Global Warming and People with Epilepsy: A Call for Neurological Leadership in the Climate Crisis

Aquecimento global e pessoas com epilepsia: um apelo à liderança neurológica na crise climática

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ABSTRACT

The climate crisis has emerged as a defining challenge of the 21st century, with profound implications for human health. While its environmental and economic consequences are widely recognized, its impact on neurological disorders remains underexplored. Epilepsy, affecting approximately 1% of the global population, represents a uniquely sensitive model to understand the complex interplay between environmental, biological, and social determinants of brain health.

This perspective examines how climate change may influence epilepsy through multiple pathways. Rising temperatures, air pollution, and the expansion of climate-sensitive infectious diseases contribute both directly and indirectly to seizure risk and disease burden. Mechanisms include sleep disruption, metabolic and electrolyte imbalance, neuroinflammation, and increased cerebrovascular risk. In addition, climate-related disruptions to healthcare systems, medication stability, and access to treatment further compromise disease control, particularly in vulnerable populations.

The climate crisis also amplifies existing social inequalities, disproportionately affecting individuals in low- and middle-income regions where epilepsy burden is already higher. These overlapping vulnerabilities and epilepsy stigma highlight the need for a broader framework that integrates environmental determinants into neurological care and research.

More than an emerging area of study, this is a call for action. Neurology must expand its scope to address the health impacts of a rapidly changing planet. Recognizing epilepsy as a sentinel condition in this context may help guide more resilient, equitable, and forward-looking approaches to brain health in the decades ahead.

Keywords: Epilepsy; Climate Change; Air Pollution; Environmental Exposure; Planetary Health.

RESUMO

A crise climática emergiu como um desafio definidor do século XXI, com profundas implicações para a saúde humana. Embora suas consequências ambientais e econômicas sejam amplamente reconhecidas, seu impacto sobre os distúrbios neurológicos permanece pouco explorado. A epilepsia, que afeta aproximadamente 1% da população mundial, representa um modelo singularmente sensível para a compreensão da complexa interação entre os determinantes ambientais, biológicos e sociais da saúde cerebral.

Esta perspectiva demonstra como as mudanças climáticas podem influenciar a epilepsia por meio de múltiplas vias. O aumento das temperaturas, a poluição do ar e a expansão de doenças infecciosas sensíveis ao clima contribuem, direta e indiretamente, para o risco de crises epilépticas e para a carga da doença. Os mecanismos incluem distúrbios do sono, desequilíbrios metabólicos e eletrolíticos, neuroinflamação e aumento do risco de eventos cerebrovasculares. Além disso, as perturbações climáticas nos sistemas de saúde, na estabilidade da medicação e no acesso ao tratamento comprometem ainda mais o controle da doença, particularmente em populações vulneráveis.

A crise climática também amplifica as desigualdades sociais existentes, afetando desproporcionalmente indivíduos em regiões de baixa e média renda, onde a prevalência de epilepsia já é maior. Essas vulnerabilidades sobrepostas e o estigma associado à epilepsia destacam a necessidade de uma estrutura mais ampla que integre os determinantes ambientais ao cuidado e à pesquisa neurológica.

Mais do que uma área de estudo emergente, este é um apelo à ação. A neurologia deve expandir seu escopo para abordar os impactos na saúde de um planeta em rápida transformação. Reconhecer a epilepsia como uma condição sentinela nesse contexto pode orientar abordagens mais resilientes, equitativas e voltadas para o futuro em relação à saúde cerebral nas próximas décadas.

Palavras-chave: Epilepsia; Mudança Climática; Poluição do Ar; Exposição Ambiental; Saúde Planetária.

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The climate change has moved beyond a future projection to become a present reality with increasingly tangible impacts on life on Earth. Its effects are no longer confined to small ecosystems; they manifest concretely in human health, in healthcare delivery processes, and across the broader organization of society. In this context, an uncomfortable yet necessary question arises: is neurology prepared to deal with the impacts of the climate changes on the human brain?

