Use of AI in Breast Cancer Screening in England Has a Minimal Impact on Greenhouse Gas Emissions and May Increase Diagnostic Accuracy

Amy Swanston, Emily Archer Goode, Medha Shrivastava, John Bridgewood, Henry Swales, Lindsay Nicholson

Maverex Limited, Newcastle upon Tyne, UK

MT45

01 BACKGROUND

- In England, women aged 50–71 are screened for breast cancer every three years.[1]
- Screening mammograms miss approximately 20% of breast cancers.[2]
- Artificial intelligence (AI) tools, such as Mammography Intelligent Assessment, are being trialled to improve early cancer detection.[3]
- According to the National Cancer Institute, screening mammograms miss about 20% of breast cancers. Early research indicates that AI can detect smaller cancers at an earlier stage.[4] Further, as ~80% of biopsies performed on areas of concern are benign, AI may help to reduce the number of unnecessary biopsies.[4]

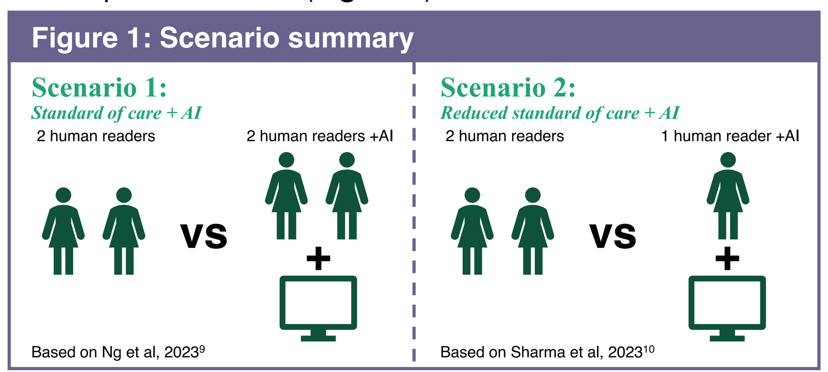
02 OBJECTIVE

- The objective of this study was to evaluate the greenhouse gas (GHG) emissions associated with AI-assisted mammography screening versus the current standard of care (SoC), in women aged ≥45 in England over one year (2023–2024).

03 METHODS

A life cycle assessment (LCA) was performed using the ReCiPe 2016 v1.1 impact assessment method,[5] with inputs from the ecoinvent database v3.8,[6] and modelled using LCA for Experts (v10.7.1.28).[7] A literature review was conducted to inform the current standard of care pathway.[1] In the SoC pathway, mammogram images were assessed by two human readers, plus a third for arbitration, if required. Real-world baseline data from NHS breast cancer screening statistics in England for 2023–2024[8] were applied to two published scenarios evaluating the use of an AI system as an independent reader (**Figure 1**) [9,10]

Figure 1: Scenario summary



Published values for sensitivity, specificity and arbitration rate[9,10] informed true/false positive and negative values, which determined referrals for triple assessment (clinical examination, imaging, and biopsy) (**Table 1**).

Table 1. Model parameters for each scenario

	Scenario 1 (2 human readers + AI)		Scenario 2 (1 human reader + AI)	
Variable	**SoC**	**AI**	**SoC**	**AI**
Published model variables (%)[9,10]				
Sensitivity	94.1%	98.8%	86.1%	83.9%
Specificity	93.7%	93.6%	97.1%	97.1%
Arbitration rate	3.3%	6.2%	3.3%	12.3%
Calculated number of patients				
True positive (TP)	16,677	17,510	16,677	16,251
False negative (FN)	1,046	213	2,692	3,118
True negative (TN)	1,811,784	1,809,850	1,875,927	1,875,927
False positive (FP)	121,817	123,750	56,027	56,027
Total screened	1,951,323	1,951,323	1,951,323	1,951,323
Patients recalled	138,494	141,260	72,704	72,278
Prevalence of cancer in screened population (TP + FN)	17,723	17,723	19,369	19,369

A study boundary is shown in **Figure 2**. Modelled GHG emissions for each module is shown in **Table 2**.

