Approaches used in assessing the environmental sustainability of digital health technologies: a systematic review

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Introduction and Aim

- Healthcare providers in many jurisdictions are committing to net zero targets to reduce the environmental impact of healthcare systems.
- Digital health technologies (DHTs) have the potential to contribute to sustainable healthcare and are widely accepted to improve efficiency and reduce workload, reliance on physical infrastructure and patient travel.
- There is growing awareness that DHTs contribute to climate change themselves through production, disposal, data collection and storage and infrastructure requirements.
- There is a lack of guidance on how to measure the environmental impact of DHTs.

To summarise existing frameworks for assessing the environmental impact of DHTs and to examine adherence to these frameworks in the evaluations of the environmental impact of DHTs.

Methods

Two inter-related systematic reviews were conducted:

Review 1. Frameworks focussing on assessing environmental impact were included, the frameworks did not have to be specifically for DHTs.
Four electronic and grey literature databases were searched with no time limits.
Data was extracted on type of technology the framework focusses on, steps in the framework, recommended use of tools, and recommended environmental and non-environmental outcomes to capture impact. A narrative synthesis was carried out to summarise the data.

Review 2. Evaluations of the environmental impact of DHTs were included. Studies assessing only a component of a DHT were excluded.
Five electronic databases and three pre-print repositories were searched from 2019 onwards.
Data was extracted on adherence to frameworks, DHT characteristics, methodology for assessment and outcomes included. A narrative synthesis was carried out to summarise the data.

Results

- Seven frameworks for assessing environmental impact were identified (Figure 1). None were-specific to DHTs; four did not target specific technologies, two targeted healthcare and one targeted software .
- Framework components could be broadly categorised into; goals, inventory, conversion tools, analysis and reporting.
- Although conversion tools were mentioned across all but one frameworks, only three frameworks recommended specific tools.
- Recommendations for outcomes to capture impact focussed mainly on environmental outcomes with a few recommendations for non-environmental outcomes .

