Derna University Journal of Medical Sciences (DUJMS)

UNIVERSITY OF DERNA

Volume 04 | Issue 01 | 2026 | Pages: 50-59
ISSN: 3005-236X (Online) | **DOI:** https://doi.org/10.58987/rarcm986

A Review Article

Global Research Trends in Medical Imaging for Breast Cancer: A Bibliometric Analysis (2000–2025)

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Received: 28 04 2026 **Accepted:** 15 06 2026 **Published:** 30 06 2026

ABSTRACT:

Background: Breast cancer remains the most common malignancy among women globally, making early detection and accurate diagnosis vital for enhancing patient outcomes. Advances in breast imaging modalities have played a pivotal role in improving diagnostic accuracy over the few decades. This study aims to summarize published literature in PubMed between 2000 and 2025 on breast cancer detection and diagnosis using various imaging modalities. A comprehensive PubMed search strategy was conducted using MeSH terms and keywords associated with breast neoplasms and breast imaging modalities (mammography, ultrasound, MRI, virtual breast tomosynthesis, assessment-stronger mammography, molecular breast

imaging, and thermography). The seek became restricted to check articles posted between 2000 and 2025, yielding a total of 4,107 studies. Mammography remains the cornerstone of breast most cancers screening applications, with ultrasound and breast MRI serving as complementary gear, especially in dense breast tissue and excessive-danger populations. In recent years, rising modalities which include digital breast tomosynthesis, assessment-superior mammography, and molecular breast imaging have won increasing interest for his or her capability to enhance sensitivity and specificity. Moreover, the integration of synthetic intelligence into breast imaging is highlighted across the literature as a promising method to enhance diagnostic performance and decrease fake-high-quality fees. The body of evidence suggests significant advancements in breast imaging technologies over the past 25 years. The future detection of the most breast cancers imaging lies in combining conventional modalities with innovative techniques and AI-driven evaluation to optimize early detection and personalized care.

KEYWORDS: Global Research Trends, Medical Imaging for Breast Cancer, A Bibliometric Analysis.

INTRODUCTION

Bibliometric analysis is a popular and rigorous method for exploring and analyzing large volumes of scientific data. It enables researchers to unpack the evolutionary nuances of a specific field, while shedding light on the emerging areas in that field. (Donthu, N., et al.2021)

The process generally involves collecting data from relevant databases, cleaning and refining that data, and then applying a variety of bibliometric techniques to extract meaningful insights. As research output continues to expand, bibliometric methods have gained importance as a reliable way to manage and interpret large volumes of information. Compared with traditional systematic reviews, bibliometric analysis offers an alternative that highlights research networks, publication trends, and thematic developments. This methodology is increasingly recognized as a valuable tool for researchers seeking to evaluate knowledge structures and monitor scientific progress across different academic disciplines. (Passas, I. 2024).

In recent years, bibliometrics has grown in popularity in scholarly research. (Khan, M.A., et al. 2021; Donthu, N., et al. 2020))

Bibliometrics demonstrates its usefulness in dealing with good sized quantities of scholarly statistics, creating a first-rate impact on studies consequences. This huge acceptance is because of numerous factors, including the progress, ease of use, and presence of bibliometric instruments including R and VOSviewer, in addition to scholarly repositories consisting of Google Scholar, Scopus, and Web of Science. The sizeable use of the bibliometric technique, which spans from information technological know-how to operations studies, has additionally had a good sized impact. (Doulani, A., et al. 2020)

Scholar Bibliometric assessment for diverse objectives, such as identifying upcoming developments in the article and the journal success, collaborative arrangements, research elements, and examining intellectua l framework of a specific field within the present publications. (Verma, S., et al. 2020; Abramo, G., et al.2014). Data essential to bibliometric assessment is often

large, consisting of hundreds or thousands of the entries, and quantifiable, measuring citation and the publication counts, keyword appearances, and also the subject area. Simultaneously, its interpretations are frequently based on subjective (such as hematic examination) and objective (such as performance assessment) judgments derive by using the knowledgeable methods and procedures. Via the committed efforts to interpret massive unstructured information, bibliometrics, or similarly, scientometrics, aids in outlining and comprehending cumulative scientific understanding and subtle evolution ary aspects of well-established disciplines. As a result, well-executed bibliometric investigations can offer a solid base in all subject areas. (Passas, I. 2024)