Figure 2: Scenario summary

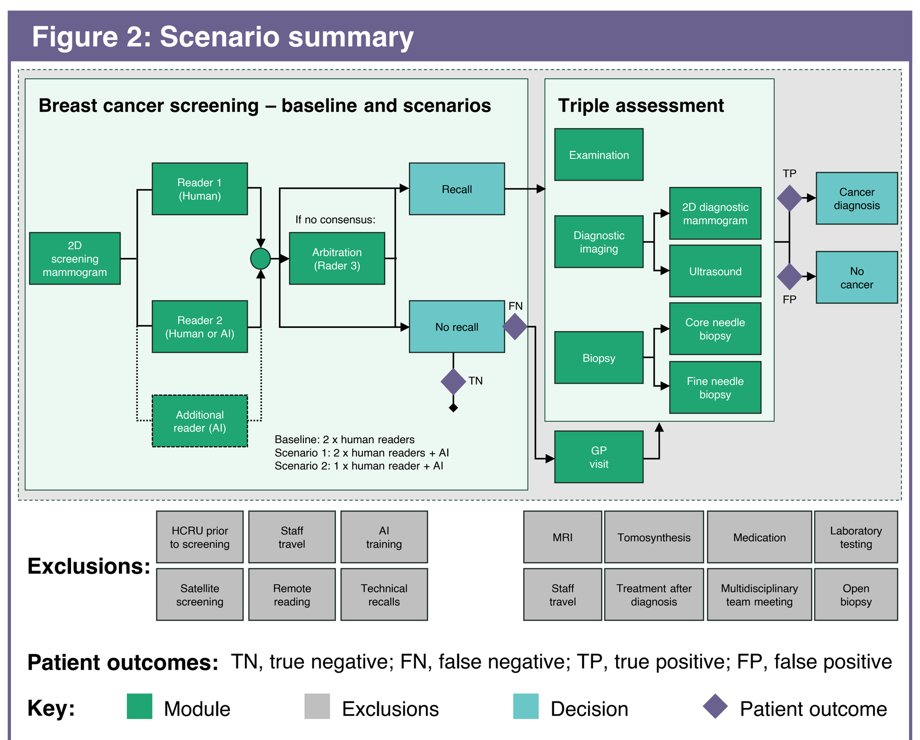


Table 2. GHG emissions associated with the breast cancer screening pathway in England

Pathway	Module	GHG emissions per module use (kg CO_2e)
Screening	Screening return travel	3.812
	Screening mammogram	0.040
	Human screen reader	0.001
	AI screen reader	0.001
	Human screen reader (arbitration)	0.003
Triple Assessment	Triple assessment return travel	4.273
	Clinical examination	0.012
	Diagnostic imaging - mammogram	0.049
	Diagnostic imaging - ultrasound	0.121
	Core needle biopsy	0.974
	FNA biopsy	0.716
Triple Assessment Results	Triple assessment results return travel	4.273
	Biopsy results meeting – in person	0.022
	Biopsy results meeting - telehealth	0.006
GP appointment (for false negatives only)	GP return travel	3.812
	GP appointment	0.012

