Deep learning models trained for BMI prediction show capability for BIRADS classification, revealing common underlying mammographic signals.

BMI Prediction from Mammography Images and its Implications for Breast Cancer Risk

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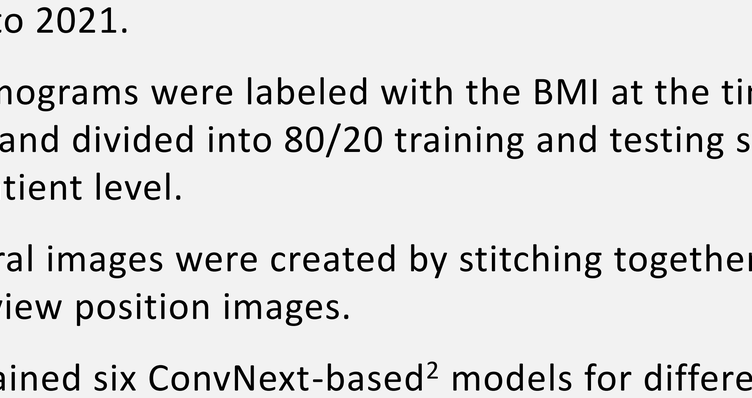
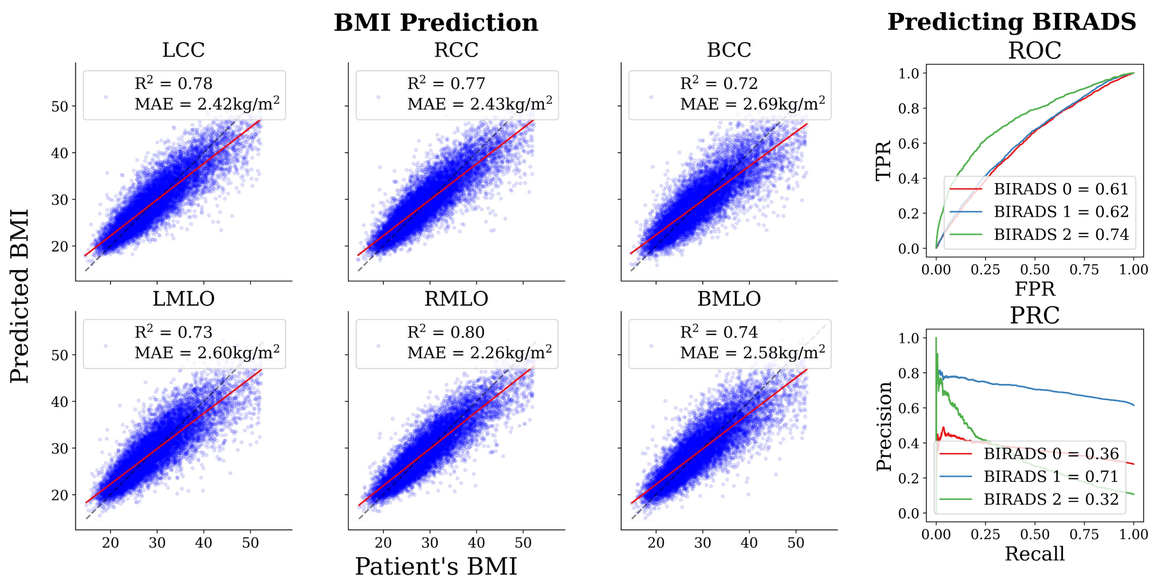
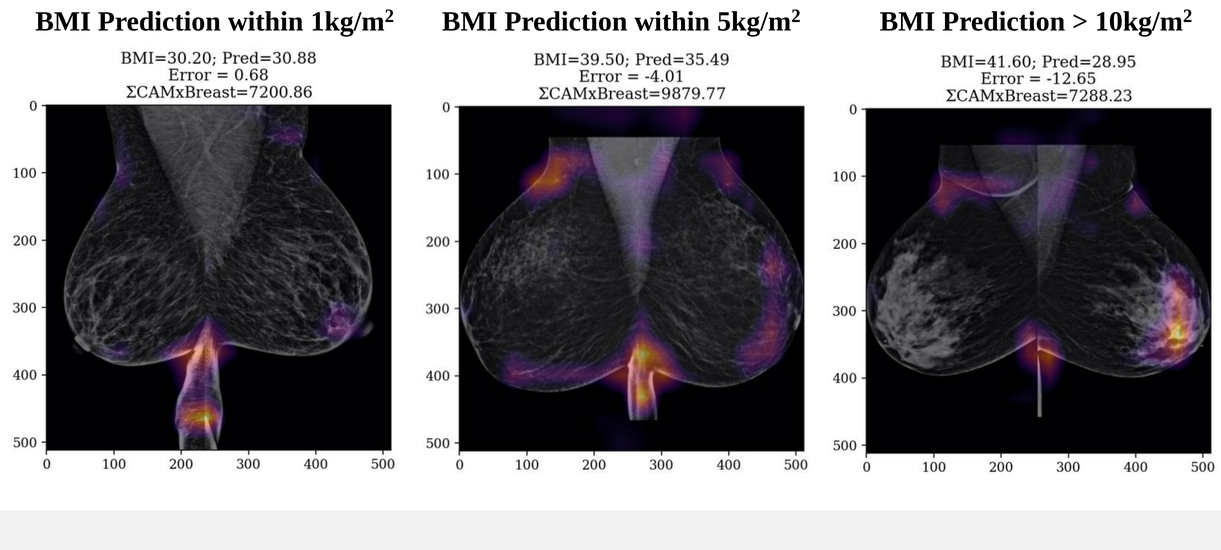
Background: Traditional breast cancer risk models often underperform, especially in minority populations. Recent advances like the image-based deep learning model Mirai[1] outperform these traditional models but lack explainability of the image features influencing their predictions. Body mass index (BMI) is a well-known, explainable risk factor for breast cancer, affecting pre- and post-menopausal women differently.
This study aims to predict BMI from mammograms, potentially shedding light on explainable features within deep-learning-based breast cancer risk prediction models.