Although bibliometric analysis has many advantages, it is still a relatively new tool in research, and its full potential remains untapped. (Rousseau, S., et al. 2021)

Breast cancer is one of the most common forces in women around the world and is the main cause of cancer -related death in many countries. Early identity increases the chances of treatment and survival, making medical imaging an essential tool for diagnosis, staging, treatment plan and follow-up.
Traditional imaging techniques include mammography (mammography) However, screening with mammography alone may be insufficient for women at high risk of breast cancer. For example, cancers can be missed at mammography in women with dense breasts because of the camouflaging effect. The need for more effective assessment strategies has led to the emergence of newer imaging techniques for supplemental screening and diagnostic, prognostic, and treatment purposes, including (Hu, Q., & Giger, M. L. (2021) ultrasound and magnetic resonance imaging (MRI).

They are often used to screen risk factors, dense breast tissue or when clinical suspicion women.

In recent years, advanced and better ways such as tomocynthesis, contrast-grown imaging and molecular breast imagination have appeared. Artificial intelligence and deep learning also play growing roles in image analysis, lowers clinical errors and improves detection speed and accuracy. (Sardanelli F., et al 2017)
For many years, systems that use artificial intelligence, like computer-aided detection (CADe), diagnosis (CADx), and triaging (CADt), have been created and put into use in medical settings, and their progress has become faster lately because of better computers and new
ways of processing information. (Vyborny CJ., et al 1994)

These artificial intelligence techniques pull out and look at lots of numerical details from pictures, which
helps radiologists understand images better, either at the same time as them, as a backup, or as the main reader, at different points in the medical process.

Even though artificial intelligence systems seem like they could really help with checking images for breast cancer, it is important to remember that they also come with some problems and need to be created and used very carefully. (Hu, Q., & Giger, M. L. (2021)

There are at present more than 20 FDA-approved AI applications for breast imaging, but adoption and utilization are widely variable and low overall. (Taylor CR., et al. 2023)

MATERIALS AND METHODS

This investigation relies primarily on scholarly articles indexed in major bibliographic databases, with a focus on health sciences and medicine, as these fields share similar research processes and channels of information dissemination.

PubMed was chosen as the main database due to its extensive biomedical coverage and structured indexing through MeSH terms, ensuring the inclusion of high-quality

literature.

Although other databases, such as Scopus or Web of Science, provide broad coverage, PubMed offers a sufficient and representative corpus of medical publications for the purpose of this study.

A comprehensive PubMed search strategy was conducted using MeSH terms and keywords related to breast neoplasms and breast imaging modalities (mammography, ultrasound, MRI, digital breast tomosynthesis, contrast-enhanced mammography, molecular breast imaging, and thermography).

The search was restricted to review articles published between 2000 and 2025, yielding a total of 4,107 studies.

In addition, the bibliometric analysis was conducted using VOSviewer software to visualize and measure co-authorship networks, keyword co-occurrence, and institutional collaborations.

This approach enabled a detailed examination of research trends, thematic structures, and influential organizations within the field of breast cancer imaging.

RESULTS AND DISCUSSION

This network map provides a clear visual representation of the scientific collaboration structure in this field. It highlights the prominent role of Nehmat Houssami as a central connector and shows the existence of several well-defined research groups, some of which are interconnected, while others operate on the periphery.

This type of analysis is useful for identifying key opinion leaders and understanding the overall dynamics of a research community. As shown in Fig. 1.

