Introduction

Climate change, defined as a long-term change in the Earth's temperature and weather patterns, is largely caused by the burning of fossil fuels (coal, oil, and gas),¹ resulting in the emissions of greenhouse gases. Climate change poses significant challenges to health and healthcare. Health harms driven by climate change are projected to increase substantially² without prompt and substantive reductions in such greenhouse gas emissions. The effects of climate change, including extreme temperatures, air pollution, and natural disasters, impact the incidence, progression, and severity of endocrine diseases and disorders^{3,4,5}. Special considerations are necessary for the disproportionate impacts on vulnerable and under-resourced populations.

As the world's oldest and largest professional organization dedicated to the understanding of endocrinology and the care of patients with endocrine diseases, the Endocrine Society is committed to excellence in endocrine research and incorporation of scientific knowledge into patient care and public health. The Endocrine Society is concerned about the progression of climate change and impact of rising global temperatures and other climate change-induced manifestations on the health and well-being of humans, especially patients with existing endocrine diseases and disorders. Urgent action is needed to protect endocrine health and well-being from the effects of climate change through informed decision making that utilizes endocrine science.

Background

Climate change is driven by increasing levels of greenhouse gas emissions such as carbon dioxide (CO₂) and methane, predominantly generated by fossil fuel extraction, transport, and combustion, causing a significant increase in global average temperatures. The pace and intensity of the change has generated significant concern, as the global average temperature increase in 2024 breached an internationally agreed limit of 1.5°C relative to pre-industrial temperatures. This rise in temperature increases the frequency and severity of extreme weather events, ^{6,14} which will interrupt the practice of endocrinology and lead to poorer outcomes for patients with endocrine diseases and disrupt biomedical research in areas affected by natural disasters.

¹ United Nations. What is climate change? | United Nations. https://www.un.org/en/climatechange/what-isclimate-change

² IPCC, 2023: Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34, doi: 10.59327/IPCC/AR6-9789291691647.001

³ Ratter-Rieck, J. M., Roden, M., & Herder, C. (2023). Diabetes and climate change: current evidence and implications for people with diabetes, clinicians and policy stakeholders. Diabetologia, 66(6), 1003–1015. https://doi.org/10.1007/s00125-023-05901-y

⁴ Segal, T. R., & Giudice, L. C. (2022). Systematic review of climate change effects on reproductive health. Fertility and Sterility, 118(2), 215–223. https://doi.org/10.1016/j.fertnstert.2022.06.005

⁵ Hannan, F. M., Leow, M. K. S., Lee, J. K. W., Kovats, S., Elajnaf, T., Kennedy, S. H., & Thakker, R. V. (2024b). Endocrine effects of heat exposure and relevance to climate change. Nature Reviews Endocrinology, 20(11), 673–684. https://doi.org/10.1038/s41574-024-01017-4

⁶ IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change[Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, In press, doi:10.1017/9781009157896.

Extreme weather events driven by climate change threaten endocrine health and disproportionately impact vulnerable populations. For example, patients may have difficulty accessing care or storing medications such as insulin at appropriate temperatures, and extreme weather can cause significant, chronic mental and physical stress, thereby contributing to adverse health effects⁷. Climate-driven wildfires produce smoke and particulate matter that affects cardiovascular health⁸ and may contribute to adverse health complications in patients with diabetes³. Exposure to extreme heat also increases risks for insulin resistance, incident diabetes, and for diabetes-related mortality. In pregnancy, extreme heat is associated with higher risks of babies born small for gestational age, preterm birth, low birth weight and stillbirth. Outside of pregnancy, extreme heat is also associated with reduced ovarian reserve⁹. There is also evidence that heat stress may affect thyroid hormone levels and thyroid function and in turn, may affect the body's ability to regulate body temperature,⁵ with compounding impacts for patients who struggle to effectively regulate body temperature e.g., in the case of diabetes due to impaired blood flow and perspiration¹⁰. Rising temperatures may also be associated with obesity as extreme temperatures may lead to decreased physical activity and impact food supplies with downstream effects on nutrition.¹¹

Activities associated with the generation of greenhouse gases also contribute to other myriad environmental and human health harms, compounding the hazards from climate change. Many endocrine-disrupting chemicals (EDCs) are derived from fossil fuel feedstocks and used in the manufacture of plastics and other commercial products contributing to additional endocrine hazards¹². EDCs are also used in processes to generate fossil fuels (e.g., hydraulic fracturing), and extreme weather events lead to additional and often compounding exposure to EDCs such as via smoke inhalation, particulate matter from wildfires, and water contamination. These chemicals are linked to diabetes, obesity, adverse cardiovascular events, altered thyroid health, disruption of hormonal regulation, and reproductive health complications. As the case of plastics makes clear, the full lifecycle of fossil fuel use from extraction to production and emissions introduces myriad hazards leading to endocrine health effects listed above. ¹³

 ⁷ Crews, D. E., Kawa, N. C., Cohen, J. H., Ulmer, G. L., & Edes, A. N. (2019). Climate change, uncertainty and allostatic load. *Annals of Human Biology*, *46*(1), 3–16. https://doi.org/10.1080/03014460.2019.1584243
⁸ Xu, R., Yu, P., Abramson, M. J., Johnston, F. H., Samet, J. M., Bell, M. L., Haines, A., Ebi, K. L., Li, S., & Guo, Y.