Methods:

- We acquired a dataset of 11,874 patients who had undergone 4-view screening mammography at Emory Healthcare with corresponding BMI measurements from 2012 to 2021.
- Mammograms were labeled with the BMI at the time of the study and divided into 80/20 training and testing splits at the patient level.
- Bilateral images were created by stitching together left and right view position images.
- We trained six ConvNext-based[2] models for different views (LMLO, LCC, RMLO, RCC, BMLO, BCC)*.
- Model performance was evaluated on MAE and R^2 metrics and GradCAM++ was used for model explainability.
- Subgroup analyses were conducted on race, sex, age, marital status, tissue density, and BIRADS score subgroups.
- Finally, we took the pre-logit layer from the model and used it to predict BIRADS as well as pathological severity.







Results: All 6 models performed similarly, with mean R^2 of 0.76 (SD: 0.03) and mean MAE of 2.5 kg/m2 (SD: 0.14 kg/m2). The RMLO model outperformed others with R^2 of 0.80, suggesting sufficient BMI encoding in unilateral mammograms. Subgroup analysis on race revealed higher model performance in White patients compared to Black patients across all models, notably RMLO (R^2=0.81 vs. R^2=0.76, respectively). Model performance was lower in postmenopausal-age women (R^2=0.70 vs. R^2=0.76, respectively). BIRADS Breast Density C and BIRADS score 1 yielded the highest performance with R^2=0.67 - 0.69 and R^2=0.74, respectively. Finally, pre-logit prediction showed signal in predicting BIRADS scores with AUROC= 0.61 - 0.74.

Conclusion:

DL models demonstrate the ability to predict BMI, a risk factor in breast cancer, from mammography exams with acceptable performance. Models trained for BMI prediction were also able to predict BIRADS scores by a classification head on the last layer.

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*) List of views
- LCC: Left Cranio-Caudal
- LMLO: Left Medio-Lateral Oblique
- RCC: Right Cranio-Caudal
- RMLO: Right Medio-Lateral Oblique
- BCC: Bilateral Cranio-Caudal
- BMLO: Bilateral Medio-Lateral Oblique

References:

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2. Liu, Z., Mao, H., Wu, C.-Y., Feichtenhofer, C., Darrell, T., & Xie, S. (2022). A ConvNet for the 2020s. arXiv. https://doi.org/10.48550/ARXIV.2201.03545