Evaluating Environmental Sustainability in Health Technology Assessment: A Multisectoral Systematic Review

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Background

- Climate change is a significant global health threat.
- Health technologies used in the UK NHS contribute 60% of the 26 million tonnes of greenhouse gases (GHGs) generated each year.
- Committed to deliver net zero carbon emission by 2045, the National Health Service (NHS) has set ambitious environmental targets.
- Healthcare decision making bodies such as the National Institute for Health and Care Excellence (NICE) have started to consider environmental sustainability in their objectives.
- Decision makers involved in HTA are challenged in incorporating environmental sustainability (ES), attributed to a lack of resources, consensus in scope, boundary, environmental outcomes and how to "trade off" health economics and environmental outcomes.
- The objectives of the study are to identify, critically evaluate and make methodological recommendations to support development of HTA environmental sustainability.

Methods

- **Databases:** GreenFILE, PubMed, Cochrane Library, Clarivate Web of Science, Embase on Ovid, IEEE Xplore Digital Library, INAHTA
- **Search period**: 2008 to 2023.
- **Inclusion**: full text published studies that include frameworks to assess environmental sustainability of technologies.
- **Extraction**: followed PRISMA guidelines and checklist focusing on study design, performed analysis and main outcomes measures.
- Study frameworks were evaluated for their comprehensiveness based on the scope of the sustainability domains (Venn diagram in Fig 1) within their methods.
- Studies were ranked according to how transparent and feasible the frameworks were in their ability to assess technology environmental sustainability; this determined aligned with HTA principles.

Results

- A total of 10 studies were identified as potential frameworks for assessing ES of technologies.
- The One Health "extended" life cycle assessment (LCA) that utilised SimaPro LCA advanced software was ranked first amongst the study frameworks (see Table 1). Studies are referenced below based on their ranking in Table 1.
- Ranked second, the Circular Economy (CE) framework used in conjunction with an analytical hierarchy process (AHP) makes use of weighting and expert consultation to support multi criteria decision making (MCDM).

Methods to support environmental scope and boundary setting

- Four studies (1,4,5,9) define the scope and boundary using a LCA. The One Health and CE (2) frameworks facilitate scope and boundary setting. Technology characteristics determining environmental hotspots defined the scope and boundary in two studies (2,9). Advanced SimaPro software is used in three studies (1,3,4) to support scope and boundary decision making.

Methods to support multiple criteria decision making

- Multi criteria decision analysis (MCDA) models have been combined with life cycle assessment (LCA) in three studies (2,3,4) to facilitate decision making across a broad range of criteria. Two studies (3, 4) applied mathematical models to support MCDA. Analytical hierarchy process (AHP) helped prioritize CE criteria of technology. Six studies (2,3,4,5,9,10) applied weighting and values to environmental, financial, technical, and other criteria. A DPSIR model is used to focus criteria in one study (3); "Driver (e.g., population focus), Pressure (e.g.,, water consumption), State (e.g., water pollution), Impact (e.g., waste volumes generated) and Response (e.g.,, reduction in plastic consumed). Expert consultation was used to assess data quality and support decision making in four of the studies (2,3,5,6) making this an important part of a sustainability assessment framework.

Methods to support environmental data generation and quality

- One study utilised an economic input-output life cycle assessment (EIO-LCA) (9) to help overcome a lack of environmental data that simultaneously facilitated a broader evaluation of the complex technology. Three studies (1,4,5) highlight methods to deal with uncertain environmental data. Three studies (1,4,5) utilise advanced SimaPro to aggregate data into four environmental outcome endpoints: climate change (CO_2e), resource use ($), biodiversity impact (no species lost per year) and human health outcome [in disability-adjusted life years (DALYs)].