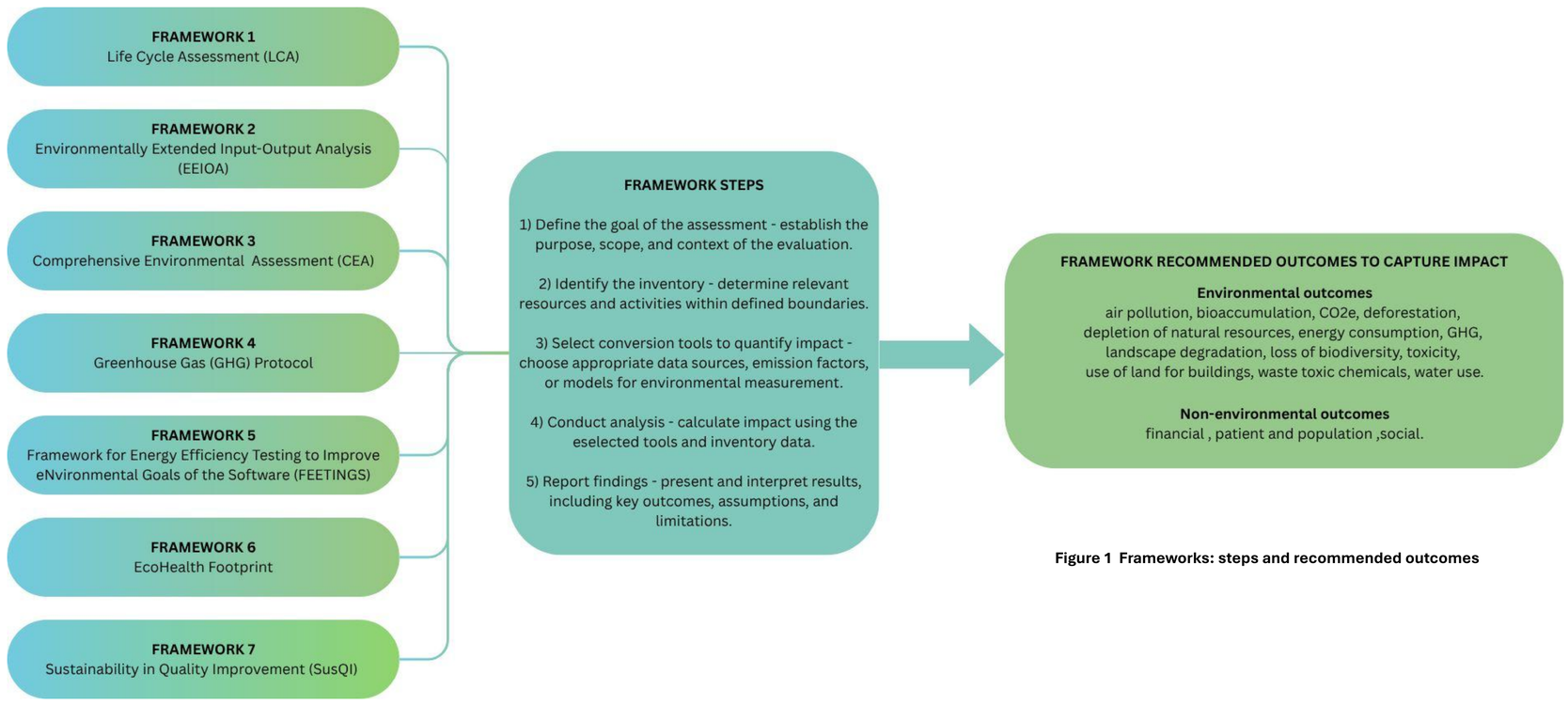

Figure 1 Frameworks: steps and recommended outcomes

- The second systematic review identified 73 studies, 27 from countries with explicit net zero targets for healthcare, 21 from countries with implicit net zero targets (e.g. 'whole economy' net zero targets) and the remaining 34 with no set targets.
- The majority evaluated telemedicine (n=70), most of these provided support in real-time at a patient's home or local healthcare clinic (n=60). Non-telemedicine studies included deep learning for digital pathology, robotic exoskeleton and electronic medical records.
- Many studies did not include a comparator for assessing the DHT (n=53), most presenting environmental impact as savings from using DHT but without a base to compare to.
- Inventory captured mostly included travel (patient, carer and staff), followed by facilities use (clinic rooms for in-person visits), consumables (PPE, paper) and equipment and devices (medication, inpatient stays) (Figure 2). Most studies only included travel in inventory (n=43).

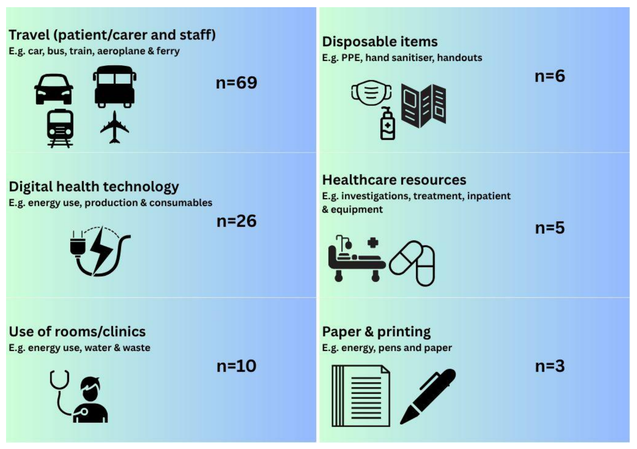

Figure 2 Inventories included

- A wide range of conversion tools were used to convert inventory to emissions; most were country specific and emission factors were not consistent across tools (e.g. 227g to 411g CO2 per mile for car travel).
- Frameworks were used in 12 studies with good adherence, those studies not using frameworks broadly adhered to five components, but reporting was poor.
- Most studies (n=70) reported positive environmental impact of DHTs (savings), but a small number (n=3) indicated a negative impact.
- Environmental outcomes focussed mainly on greenhouse gas emissions - CO2 and CO2e were most reported (n=37 each) (Figure 3). Other environmental outcomes included measures of pollution and waste (e.g. particulate matter and water). Most studies included a single environmental outcome (n=58).
- Indirect outcomes (e.g. distance travelled) were reported in a majority of studies (n=58).
- Non-environmental outcomes included clinical efficiency, compliance and engagement, and clinical experience/satisfaction.
- A number of co-benefits were reported ranging from patient travel time and costs to productivity loss.

