Mental health, climate anxiety, and progression of Parkinson's disease

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Abstract

Climate-related stressors, including natural disasters, displacement, and environmental threats, significantly impact mental health, contributing to heightened stress, trauma, and climate anxiety. In patients with Parkinson's disease, these stressors can influence disease expression and progression, with phenomena such as paradoxical kinesia illustrating the complex interaction between acute stress and motor function. Understanding how environmental adversity and psychological stress intersect with

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International Review of Movement Disorders
ISSN 2666-7878, https://doi.org/10.1016/bs.irmvd.2026.03.003

neurological vulnerability is critical for developing interventions aimed at mitigating mental health burden and supporting disease management in populations exposed to climate-related stress.

1. Introduction

1.1 Climate change and PD and related movement disorders

Climate change is an ever present current issue which is largely considered by most to cause extensive adverse impacts on various aspects of nature as well as human disease processes related to rising temperatures and extreme weather events (IPCC, 2022). There are specific neurological effects that can be triggered by effects of climate change and some of these relate to nonmotor phenotypic manifestations of Parkinson's disease (PD), the fastest growing neurodegenerative disorder in the world. Climate change is expected to affect countries globally but the effects are already acutely felt in the low-income and middle-income countries (LMICs) where the global neurological burden and specifically impact of PD is likely to increase (Feigin et al., 2020; World Health Organization, 2006). In the period between 1990–2019, the number of disability-adjusted life-years (DALYs) doubled in the Middle East and African regions where considerable effects of climate change have been felt.4 For instance in countries like Afghanistan, Egypt, and Sudan the highest proportion of neurological DALYs appear to be associated with air pollution (>36 %) and increase in ambient particulate matter pollution (GBD, 2019 North Africa & the Middle East Neurology Collaborators, 2024). (Fig. 1).

2. Climate change and its multifaceted effect on PD (Fig. 1)

2.1 Climate anxiety

Climate anxiety is also known as eco-anxiety or eco-distress and relates to tangible worry that PD patients may experience in response to a specific or general issue of climate crisis resulting from climate change. Issues may relate specifically to early onset PD (EOPD) who tend to be younger and have a specific non-motor symptom (NMS) expression specially with an emphasis on mental health (Poplawska-Domaszewicz et al., 2024). Anxiety

