DIGITAL HEALTH VALIDATION LAB

University of Glasgow

NHS Fellowship in Clinical AI
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Link to study protocol

Evaluating the environmental sustainability of AI in radiology: A systematic review of current practice

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Introduction

Data- and energy-heavy artificial intelligence (AI) technologies are increasingly applied in radiology, often without consideration of their potential environmental consequences.

We aimed to assess current practice in evaluating environmental sustainability (ES) impacts of AI-enabled clinical pathways in radiology.

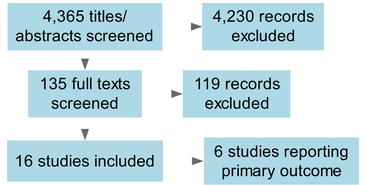
Methods

- We systematically searched MEDLINE and Embase on 5th November 2024 for **clinical radiology studies using AI** to aid in radiological diagnosis or intervention **which discussed ES impacts**
- We included peer-reviewed, English-language studies published from 2015 onwards
- Our **primary outcome** was any quantitative reporting of ES impacts (including carbon emissions, energy/water/mineral usage, waste generation/disposal, and impacts on material environments)
- Our **secondary outcome** was any within-text discussion of ES impacts
- We used Synthesis Without Meta-analysis (SWiM) based on effect size for our primary outcome, with our secondary outcome synthesized narratively

Study characteristics

- Of 16 included studies, only 6 reported quantitative ES measures:
  - 3 reported on **carbon emissions**
  - 5 reported on **energy use**
- MRI was the most common imaging modality (68.8%), and the most common sites were prostate (31.3%), head (25.0%), and chest (12.5%)
- Mostly used **supervised learning** (75.0%)
- **Most frequent AI tasks**: classification (43.8%) and segmentation (31.3%)
- **Most common architectures**: Green Learning (31.3%) and U-Net (37.5%)

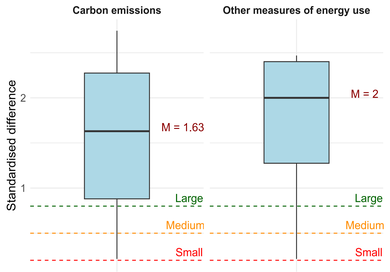
Figure 1: PRISMA Diagram



Results

- All 6 quantitative studies evaluated AI algorithms designed to be resource/time efficient, comparing them with less lightweight algorithms applied to the same clinical task(s)
- For all datapoints, **study algorithms outperformed state-of-the-art comparators on both environmental and technical performance**, producing
  - From **2.2 to 17.2 times less carbon emissions** (median 7.8)
  - From **1.6 to 751.6 times less energy consumption** (median 3.2)
- Standardised effect differences were almost all classed as **large** (Figure 2)
- **No studies** compared ES outcomes for AI-enabled pathways versus standard-of-care
- 70% of studies for our secondary outcome included just a **single sentence on sustainability**

Figure 2: Standardised differences of lightweight vs non-lightweight algorithms



Each plot represents 16 datapoints. M = median. Lines indicate Cohen's classification of standardised mean difference sizes.

Discussion

- Despite increasing concern about the climate impacts of AI, **environmental outcomes are rarely measured** or discussed within evaluations of AI-enabled clinical pathways in radiology
- However, our evidence suggests **designing AI products with sustainability in mind can substantially reduce their carbon footprint**, and highlights that more sustainable AI products already exist
- There remains a **large evidence gap** around comparing climate impacts of AI versus no AI in clinical pathways
- **Environmental sustainability should be better integrated into AI evaluation and procurement** to ensure costs and benefits for both climate and health are fully considered

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