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Table 1. Key studies methods ranked in order of comprehensiveness for HTA

Study framework and methods	Domains of Sustainability (outlined in Fig 1 Venn diagram)	Ranking (also shown in Fig 2 bubble chart)
One Health "extended" life cycle assessment (LCA) framework, the use of a global epidemiological database and SimaPro	E	1
A MCDA Analytical hierarchy process (AHP) model in combination with a Circular Economy framework + weighting technique + expert consultation	B	2
A MCDA using Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) mathematical model used in combination with a Driver, Pressure, State, Impact and Response (DPSIR) model used in environmental management +SimaPro + weighting technique + expert consultation	B	3
A MCDA Preference Ranking Organisation Method for Enrichment Evaluation (PROMETHEE) mathematical model + SimaPro + weighting technique	B	4
Risk Reduction, Environmental Merit and Cost (REC) framework + SimaPro + weighting technique + expert consultation	B	5
"Bottom up" Cost Benefit Analysis (CBA) + use of Evidence Based Deliberation Process (EBDP) + expert and public consultation	B	6
Health Impact Assessment (HIA) + use of Quality Adjusted Life Years (QALYs) model	B	7
A Discrete Choice Experiment (DCE) model	B	8
Life Cycle Sustainability Assessment (LCSA) using Extended Input-Output (EIO) + 16 "sustainability indicators" chosen depending on the technology + weighing technique	D	9
Societal Cost of Carbon (SCC) + weighting technique	B	10

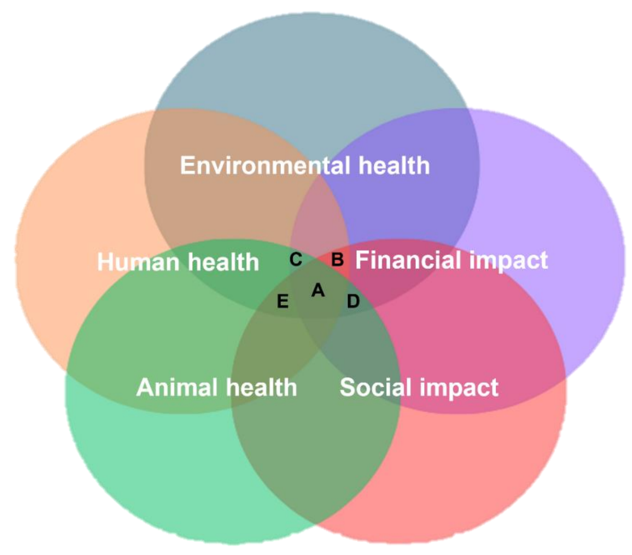
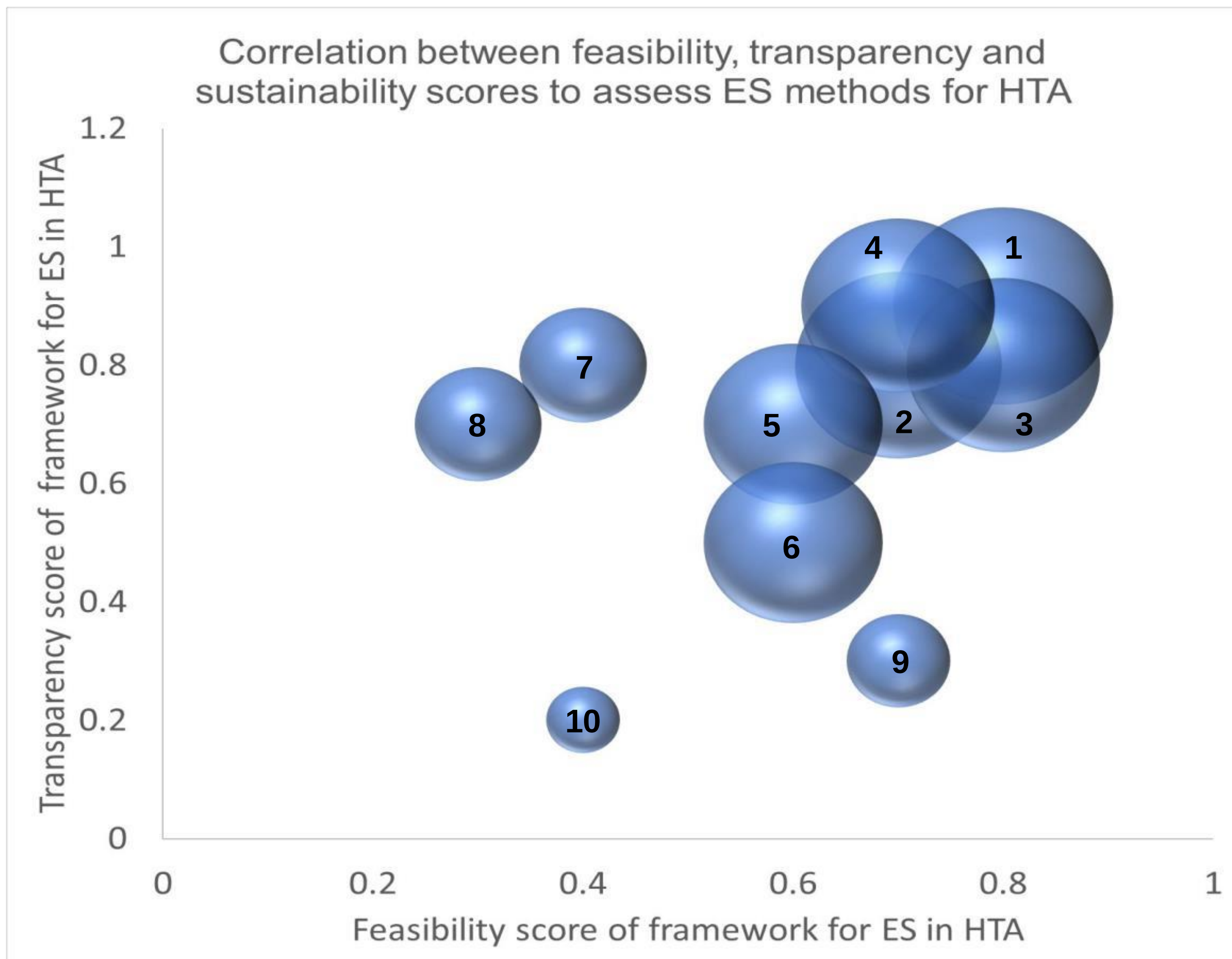