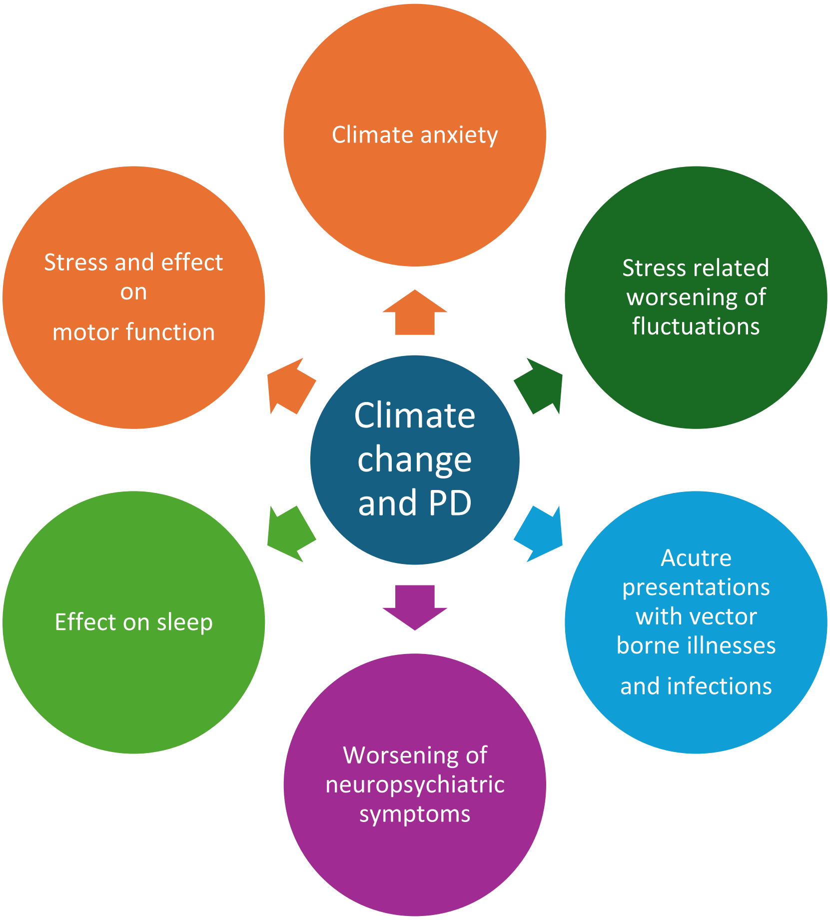

Fig. 1 The variable and multidimensional effects of climate change on symptomatic expression of Parkinson’s disease (PD).

can worsen off periods through the phenomenon of metacognitions as well as precipitate dyskinesias in levodopa treated PD and specially younger patients with EOPD (Poplawska-Domaszewicz et al., 2024).

3. Climate change related stress and cortisol related effects

Climate change could, in extreme situations, lead to natural disasters or phenomena which could in turn lead to significant stress for a PD subject. In addition several direct or indirect consequences of climate change could also function as specific stressors in PD (Fig. 2). Earthquakes, auditory "stressors" as well as visual effects of war, migration, asylum related stress could provoke paradoxical kinesia where patients can briefly overcome severe or existing bradykinesia or akinesia due to extreme climate change related circumstances such as an earthquake or a wildfire although the benefits are short-lasting (Bonanni et al., 2010; Daroff, 2008; Schlesinger et al., 2007). (Fig. 2).

Climate change could result in biological stress in PD where a biphasic response is obtained; a phase 1 response of rapid activation of central and peripheral autonomic nervous system (ANS) causing a spike in blood noradrenaline levels which in turn leads to hypertension, tachycardia, and increased cardiac and muscular blood flow (Joëls et al., 2012). In the second phase there is activation of the hypothalamic–pituitary–adrenal

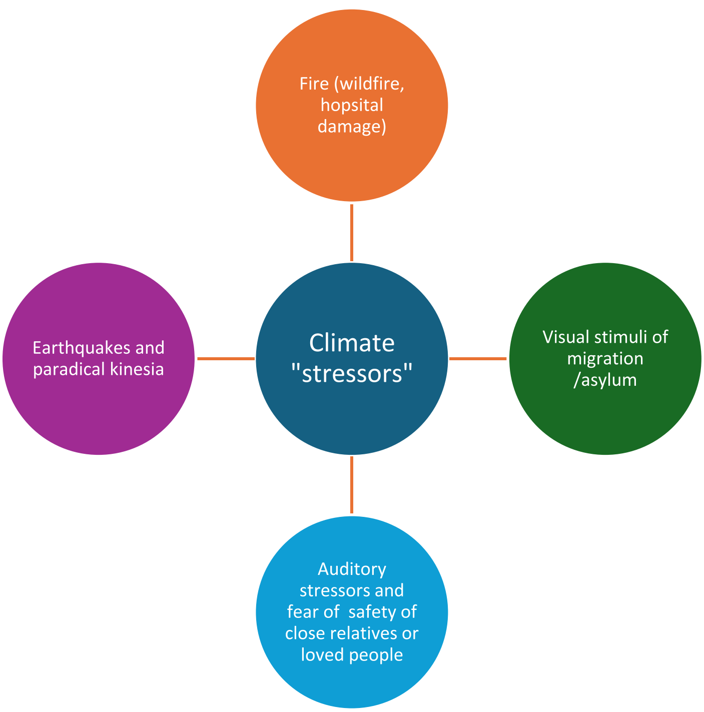

Fig. 2 Diagram illustrating various climate-related stressors and their psychological or social impacts, including wildfire and hospital damage, earthquakes linked with paradoxical kinesia, visual stimuli related to migration/asylum, and auditory stressors with fear for the safety of loved ones.

