EasyChair Preprint

№ 13921

A Literature Review on Mammography for Detecting Breast Cancer

Calvin Apin, Nathanael Kurniawan, Alif Handoyo and Edy Irwansyah

July 10, 2024

A Literature Review On Mammography For Detecting Breast Cancer

1st Calvin Apin
Undergraduate Binus University
Binus University
Jakarta, Indonesia
calvin.apin@binus.ac.id

2nd Nathanael Kurniawan
Undergraduate Binus University
Binus University
Jakarta, Indonesia
nathanael.kurniawan@binus.ac.id

3rd Alif Tri Handoyo
Lecturer Binus University
Binus University
Jakarta, Indonesia
alif.handoyo@binus.ac.id

4th Edy Irwansyah
Lecturer Binus University
Binus University
Jakarta, Indonesia
edirwan@binus.ac.id

Abstract—

Keywords— Detecting Breast Cancer, Mammography

I. INTRODUCTION

A.I. has been developing around the world for the past few years and continues until this point in time. A.I. has been helping people in different fields. It is believed one day A.I. can help the people in the radiology field, either generating pictures, examining patients, or another job. People always assume that A.I. can do anything in the future. One thing people have been debating a lot is whether A.I. will be able to take the job of the radiologists or will A.I. only be able to assist radiologists in their job. According to Dr. Amar Udare, MD in radiogyan.com, it is stated that A.I. will reshape how radiologists work but the role of the radiologists won't be able to be taken entirely. Most AI models are used to support lesion detection or to help radiologists do decision making. However, there are some new approaches where AI is used to analyze the disease history of the patient and writing examination reports.

II. LITERATURE REVIEW

Mammography got a computer helper in the 1990s – CAD software. It came with other tools to aid doctors. These extra tools got the green light for medical use, even though the first wave of CAD seemed like it would be a bigger deal. Most studies done were small and looked back in time (retrospective). They only used carefully picked image sets that had a lot more cancers than usual (around 26% of the images were cancerous). Also, different methods were used to create the AI models, which makes it hard to compare them. A study from Oxford involving AI and 101 radiologists is given A to H datasets with different reading countries, vendors, case set population, exam types, total number of exams, exam results, radiologists' experience, and score scale. Then, compare the reader-average AUC with the AI AUC. The analysis data which yielded empirical AUC values and their 95% confidence intervals were computed following the U-statistics to provide unbiased estimates of the variance components. Next, the AUC and operating points were compared between AI and the radiologists for each dataset. The result proves that the AUC of the AI system was statistically non inferior to that of the 101 radiologists with 0.026 of AUC difference, which is slightly higher for the AI system at the range of low and mid-specificity. Although AI had higher AUC than 62 radiologists, the performance of AI was always lower than that of the best radiologist. The performance of the AI is 0.840, 95% CI = 0.820 to 0.860 and the performance of the radiologists is 0.814, 95% CI = 0.787 - 0.841 [6].

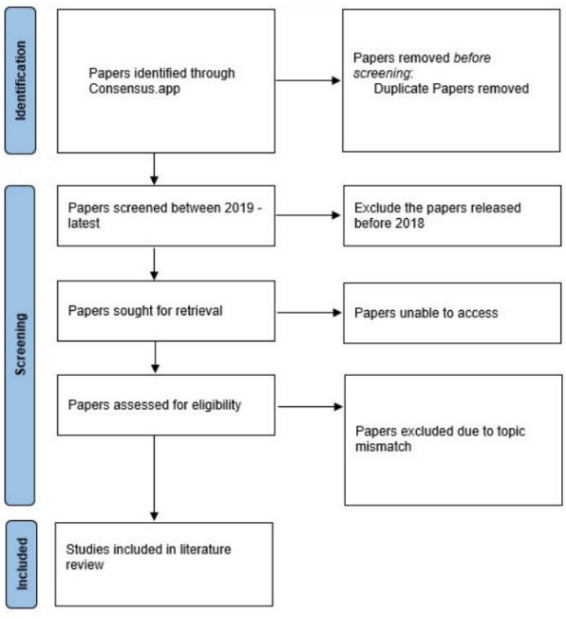
Researchers in South Korea tested an AI system for mammograms using a dataset of 320 screening mammograms. To avoid bias, the radiologists who reviewed the images (14 of them) worked at different hospitals than where the images were used to develop the AI. To measure how well the AI performed, they focused on a statistic called LOM-based mammogram level AUROC. They also looked at other factors, like how well the AI could pinpoint suspicious areas (POM) and how many cancers it correctly identified (recall) compared to how many healthy cases it flagged specifically. The radiologists scored 0.810 (AUROC) on the overall diagnostic performance. Meanwhile, the AI scored 0.940 (AUROC). The other test where the radiologists

