along the southern Adriatic coast and in the continental lowlands. By 2050, days above 35°C in the Mediterranean are projected to increase two- to four-fold, with European heat-related deaths potentially reaching approximately 120,000 annually and a projected global

stroke burden of 21.43 million new events. Heatwaves represent a modifiable, climate-driven risk factor for stroke, and Croatia is disproportionately exposed. A national heat-stroke surveillance registry integrating meteorological and stroke incidence data is urgently needed, and cerebrovascular medicine must incorporate climate factors into prevention and emergency care strategies.

Keywords

Climate Change, Heatwaves, Stroke, Cerebrovascular Disease, Heat-related Mortality, Epidemiology, Croatia, Cardiovascular Mortality