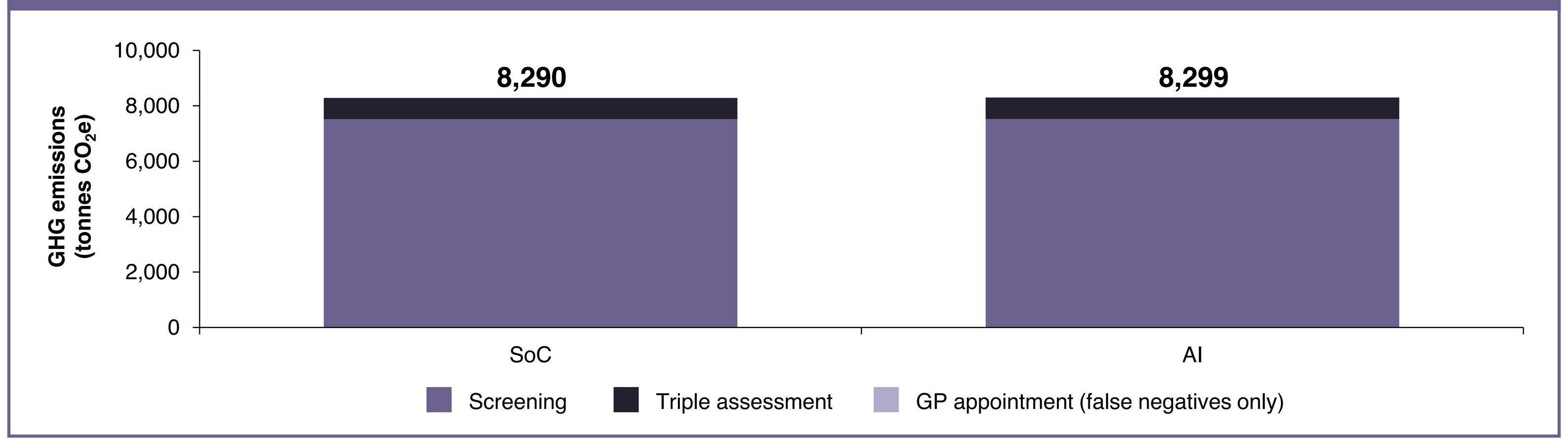
AI, artificial intelligence; GP, general practitioner; FNA, fine needle aspiration

04 RESULTS

Scenario 1: 2 human and 1 AI

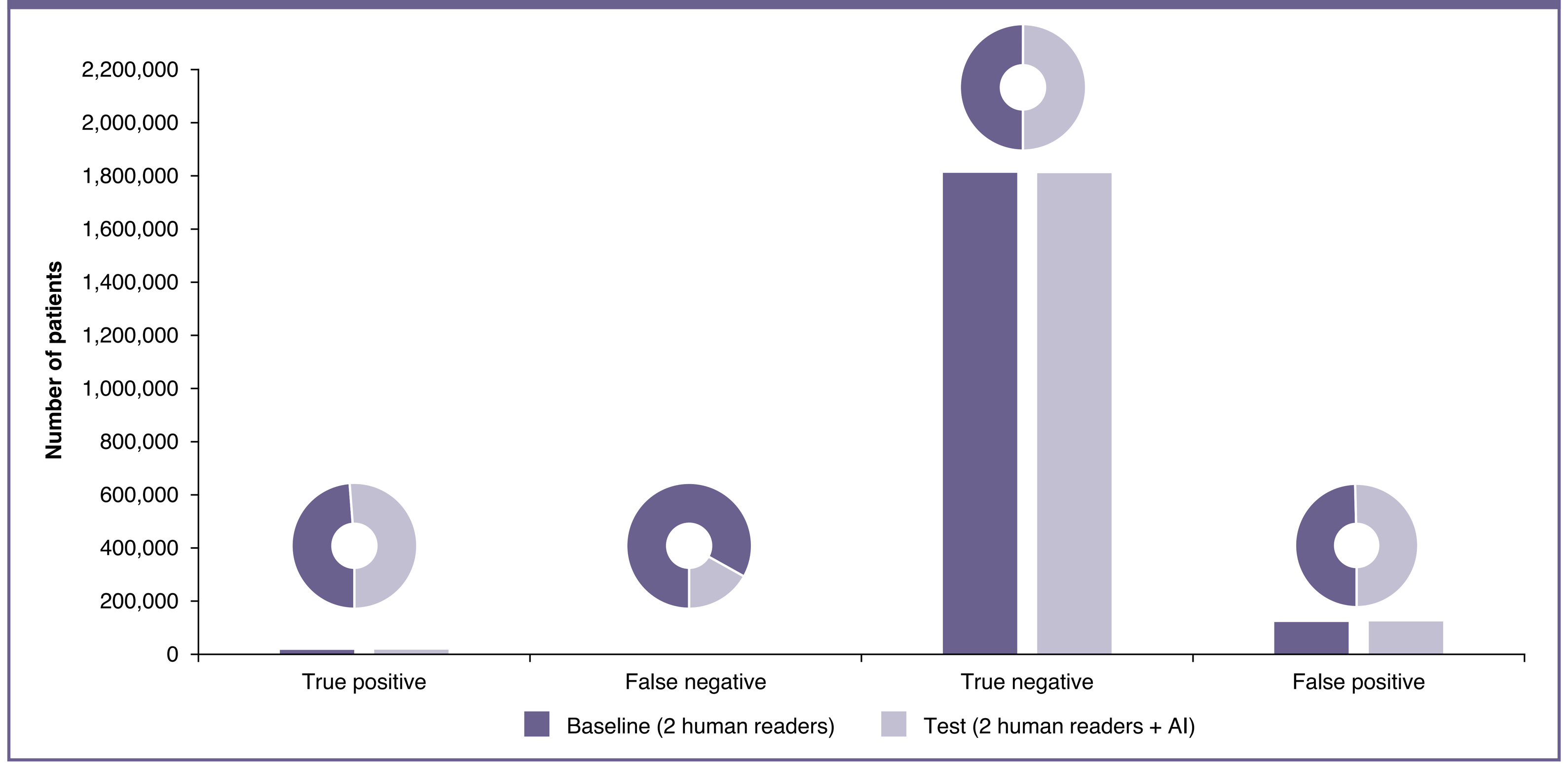
For scenario 1, the SoC pathway generated 8,290 tonnes of carbon dioxide equivalents (CO_2e). Incorporating an additional AI reader resulted in total emissions of 8,299 tonnes CO_2e – an annual increase of 9 tonnes, equivalent to the average annual GHG emissions of two people in the UK (**Figure 3**).[11]