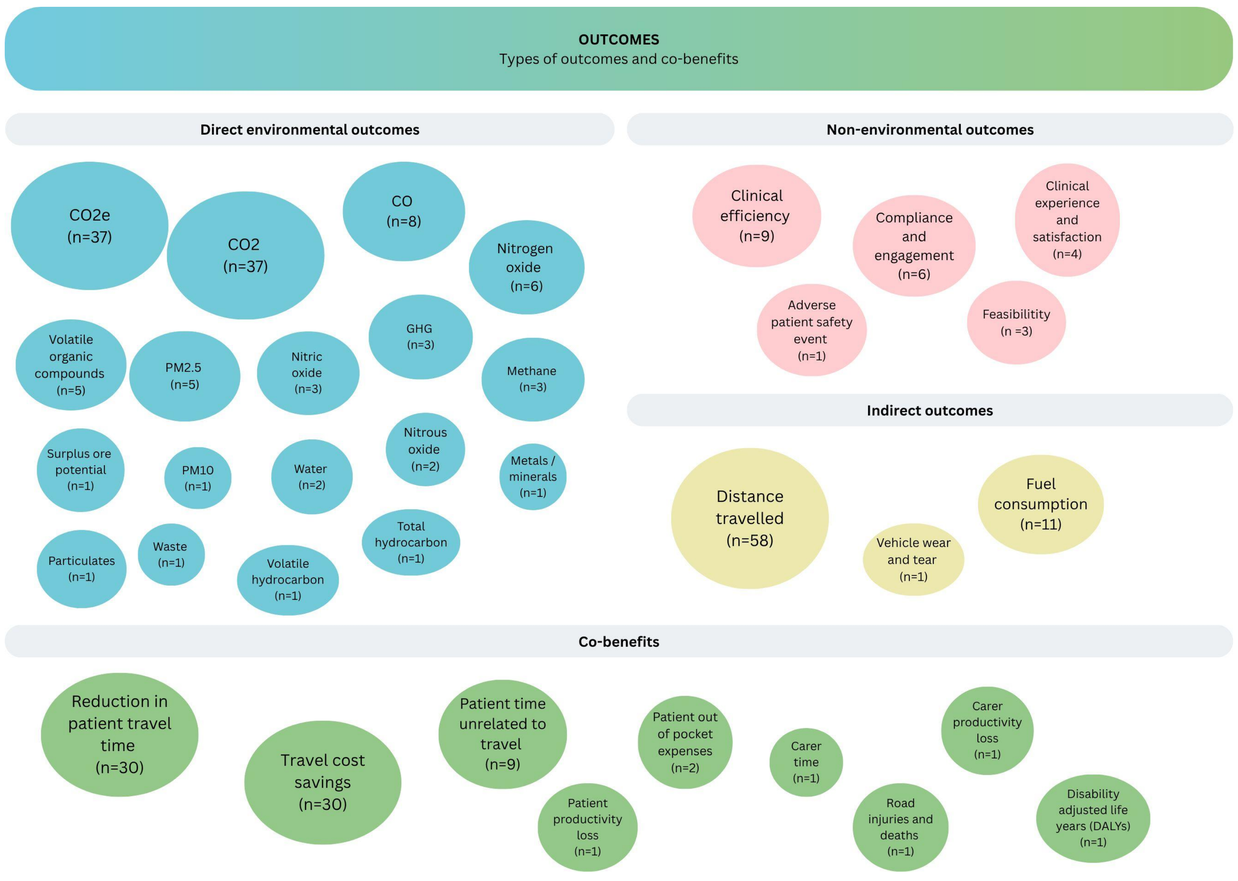

Figure 3 Outcomes
CO2e, carbon dioxide equivalent; CO2, carbon dioxide; CO, carbon monoxide; PM2.5, particulate matter less than 2.5 micrometres in diameter; GHG, greenhouse gases; PM10, particulate matter less than 10 micrometres in diameter

Conclusions

We found that frameworks are rarely used when assessing environmental impact of DHTs but are broadly adhered to. A wide range of conversion tools were used to convert inventory to impact, most were country specific, but variability in emission factors between tools makes comparison between studies challenging. Environmental outcomes mainly focussed on greenhouse gas emissions. Whilst most studies reported a positive impact on the environment there was no discussion of whether this was a meaningful impact, particularly in relation to reaching net zero targets. In this rapidly evolving field, it is important to standardise methodologies and reporting to allow comparison and interpretation of impact of DHTs across studies.

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