were aided by AI, the radiologists scored 0.881 (AUROC) which is an improvement [3].

A study conducted in Western Australia utilized data from the population-based breast cancer screening program, BreastScreen WA (BSWA). The study cohort comprised women aged 50 to 74 years, aligning with the standard age range for breast cancer screening invitations in Australia, with mammograms obtained using Siemens' MAMMOMAT Inspiration system. Employing commercially available artificial intelligence (AI) algorithms, the research conducted independent validation testing by comparing AI readings with human interpretations within a real-world screening context. The dataset included sequential screening data from BSWA, encompassing participant demographics, screening outcomes, and cancer diagnoses. Utilizing the DeepHealth AI model, which holds FDA clearance and is commercially available in the US, the algorithm's performance was evaluated against Siemens digital mammography images, the system commonly used in Western Australian breast cancer screening. The study findings suggest that AI holds promise in enhancing cancer detection and reducing false recall rates within breast cancer screening [2].

The AI systems used are contemporary data driven models, most of which use convolutional neural networks or deep learning technology. However, the application of AI in healthcare poses ethical risks, including concerns about clinical outcome evidence, algorithmic bias, and implications for patient trust. The aim is to understand women's values regarding the application of AI in breast cancer screening through a dialog group-based study. Ethics approval was obtained, and dialogue groups were conducted online from June to August 2021, facilitated by senior researchers. Data collection involved a brief online survey and audio-recorded discussion, focusing on women's responses to AI in breast examination scenarios and their underlying judgments and values [1].

III. Methodology



A comprehensive search was conducted using Google Scholar and Consensus. The keywords used are "mammography", "AI", and "radiology". Searches were limited to peer-reviewed articles published in English and releases range from 2018 to the latest research papers.

25 research papers from different researchers all over the world were gathered and identified. In search of article relevance, titles, abstracts, and matching datasets is the most important information. If it does not provide any tested datasets, then the information regarding the topic will be extracted.

Here, the focus is on how AI can help radiologists in their work instead of replacing radiologists' work. So, the look for the implementation of AI in radiology begins and how much these AI can assist the radiologists.

Quality management is done by checking how relevant the topic is and how much information can be extracted along with the test results such as how many percent of the radiologists; work was eased with the help of AI.

IV. Result & Discussion

This section presents the findings from the reviewed literature on how much AI can help radiologists in their work. From the many papers available, we have selected and reviewed 25 papers to seek the information required to answer the research questions.

To squeeze the detail in each paper, the result is limited to less than 10 papers of the most related ones.

A. Performance: AI vs Radiologists

Appropriate Use Criteria (AUC) and sensitivity of AI system in radiology has been proven to have higher score than the Appropriate User Criteria (AUC) and sensitivity of most radiologists which means AI does not have higher AUC compared to all the radiologists (higher 50% - 60% of the total radiologists). The higher AUC is shown by most papers, one of them is a paper by Hyo-Eun Kim (2020), on average, the AUROC (Area Under the Receiving Operating Characteristic curve) is 0.959 with the sensitivity of 0.914. The prove that the AI does not have higher AUC than all radiologists is shown in a paper by Alejandro Rodriguez-Ruiz which is titled "Stand-Alone Artificial Intelligence for Breast Cancer Detection in Mammography: Comparison With 101 Radiologists", it is stated in the sentence "The system had a higher AUC than 62 of 101 radiologists (61.4%, Figure 2) and higher sensitivity than 55 of 95 radiologists (57.9%, Figure 3, …)".

