

Artificial Intelligence & Machine Learning

November 17-18, 2025 | London, UK



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Beyond Cancer Detection: An AI Framework for Multidimensional Risk Profiling on Contrast-Enhanced Mammography

Purpose

To assess whether AI-based models improve reproducibility of breast density (BD) and background parenchymal enhancement (BPE) classification, and to explore whether contrast-enhanced mammography (CEM) can serve as a proof-of-concept platform for systemic risk surrogates.

Materials and Methods

In this retrospective single-center study, 213 women (mean age 58.3 years; range 28–80) underwent CEM in 2022–2023. Histology was obtained when lesions were present (BI-RADS 4/5). Five radiologists independently graded BD and BPE; consensus served as ground truth. Linear regression and a deep neural network (DNN) were compared with a simple linear baseline. Inter-reader agreement was measured with Fleiss' κ . External validation on 500 BI-RADS C/D cases from VinDr-Mammo targeted density endpoints. A secondary exploratory analysis tested a multi-output DNN to predict BD/BPE together with bone mineral density and systolic blood pressure surrogates.

Results

Baseline inter-reader agreement was $\kappa=0.68$ (BD) and $\kappa=0.54$ (BPE). With AI support, agreement improved to $\kappa=0.82$. Linear regression reduced prediction error by 26% versus baseline (MSE 0.641 vs 0.864), while DNN achieved similar performance (MSE 0.638). AI assistance decreased false positives in C/D by 22% and shortened reading time by 35% (6.3–4.1 min). Validation confirmed stability (MSE ~ 0.65 ; AUC 0.74–0.75). In exploratory analysis, surrogates correlated with DXA ($r=0.82$) and sphygmomanometry ($r=0.76$).

Conclusion

AI significantly improves reproducibility and efficiency of BD/BPE assessment in CEM and supports feasibility of systemic risk profiling.

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Keywords

background parenchymal enhancement; breast density; contrast-enhanced mammography; deep learning; interobserver variability; multi-task learning; preventive imaging

Biography

Graziella Di Grezia is a Tenure-Track Researcher at Link Campus University, Department of Life Sciences, Health, and Healthcare Professions, Rome, Italy. She is also an ASN Associate Professor (Seconda Fascia) and serves on the board of the Italian Society of Medical and Interventional Radiology (SIRM). She holds an MD with honors, a PhD in Pharmacological Sciences and Clinical and Experimental Medicine, a specialization in Radiodiagnostics, and a Master's Degree in Breast Diagnostics and Interventional Surgery. Dr. Di Grezia has an extensive research portfolio, with over 100 publications indexed in PubMed and a Scopus h-index of 20. Her scientific expertise spans oncological and abdominal imaging, focusing on advanced techniques such as diffusion-weighted imaging (DWI), contrast-enhanced mammography, and artificial intelligence applications in diagnostic imaging. She is Principal Investigator in clinical research on DWI Breast MRI for dense breast tissue and actively participates in translational studies on gastrointestinal pathologies and tumor imaging.

She contributes to the scientific community as a reviewer and editorial board member for multiple international journals, maintaining rigorous standards in scientific publication. Beyond medicine, Dr. Di Grezia is a classical pianist and artist, and founder of the Mail Poetry Project®, bridging creativity with scientific outreach.