(HPA) axis which triggers a rise in serum cortisol levels. The activation of the HPA axis leads to expression of a range of NMS in PD including emotional, cognitive and autonomic changes (Lucassen et al., 2014). A more detailed mental health related and neuropsychiatric basis of stress in humans as translatable to PD is shown in Fig. 3. A range of circumstantial and situational stimuli may affect the mental health of PD patients in this situation and these include specific stressors as shown in Fig. 3 such as "feeling cut off", hyperarousal, avoidance, anhedonia and depression. Overall these symptoms can also culminate in significant sleep disorders such as insomnia.

3.1 Climate change and effect on fluctuations in motor and nonmotor responses in PD

Temperature changes are a direct consequence of climate change as are extreme heatwaves or cold. These temperature changes can affect fluctuations in PD and cognitive and neuropsychiatric changes may occur as a collateral association of the motor and nonmotor fluctuations. For instance heat related stress and elevated core temperatures of the body can bring about dyskinesias or worsen existing dyskinesias in PD. There is also the

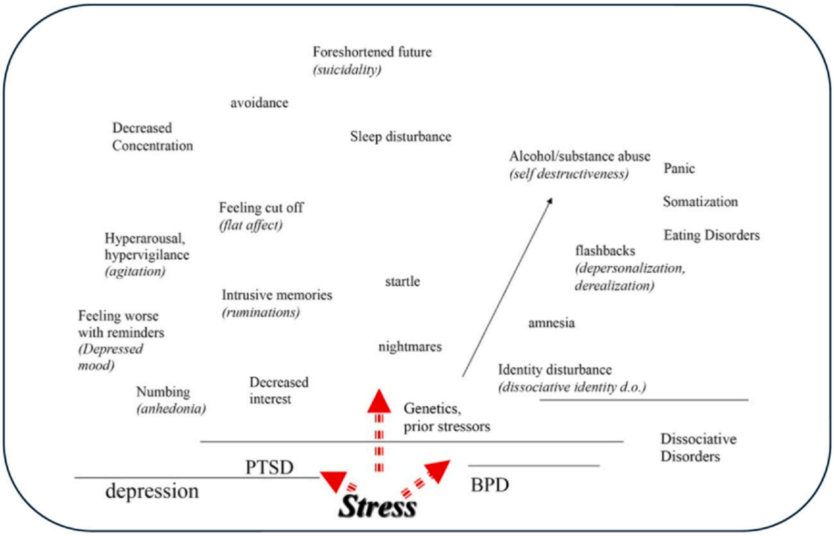

Fig. 3 Conceptual model illustrating the interplay between stress, genetic and prior stressor influences, and their impact on symptom clusters across depression, PTSD, borderline personality disorder (BPD), and dissociative disorders. *Taken from: Bremner and Wittbrodt (2020).*

syndrome of Dyskinesia-Hyperpyrexia Syndrome (DHS) which could lead to an emergency where severe dyskinesias may be associated with high fever (hyperpyrexia) as well as rhabdomyolysis and confusional state (Wang et al., 2021).

Non-motor fluctuations in PD are also common and typically characterised into cognitive, sensory and autonomic subtypes (Boura et al., 2025). The cognitive subtype is associated with mental cloudiness, apathy, depression, anxiety as well as confusional states and can be associated with temperature change related effect on fluctuation to levodopa responses in PD. All the above can influence progression of motor and nonmotor symptoms in PD.

3.2 Climate change and potential effect on impulse control disorder in PD

Climate change and related climate anxiety as well as associated acute stress (forced migration, asylum, war, earthquakes, tsunami, heatwaves) may have an adverse effect on addictive behaviour which may also influence susceptibility to impulse control disorders (ICD) in PD although this area of research is currently under-explored in PD. Stress at all stages of life can influence as well as maintain addiction and addictive behaviour along with dopamine agonist use are considered to be a major risk factor for developing ICD in PD (Weintraub et al., 2006; McLaughlin et al., 2019). Evidence from several strands of research shows an influence of stress on all stages of addiction (Fig. 4) and a potential mechanism is likely to be