B. Performance: Radiologists + AI vs Radiologists (Solo)

Point A compares the result of AI's AUC and radiologists' AUC. However, point B is a little different. It involves AI in helping radiologists detect breast cancer. This shows a better accuracy in detecting breast cancer due to there are some cases where radiologists detect the presence of breast cancer and AI don't. There is also a case where it happens the other way around, AI detects the presence of breast cancer, and radiologists don't.

Other paper written by Alejandro Rodriguez-Ruiz, the AUC was higher with AI support compared to unaided reading. Not only did the AUC increase, but the sensitivity also increased. Even if it's only a slight increase, it is still something.

V. Conclusion

From this literature review, it is known that the comparison of AI's breast cancer reading is only slightly better than radiologists' read without AI's help. But, in the digitalization era, the research of what AI is capable of helping radiologists will continue to develop. As for now, AI can help a country with less experience radiologists to make decisions and reconsider the result when there are different results. It is not best to 100% rely on AI's help but that does not mean to reject AI's help either.

Aside from the positive things, there are also negative things to consider, the difference in result may confuse and concern radiologists. Especially, when ther is a malfunction when reading cancer images.

References

[1] Ahn, J. S., Shin, S., Yang, S.-A., Park, E. K., Kim, K. H., Cho, S. I., Ock, C.-Y., & Kim, S. (2023). Artificial Intelligence in breast cancer diagnosis and personalized medicine. Journal of Breast Cancer, 26(5), 405. doi: 10.4048/jbc.2023.26.e45

[2] Alongi, P., Rovera, G., Stracuzzi, F., Popescu, C. E., Minutoli, F., Arnone, G., Baldari, S., Deandreis, D., & Caobelli, F. (2023). Artificial Intelligence in breast cancer: A systematic review on Pet Imaging Clinical Applications. Current Medical Imaging Formerly Current Medical Imaging Reviews, 19(8). doi: 10.2174/1573405619666230126093806

[3] Carter, S. M., Carolan, L., saint James Aquino, Y., Frazer, H., Rogers, W. A., Hall, J., Degeling, C., Braunack-Mayer, A., & Houssami, N. (2023). Australian women's judgements about using artificial intelligence to read mammograms in breast cancer screening. *Digital Health*, *9*. doi: 10.1177/20552076231191057

[4] Dang, L.-A., Chazard, E., Poncelet, E., Serb, T., Rusu, A., Pauwels, X., Parsy, C., Poclet, T., Cauliez, H., Engelaere, C., Ramette, G., Brienne, C., Dujardin, S., & Laurent, N. (2022). Impact of artificial intelligence in breast cancer screening with mammography. Breast Cancer, 29(6), 967–977. doi: 10.1007/s12282-022-01375-9

[5] Dileep, G., & Gianchandani Gyani, S. G. (2022). Artificial Intelligence in breast cancer screening and diagnosis. Cureus. doi: 10.7759/cureus.30318

[6] Gastounioti, A., Desai, S., Ahluwalia, V. S., Conant, E. F., & Kontos, D. (2022). Artificial Intelligence in mammographic phenotyping of breast cancer risk: A narrative review. Breast Cancer Research, 24(1). doi: 10.1186/s13058-022-01509-z

[7] Houssami, N., Kirkpatrick-Jones, G., Noguchi, N., & Lee, C. I. (2019). Artificial Intelligence (AI) for the early detection of breast cancer: a scoping review to assess AI's potential in breast screening practice. In *Expert Review of Medical Devices* (Vol. 16, Issue 5). doi: 10.1080/17434440.2019.1610387

[8] Kim, H. E., Kim, H. H., Han, B. K., Kim, K. H., Han, K., Nam, H., Lee, E. H., & Kim, E. K. (2020). Changes in cancer detection and false-positive recall in mammography using artificial intelligence: a retrospective, multireader study. *The Lancet Digital Health*, *2*(3). doi: 10.1016/S2589-7500(20)30003-0

[9] Kim, K. H., Nam, H., Lim, E., & Ock, C.-Y. (2021). Development of AI-powered imaging biomarker for breast cancer risk assessment on the basis of mammography alone. *Journal of Clinical Oncology*, *39*(15_suppl), 10519–10519. doi: 10.1200/jco.2021.39.15_suppl.10519