Figure 3: Adding an AI reader alongside two human readers in the breast cancer screening pathway (Scenario 1) has a minimal impact on GHG emissions associated with the pathway



Addition of an AI reader reduces the number of false negatives by 833, decreasing the number of patients incorrectly cleared after screening in the SoC pathway but who subsequently required cancer treatment (**Figure 4**).

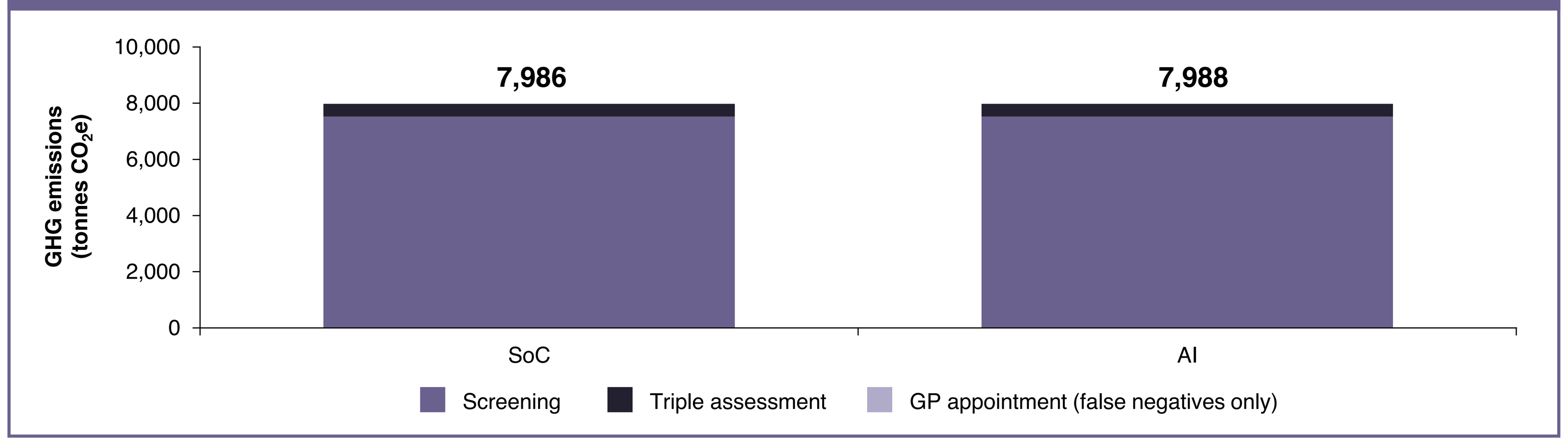
Figure 4: Adding an AI reader alongside two human readers in the breast cancer screening pathway (Scenario 1) reduces the number of false negatives