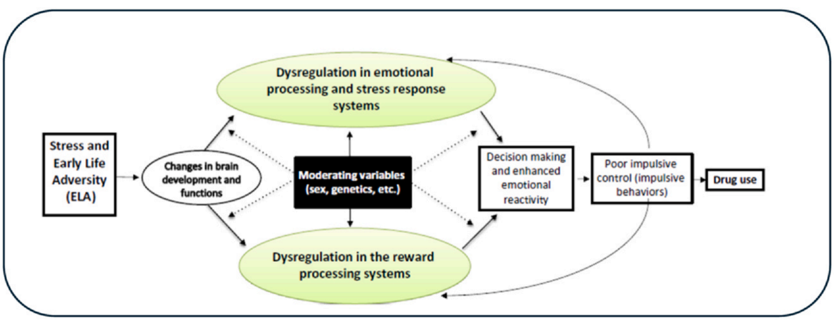

Fig. 4 Model illustrating how stress and early life adversity (ELA) influence addiction risk through dysregulation of emotional processing, stress response, and reward processing systems. The figure also highlights the roles of moderating variables (e.g., sex, genetics), decision making, and impulsive behaviours leading to drug use. *Adapted and taken from al'Absi (2020).*

mediated by HPA pathway dysregulation which also involves the dysregulation of the mesolimbic dopaminergic function (Sinha & Jastreboff, 2013). In addition, downstream and chronic changes in the BDNF gene expression may also be operational (Roth et al., 2009).

It is potentially possible that climate stress, anxiety can adversely affect patients with EOPD who are at additional risk of developing ICD and also have specific NMS signatures (Poplawska-Domaszewicz et al., 2024).

4. Vector-borne diseases

Climate change can also lead to increased expression of vector-borne diseases through a multifactorial process which includes temperature change and rainfall affecting and speeding up vector reproduction and consequently augmenting the development of the specific pathogen inside the vectors. Temperature change can also extend the transmission period which would allow vectors to survive in regions they could not survive before such as seen in higher altitudes or latitudes. An example is the threat and spread of Asian Tiger Mosquito (Bhaumik, 2013). The problem is further compounded by extreme rainfall (which create breeding grounds and stagnant water for mosquitoes) as well as droughts (which can form temporary pools of stagnant water) that can also significantly enhance breeding of vectors. Currently several diseases can be attributed to climate change and include Dengue, Zika, Chikungunya, Malaria, **Lyme Disease** and the **West Nile Virus** (de Souza & Weaver, 2024). Acute infections in PD could relate to a range of clinical scenarios as shown in Table 1. These

Table 1 Consequences of acute vector borne viral infections in PD.

Mental Health and related issues	Acute cognitive decline confusional states/delirium
Response fluctuations	Non Motor Fluctuation: Hypomania/Mania/ Anxiety/Pain Motor fluctuations (acute dyskinesias)
Consequences of worsening comorbidity	Worsening Comorbidities such as Diabetes: Dehydration
Environmental issues	Lifestyle mishaps (related to unexpected migration, anxiety, stress and temperature changes)

include acute changes in mental health related issues such as confusional states, chronic or hypoactive delirium, acute cognitive decline with some infections. Levodopa response fluctuations can be aggravated, both motor and nonmotor with precipitation of dyskinetic storms. Comorbid conditions can worsen while environmental issues related to acute illnesses or climate change induced epidemics can trigger a range of lifestyle related issues and consequent anxiety and stress.

5. Conclusions

Climate-related stressors are not just environmental challenges—they profoundly affect mental health, driving climate anxiety and exacerbating psychological distress. For individuals with Parkinson's disease, these stressors can influence disease progression and trigger acute motor responses, such as paradoxical kinesia, highlighting the brain's vulnerability to stress. Integrating awareness of environmental and psychological factors into clinical care is essential for developing interventions that protect mental well-being and support optimal neurological function in at-risk populations.

Acknowledgements

The Saivansh Chopra Research Funds for supporting KRC are acknowledged. The authors want to acknowledge the support of the Global Alliance for Inclusion and Ethnic Diversity in Parkinson's Disease (GAIPED).

CRediT authorship contribution statement

YHL, KPD and KRC conceptualised, designed and wrote the review. SH and SC liaised and coordinated the structure and writing of the paper as well as helped with research. KK helped with critique and writing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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