Traditionally, neurology has advanced through careful correlational observation between patient's clinical signs and their nervous system lesions. A modern neurology evolved later in the past 50 years expanding her knowledge by incorporating advanced diagnostic methods (imaging, electrophysiology) and an understanding of the molecular and genetic mechanisms underlying diseases of the nervous system. However, the challenges of the 21st century demand a broader perspective. Global environmental factors associated with climate change are emerging as significant determinants of brain health, influencing not only disease incidence but also its clinical presentation and prognosis[1].

Among neurological conditions, epilepsy emerges as a prominent disease. Due to its high prevalence, multifactorial etiology, and recognized sensitivity to environmental and social factors. Thus, epilepsy provides a unique model for understanding how the climate crisis may impact the human brain, both directly and indirectly.

The climate change is an anthropogenic phenomenon driven primarily by the intensive use of fossil fuels, large-scale deforestation, and, above all, unsustainable economic development models. Its consequences include rising global temperatures, increased frequency and intensity of extreme weather events, changes in precipitation patterns, sea-level rise and acidification, and ecosystem degradation[2]. While this theme is actively discussed in global environmental and economic forums such as the COP, it must also be more consistently incorporated into the health agenda, and particularly into neurology. Yet in 2011 the scientific committee of the World Federation of Neurology added the neurological consequences of global warming to its discussion agendas[3].

Epilepsy is one of the most prevalent serious neurological disorders worldwide, affecting approximately 1% of the global population. It is among the leading contributors to neurological disease burden in terms of DALYs (Disability-Adjusted Life Years), reflecting not only premature mortality but also years lived with disability[4,5]. While prevalence is relatively similar across regions, incidence is significantly higher in low- and middle-income countries, where infectious diseases, lack of perinatal assistance, traumatic brain injury, and limited access to healthcare play a central role in this disparity.

This unequal distribution of new epilepsy cases highlights the importance of social and environmental determinants. By acting as an amplifier of these disparities, the climate crisis is likely to exacerbate several of these underlying causes. In tropical regions such as Brazil, inadequate sanitation favors diseases such as neurocysticercosis, an important cause of acquired epilepsy. Environmental changes, population displacement, and social instability often associated with extreme climate events, conflict, and food insecurity can alter transmission dynamics, contributing to the emergence or re-emergence of cases in different regions.

Similarly, global warming directly affects the ecology of infectious disease vectors[6]. Arboviral diseases such as dengue, chikungunya, Zika, and Oropouche, as well as malaria, have their geographic distribution and seasonality shaped by climatic factors[7]. These diseases may involve the nervous system, presenting with meningitis, encephalitis, leading to epileptic seizures. In the case of Zika virus infection, the association with neurodevelopmental abnormalities is well established, with a high frequency of epilepsy among affected children. Rising temperatures and changing precipitation patterns facilitate the expansion of these vectors into previously non-endemic areas, increasing population-level risk[1,8].

Another important link between the climate crisis and epilepsy is air pollution, often intensified by wildfires and deforestation. Chronic exposure to fine particulate matter (PM2.5) is associated with increased cardiovascular and cerebrovascular disease, including stroke[9]. As stroke is the leading cause of epilepsy in older adults, this represents an indirect yet significant pathway through which environmental degradation contributes to the rising burden of epilepsy. It is estimated that approximately 7% of stroke survivors develop epilepsy[10], often with substantial impact on quality of life and functional status.

Beyond structural and infectious pathways, the climate crisis may also directly influence neuronal excitability and seizure susceptibility. Increased ambient temperature has been associated with impaired sleep quality, including reduced duration and fragmentation[11]. Sleep deprivation is a well-recognized trigger for seizures in individuals with epilepsy. Although direct evidence remains limited, there is biological plausibility that hyperthermia may affect neuronal function through mechanisms such as oxidative stress, mitochondrial dysfunction, and disruption of ionic homeostasis[2].