[10] Lauritzen, A. D., Rodríguez-Ruiz, A., von Euler-Chelpin, M. C., Lynge, E., Vejborg, I., Nielsen, M., Karssemeijer, N., & Lillholm, M. (2022). An artificial intelligence–based Mammography Screening protocol for breast cancer: Outcome and radiologist workload. *Radiology*, *304*(1), 41–49. doi: 10.1148/radiol.210948

[11] Marinovich, M. L., Wylie, E., Lotter, W., Lund, H., Waddell, A., Madeley, C., Pereira, G., & Houssami, N. (2023). Artificial Intelligence (AI) for breast cancer screening: BreastScreen population-based Cohort Study of Cancer Detection. eBioMedicine, 90, 104498. doi: 10.1016/j.ebiom.2023.104498

[12] McKinney, S. M., Sieniek, M., Godbole, V., Godwin, J., Antropova, N., Ashrafian, H., Back, T., Chesus, M., Corrado, G. C., Darzi, A., Etemadi, M., Garcia-Vicente, F., Gilbert, F. J., Halling-Brown, M., Hassabis, D., Jansen, S., Karthikesalingam, A., Kelly, C. J., King, D., … Shetty, S. (2020). International evaluation of an AI system for breast cancer screening. *Nature*, *577*(7788). doi: 10.1038/s41586-019-1799-6

[13] Pacilè, S., Lopez, J., Chone, P., Bertinotti, T., Grouin, J. M., & Fillard, P. (2020). Improving breast cancer detection accuracy of mammography with the concurrent use of an artificial intelligence tool. *Radiology: Artificial Intelligence*, *2*(6). doi: 10.1148/ryai.2020190208

[14] Park, G. E., Kang, B. J., Kim, S. H., & Lee, J. (2022). Retrospective Review of Missed Cancer Detection and its mammography findings with artificial-intelligence-based, computer-aided diagnosis. *Diagnostics*, *12*(2), 387. doi: 10.3390/diagnostics12020387

[15] Rodríguez-Ruiz, A., Krupinski, E., Mordang, J.-J., Schilling, K., Heywang-Köbrunner, S. H., Sechopoulos, I., & Mann, R. M. (2019). Detection of breast cancer with mammography: Effect of an Artificial Intelligence Support System. *Radiology*, *290*(2), 305–314. doi: 10.1148/radiol.2018181371

[16] Rodriguez-Ruiz, A., Lång, K., Gubern-Merida, A., Broeders, M., Gennaro, G., Clauser, P., Helbich, T. H., Chevalier, M., Tan, T., Mertelmeier, T., Wallis, M. G., Andersson, I., Zackrisson, S., Mann, R. M., & Sechopoulos, I. (2019). Stand-Alone Artificial Intelligence for Breast Cancer Detection in Mammography: Comparison With 101 Radiologists. *Journal of the National Cancer Institute*, *111*(9). doi: 10.1093/JNCI/DJY222

[17] Taya, M. (2020). Comparative performance of artificial intelligence algorithms for screening mammography. *Radiology: Imaging Cancer*, *2*(6). doi: 10.1148/rycan.2020209034

[18] Tran, W. T., Sadeghi-Naini, A., Lu, F.-I., Gandhi, S., Meti, N., Brackstone, M., Rakovitch, E., & Curpen, B. (2020). Computational Radiology in breast cancer screening and diagnosis using Artificial Intelligence. Canadian Association of Radiologists Journal, 72(1), 98–108. doi: 10.1177/0846537120949974

[19] Uzun Ozsahin, D., Ikechukwu Emegano, D., Uzun, B., & Ozsahin, I. (2022). The systematic review of artificial intelligence applications in breast cancer diagnosis. Diagnostics, 13(1), 45. doi: 10.3390/diagnostics13010045

[20] Zheng, D., He, X., & Jing, J. (2023). Overview of artificial intelligence in Breast Cancer Medical Imaging. Journal of Clinical Medicine, 12(2), 419. doi: 10.3390/jcm12020419