Scenario 2: 1 human and 1 AI

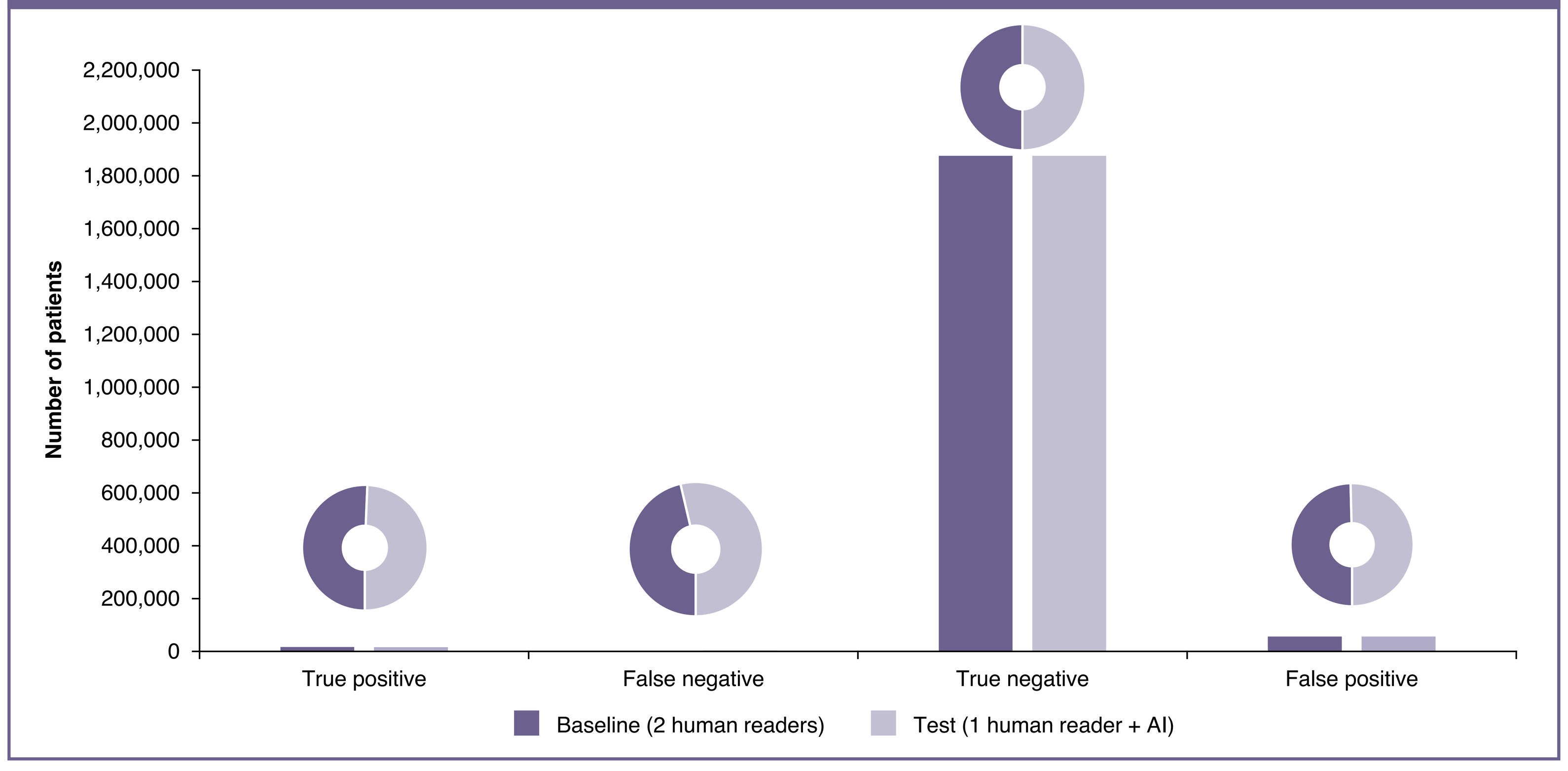
In Scenario 2, replacing one human reader with AI resulted in minimal change, with SoC and the AI-assisted approach generating 7,986 and 7,988 tonnes CO_2e, respectively (**Figure 5**).