Figure 1. Venn diagram illustrating five domains of sustainability: financial impact, social impact, human health, environmental health, and animal health

(**A**) Financial, environmental, human, social, and animal
(**B**) Financial, environmental, human, and social
(**C**) Financial, environmental, and human
(**D**) Financial, environmental, social, and animal
(**E**) Environmental, human, social, and animal

Figure 2. Bubble chart showing comprehensiveness of methods using transparency, feasibility, and sustainability scoring (based on the sustainability domains covered by the framework and ranking shown in Table 1



Discussion

- The One Health and Circular Economy frameworks used in conjunction with other methods that support technology decision making represents an important and timely shift to embracing environmental sustainability through transdisciplinary collaboration.
- A LCA used in conjunction with other methods supports overcoming known challenges to incorporating sustainability in HTA including; data availability, suitable scope and boundary of environmental assessment.
- Most studies state that technology sustainability requires expert consultation to weight financial, social, and environmental criteria and facilitate "trade off".
- Prioritising highest environmental impacts provides a framework assessment.
- Utilising advanced LCA software such as SimaPro addresses resource constraints, data quality and methodological development.

Conclusion

- This is the first systematic review to identify multidisciplinary methods supporting environmental sustainability decision making in HTA.
- This study provides valuable insight in an area where there is limited research.
- In addition, this review highlights a broad range of methods challenging the limitations to methodological development highlighted by previous research.

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