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Environmental Impacts of External Beam Radiation Therapy in Brazil: A Comparative Life Cycle Assessment

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Abstract
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Abstract

Purpose: As climate change continues to threaten global health, it is imperative for oncology care to address its own negative environmental impacts. Radiation therapy is a cornerstone of cancer care, involving over half of cancer patients. The environmental impacts of external beam radiation therapy (EBRT)—driven by high energy use and resource consumption—contribute to climate change and environmental degradation, potentially resulting in downstream inequitable health outcomes, particularly in low- and middle-income countries. To date, little is known about the environmental impacts of EBRT in the Global South, where climate change disproportionately burdens patients and healthcare systems. This study aims to quantify the environmental impact of EBRT in Brazil, comparing it to EBRT delivery in the U.S.[1] and exploring how resource-efficient practices may improve environmental outcomes and, ultimately, equity in radiation oncology access.

Methodology: A life cycle assessment (LCA) of EBRT for ten cancer disease sites was conducted at a radiation oncology clinic (Vitta) in Brasília, Brazil, following ISO 14040 and 14044 standardized methodology. Data on medical supplies, equipment usage, building energy consumption, and staff and patient travel from 2018-2023 was analyzed to assess environmental impacts across nine categories, including greenhouse gas emissions, air pollution, and carcinogenic potential. These results were compared with a previously published LCA of EBRT across four U.S. healthcare centers.

Results: EBRT at Vitta showed a lower environmental impact across all categories compared to U.S. centers. Transit was the highest contributor to Vitta's emissions, though overall emissions from staff travel were lower than in the U.S. due to shorter distances (median 15 miles/week by public transit at Vitta vs. 48-90 miles/week by car in the U.S.). Supplies at Vitta contributed higher impacts than U.S. supplies across all of the ten categories. Vitta's cooling relied solely on hydroelectricity without additional heating, while U.S. clinics used natural gas and mixed-grid electricity, making building energy the largest U.S. emissions source (74.0% CO2 emissions vs. 9.3% at Vitta).

Conclusions: These findings represent novel insights into the environmental impact of EBRT internationally, which have been largely unexplored. Our results highlight the importance of considering regional context and difference. The reduced environmental footprint of the Vitta clinic in Brazil underscores the impact of sustainable practices (lower energy consumption, renewable energy use, uptake of public transit) in mitigating the environmental externalities of care. Sustainable practices reduce the health sector's climate impact and also hold promise for reducing operational costs, thereby expanding access to life-saving treatments in underserved regions. Future research should assess environmentally sustainable efforts that support broader EBRT access, including at publicly-funded and rural clinics, to guide adaptable, scalable, and equitable models for global radiation oncology.

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