Figure 5: Adding an AI reader in place of one of the two human readers in the standard of care breast cancer screening pathway (Scenario 2) has a minimal impact on its GHG emissions



Replacing one human reader with an AI reader in the screening pathway leads to 426 patients being incorrectly classified as cancer-free (**Figure 6**). Clinical outcomes are likely to be worse for these patients, as diagnosis of their cancer will be delayed due to being missed during initial screening.

Figure 6: Adding an AI reader in place of one of the two human readers in the standard of care breast cancer screening pathway (Scenario 2) increases the number of false negatives



05 DISCUSSION AND CONCLUSIONS

- **Implementing AI assistance in addition to SoC in the breast cancer screening programme in England may result in earlier and more accurate cancer detection, whilst having minimal environmental impact.**
- **To optimise patient and environmental outcomes, an AI reader should be used as an add-on to current SoC, not replace it.**
- **When adding AI to current SoC, a minor additional impact is generated by more people being sent incorrectly for further assessment, equivalent to two times the annual GHG emissions of a single person in the UK.**
- **Future improvements in accuracy of the tool are necessary for implementation of AI in place of a second reader, ensuring patient outcomes remain the primary consideration over environmental benefits.**
- **While the model focuses on diagnosis, earlier detection could lead to less advanced cancer in some patients, potentially lowering the environmental impact of subsequent treatments.**

References

1. NHSBSP. Breast screening: clinical guidelines for screening assessment. *GOV.UK* https://www.gov.uk/government/publications/breast-screening-clinical-guidelines-for-screening-management (2016); 2. National Cancer Institute. Mammograms - NCI. https://www.cancer.gov/types/breast/mammograms-fact-sheet (2023); 3. Kheiron medical technologies. Mia: Mammography Intelligent Assessment - AI Mammograms. *Kheiron Medical* https://www.kheironmed.com/mammography/ (2021); 4. BreastCancer.org. Using AI to Detect Breast Cancer: What We Know. *Using AI to Detect Breast Cancer: What We Know* https://www.breastcancer.org/screening-testing/artificial-intelligence (2024); 5. Huijbregts, M. A. J. *et al.* ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level. *The International Journal of Life Cycle Assessment* **22**, 138–147 (2017); 6. Ecoinvent. Ecoinvent Database – ecoinvent. https://ecoinvent.org/the-ecoinvent-database/ (2022); 7. Sphera. LCA For Experts. *Sphera* https://sphera.com/solutions/product-stewardship/life-cycle-assessment-software-and-data/lca-for-experts/ (2025) ; 8. NHS England Digital. Breast Screening Programme, England, 2023-24. *NHS England Digital* https://digital.nhs.uk/data-and-information/publications/statistical/breast-screening-programme/england---2023-24 (2025); 9. Ng, A. Y. *et al.* Prospective implementation of AI-assisted screen reading to improve early detection of breast cancer. *Nat Med* **29**, 3044–3049 (2023); 10. Sharma, N. *et al.* Multi-vendor evaluation of artificial intelligence as an independent reader for double reading in breast cancer screening on 275,900 mammograms. *BMC Cancer* **23**, 460 (2023); 11. Ritchie, H., Rosado, P. & Roser, M. CO_2 and Greenhouse Gas Emissions. *Our World in Data* https://ourworldindata.org/co2-and-greenhouse-gas-emissions (2023).

maverex