^{(2020).} Wildfires, global climate change, and human health. New England Journal of Medicine, 383(22), 2173–2181. https://doi.org/10.1056/nejmsr2028985

⁹ U.S. Global Change Research Program. (2016, April 4). The Impacts of climate change on Human health in the United States: a scientific assessment. https://health2016.globalchange.gov/

¹⁰ Kenny, G. P., Sigal, R. J., & McGinn, R. (2016). Body temperature regulation in diabetes. Temperature, 3(1), 119–145. https://doi.org/10.1080/23328940.2015.1131506

¹¹ Koch, C. A., Sharda, P., Patel, J., Gubbi, S., Bansal, R., & Bartel, M. J. (2021). Climate change and obesity. Hormone and Metabolic Research, 53(09), 575–587. https://doi.org/10.1055/a-1533-2861

¹² Kassotis, C. D., Klemp, K. C., Vu, D. C., Lin, C., Meng, C., Besch-Williford, C. L., Pinatti, L., Zoeller, R. T., Drobnis, E. Z., Balise, V. D., Isiguzo, C. J., Williams, M. A., Tillitt, D. E., & Nagel, S. C. (2015). Endocrine-

Disrupting activity of hydraulic fracturing chemicals and adverse health outcomes after prenatal exposure in male mice. Endocrinology, 156(12), 4458–4473. https://doi.org/10.1210/en.2015-1375

¹³ Woodruff, T. J. (2024). Health effects of Fossil Fuel–Derived endocrine Disruptors. New England Journal of Medicine, 390(10), 922–933. https://doi.org/10.1056/nejmra2300476

Carbon emissions are expected to increase further without substantial near-term reductions in fossil fuel use, while global energy consumption is estimated to continue to grow through 2050¹⁴. However, national and international policymaking bodies recognize the environmental and public health threat posed by growing energy needs and climate change¹⁵. A variety of solutions have been proposed including:

- transitioning from fossil fuels to lower carbon emission energy sources (e.g., solar, wind, geothermal) to meet global energy needs and reduce environmental impact
- reducing energy consumption and increasing efficiency, thereby reducing pollution
- developing decarbonization strategies and technologies to reduce atmospheric carbon

Considerations

Special consideration is needed to protect and build resilience for vulnerable populations that are disproportionately harmed by climate change, such as children, the elderly, underserved or socioeconomically disadvantaged communities, outdoor workers, pregnant populations, individuals with comorbidities, communities that live or work near industrial facilities, and other communities that already experience health disparities. The health effects of climate change will depend in some part on geography. For example, residents in urban areas already experience higher exposure to air pollution, increasing the likelihood of developing chronic endocrine diseases. A person's work environment also creates different exposure scenarios and vulnerabilities. For example, individuals employed in construction or farming who predominantly work outdoors have disproportionate exposure to extreme temperatures while engaging in strenuous, physical activity, putting the health of patients with existing endocrine diseases and disorders at increased risk. Finally, a lack of access to resources in rural, underserved, or socioeconomically disadvantaged populations can also disproportionately affect vulnerable populations by interfering with the implementation of adaptation strategies.

Coordinated, multi-sectoral action driven by science-based policy and implementation of healthprotective measures is necessary to address climate change; such measures will have significant, positive effects on human health. Consistent, sustainable regulatory action is needed to set standards and rules governing activities that drive climate change to protect endocrine health. In the United States, the Environmental Protection Agency (EPA) has taken action to regulate emission standards for vehicles¹⁶. Because agriculture contributes as much as 10.5% of total greenhouse gas emissions in the United States, the United States Department of Agriculture (USDA) is working to mitigate climate change by providing incentives and financial assistance to improve agricultural practices and land use¹⁷. Collaborative action through a multi-agency agreement by these agencies and the US Food and Drug Administration (FDA) is aimed at reducing food loss and waste¹⁸, which will minimize greenhouse gas emissions from the breakdown of food in landfills.

¹⁴ U.S. Energy Information Administration - EIA - Independent Statistics and Analysis.

https://www.eia.gov/pressroom/releases/press542.php (Accessed August 25, 2024.)

¹⁵ Congressional Research Service. (2021). U.S. Climate Change Policy.

https://crsreports.congress.gov/product/pdf/R/R46947

¹⁶ Final rule: Multi-Pollutant emissions standards for model years 2027 and later Light-Duty and Medium-Duty vehicles | US EPA. (2024, December 4). US EPA. https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-multi-pollutant-emissions-standards-model

¹⁷ Climate solutions. USDA. <u>https://www.usda.gov/climate-solutions</u> (Accessed December 5, 2024.)