Recent studies have explored the relationship between rising temperatures, air pollutants, and seizure exacerbation, suggesting that environmental factors may modulate brain electrical activity[12]. While further validation is needed, these findings underscore an important point: environmental variables must be incorporated into our understanding of epilepsy, spanning clinical, epidemiological, and molecular-genetic perspectives.

From a practical standpoint, rising temperatures pose additional challenges to the clinical management of epilepsy. Dehydration, common during heat waves, may lead to electrolyte imbalances such as hyponatremia[13].

Patients treated with certain antiseizure medications, including carbamazepine and its derivatives, are at increased risk for these disturbances, which may result in clinical decompensation and increased hospitalizations. Emerging evidence suggests an association between heat exposure and higher rates of hospital admissions due to hyponatremia in patients with focal epilepsy treated with carbamazepine or its derivatives[14].

Another often overlooked aspect is the relationship between environmental conditions and medication stability and efficacy. Many antiseizure drugs are sensitive to temperature and humidity variations, and improper storage may compromise their therapeutic potency. In vulnerable settings where adequate storage conditions are not guaranteed, this may contribute to poorer seizure control[15].

The climate crisis also imposes logistical and structural challenges on healthcare systems. Extreme events such as floods, droughts, and heat waves may disrupt supply chains, hinder access to healthcare services, and compromise continuity of care. For patients with epilepsy, whose stability often depends on regular medication use, such disruptions can have serious consequences.

In addition, the impact of climate - related humanitarian crises, including population displacement and resource-driven conflicts, must be considered. In these contexts, individuals with chronic conditions such as epilepsy become particularly vulnerable, facing additional barriers to diagnosis, treatment, and follow-up. The COVID-19 pandemic provided a clear example of this vulnerability. Loss of social support and increased exposure to stress may further worsen seizure control.

Finally, the role of stigma associated with epilepsy cannot be overlooked. Despite advances in knowledge and treatment, individuals with epilepsy continue to face discrimination in various social contexts. In times of crisis, when resources are scarce and priorities shift, this stigma may lead to increased neglect and exclusion, further amplifying existing inequalities.

In light of this scenario, it becomes evident that the climate crisis represents not only an environmental challenge but a structural issue for contemporary neurology. Epilepsy, given its complexity and sensitivity to multiple determinants, emerges as a sentinel condition in this new reality, clearly illustrating the intersections between environment, biology, and social inequality.

There is an urgent need to expand scientific research at the interface between climate change and neurological diseases, including epidemiological, clinical, and translational studies. Likewise, this topic must be incorporated into the education and training of healthcare professionals, preparing them to recognize and address the impacts of the climate crisis in clinical practice. At the policy level, adaptation and mitigation strategies must explicitly consider the needs of individuals with chronic neurological conditions, ensuring continuous access to treatment and strengthening resilient healthcare systems.

More than an emerging field of investigation, this is an agenda that demands positioning, global articulation, and innovation. Neurology cannot remain detached from one of the most profound transformations of our time. The climate crisis does not respect borders, nor should our responses. Brazil is an important nation in the Global South and strategic as a hub for global collaborative efforts that are essential to generate faster and more effective solutions in the face of ongoing changes to countries in dire and more needy situations. As an example, Society for Brain Mapping and Therapeutics organize Neuroscience (N20) during G20 foster this important discussion. Recognizing the climate crisis as a determinant of brain health means acknowledging that neurological care extends beyond the clinic and into a broader framework of social, environmental, and ethical responsibility. To meet this challenge, reinvention is necessary, and innovation is key.

At the end of the 20th century, neurology consolidated itself during the “Decade of the Brain” by unraveling the mechanisms of brain function, in the 21st century it will be called upon to address how the human brain responds to the pressures of a changing planet. Ignoring this call is to accept an incomplete practice. Embracing it is to reaffirm neurology’s commitment to life in all its complexity.

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