¹⁸ Final rule: Multi-Pollutant emissions standards for model years 2027 and later Light-Duty and Medium-Duty vehicles | US EPA. (2024, December 4). US EPA. https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-multi-pollutant-emissions-standards-model

Global agreements reflect the transboundary nature of the climate crisis. In 2015, 196 countries adopted an international, legally binding treaty with the aim of holding "the increase in the global average temperature to well below 2°C above pre-industrial levels."¹⁹ However, in 2025 the United States unfortunately withdrew from this agreement. On December 11, 2019, the European Union, acknowledging the existential threat posed by climate change, included a set of proposals "to make the EU's climate, energy, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels" as part of the EU Green Deal.²⁰ Furthermore, the Organization for Economic Cooperation and Development (OECD) has established programs such as the International Programme for Action on Climate (IPAC), which "supports country progress towards net-zero greenhouse gas (GHG) emissions and a more resilient economy by 2050." ²¹

Sectors outside of government, like healthcare and academia, have a role to play in addressing climate change and health. The healthcare sector contributes an estimated 8.5% of greenhouse gas emissions in the United States²² and 5% of worldwide greenhouse gas emissions,²³ generated by the manufacturing and use of medical supplies, in addition to energy use for transportation and for maintenance of healthcare facilities. The academic research sector also contributes to climate change through the generation of waste, such as single-use labware and use of products derived from fossil fuels²⁴. Importantly, healthcare workers and scientists can contribute not only through decarbonization of the sectors in which they work, but also by leveraging and reinforcing trust in science and medicine and engaging with patients and community members about the impacts of climate change on health. Scientific organizations, including our own Society, need to identify ways to reduce our contribution to climate change by e.g., carefully considering travel policies and the use of plastic at events. More research is needed to understand how climate change impacts endocrine health and to fill in knowledge gaps, to enable people to make decisions that reduce the impact of climate change on their well-being.

In the near-term, adaptation strategies are necessary to protect human health from the current effects of climate change.

Positions

The Endocrine Society is concerned about the severe health threats associated with climate change. The primary approaches to address climate change are to transition energy needs from

¹⁹ The Paris Agreement. United Nations Climate Change. https://unfccc.int/process-and-meetings/the-parisagreement

²⁰ The European Green Deal. (2021, July 14). European Commission. https://commission.europa.eu/strategyand-policy/priorities-2019-2024/european-green-deal_en

²¹ International Programme for Action on Climate (IPAC). Organisation for Economic Co-operation and Development (OECD). https://www.oecd.org/en/about/programmes/international-programme-for-action-on-climate.html

²² Eckelman, M. J., Huang, K., Lagasse, R., Senay, E., Dubrow, R., & Sherman, J. D. (2020). Health care pollution and public health damage in the United States: an update. Health Affairs, 39(12), 2071–2079. https://doi.org/10.1377/hlthaff.2020.01247

²³ Or, Z., & Seppänen, A. (2024). The role of the health sector in tackling climate change: A narrative review. Health Policy, 143, 105053. https://doi.org/10.1016/j.healthpol.2024.105053

²⁴ Tay, A. (2024). Can science cure its addiction to plastic? Nature. https://doi.org/10.1038/d41586-024-03010-3

fossil fuels to reduced carbon emission energy sources and to identify and deploy effective adaptation strategies. Without action from policy makers, federal agencies, researchers, clinicians, research and healthcare institutions, and other relevant stakeholders, endocrine health threats from extreme temperatures and natural disasters will become more severe as climate change accelerates. Coordinated, multi-sectoral approaches are essential to reduce the drivers of climate change and protect human health and well-being.

To protect endocrine health from the effects of climate change, the Endocrine Society supports the following positions:

- Policymakers need to enact laws and regulations to reduce greenhouse gas emissions, considering lifecycle impacts from fossil fuels, including extraction, combustion, production of materials derived from fossil fuels (including plastics), and resultant waste.
- Policymakers should consider economic incentives that promote the adoption of lower carbon emission energy sources, considering the economic burden of adverse health impacts associated with climate change, and benefits associated with reducing impacts.
- Laws and regulations aimed at addressing climate change should consider the perspectives of, and effects on, vulnerable populations.
- Governments need to support the development and adoption of lower carbon emission sources that reduce carbon emissions, if they minimize potential environmental harms and health risks, and encourage the responsible reduction and conservation of energy needs across all sectors.
- Government agencies and healthcare institutions need to educate, and to develop and implement adaptation strategies, with consideration for patients with existing chronic health conditions and vulnerable populations, to mitigate the effects of extreme temperatures and severe weather events.
- Federal agencies need to support cross-collaborative research on the impact of climate change on endocrine health and to develop informed mitigation and adaptation strategies for the health and well-being of patients.
- Healthcare and research institutions must develop strategies and best practices to reduce their own fossil fuel consumption. These strategies and best practices may include characterizing products, activities, and services and altering them to reduce greenhouse gas emissions and promoting the use of telehealth and virtual meeting platforms to reduce travel-related greenhouse gas emissions.
- Professional societies should engage in the development of climate-related agreements and advocate for their governments to take part in those agreements.
- Professional societies should develop educational and advocacy materials for their members to discuss how climate change impacts patient health and how they can work with patients to advance health-protective policies.
- Professional societies should adopt policies that reduce their contribution to climate change.