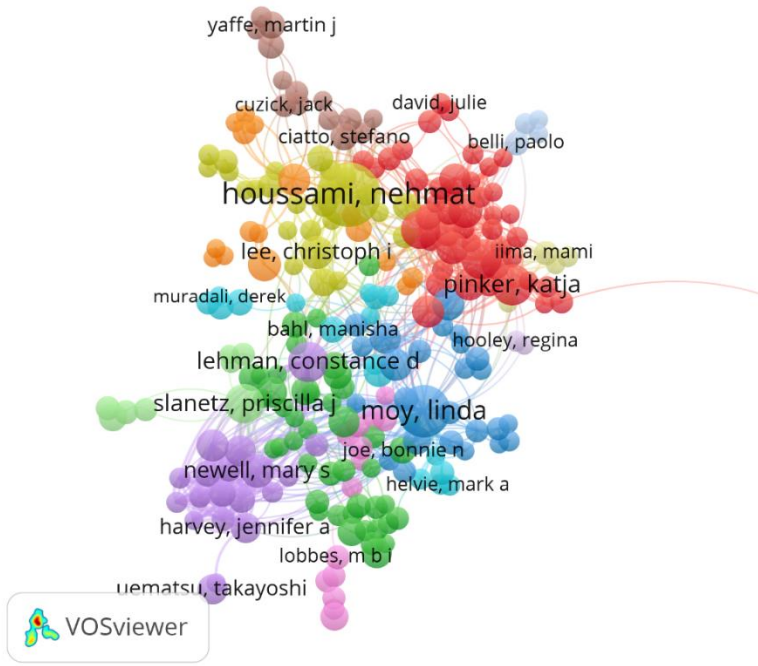

Figure. 1 Co-Authorship Network.

Central and Highly Connected Cluster: The biggest and most valuable cluster (colored red) is ruled through the researcher "houssami, nehmat". This shows that this individual is a distinctly influential and critical figure on this studies area, likely a frontrunner in the biggest and most productive collaboration group. Other prominent researchers in this cluster encompass "belli, paolo" and "pinker, katja".

Distinct Collaborative Groups: Several different distinct clusters are seen, which include the inexperienced cluster with "moy, linda" and "harvey, jennifer a," the red cluster with "slanetz, priscilla j," and the yellow cluster with "cuzick, jack." These clusters constitute specific research groups or sub-fields that have sturdy internal collaborations.

Peripheral and Isolated Researchers: A small, separate cluster is seen on the a long way right, containing "cassano, enrico" and "latronico, antuono." Their remoted function from the principle community suggests that

they either paintings on a totally specific, niche topic or collaborate much less regularly with the larger, more valuable agencies in this domain.

This map represents the evolution of research collaboration in the field of breast cancer over time. The same co-authorship network is shown as before, but the nodes (researcher circles) are now colored based on the average publication year of their work. As shown in Fig. 2

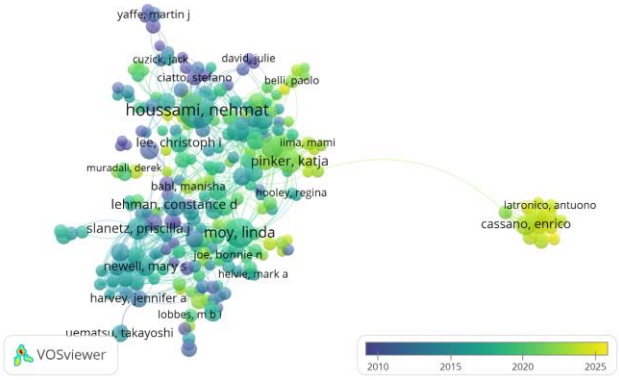

Figure 2. Co-Authorship Network according to Time Published.

Sustained Collaboration: The significant community, led by "houssami, nehmat," suggests a mix of colours, from antique (blue) to recent (yellow/green). This suggests that the core group has been continuously active and efficient over a long period, with new research always emerging from their collaborations.

Recent Research Focus: The map highlights that the most current studies activity (indicated by using yellow and light green nodes) is concentrated in particular regions. The previously isolated group of "cassano, enrico" and "latronico, antuono" seems to have come to be greater active in recent years, as their nodes are predominantly warm-coloured. There is also huge recent hobby inside the valuable cluster and other agencies just like the one along with "moy, linda."

Network Dynamics: The visualization demonstrates the dynamic nature of the network. Some researchers, inclusive of "harvey, jennifer a" and "newell, mary s," have a long records of collaboration (indicated with the aid of blue/crimson nodes), whilst others with more latest colours like "banti, manisha" can be more moderen contributors to the collaboration network.This VOSviewer map illustrates a network of collaboration between different **organizations** involved in breast cancer research. The links show which institutions have co-authored publications, and the colors represent the timeframe of those collaborations. As shown in Fig. 3

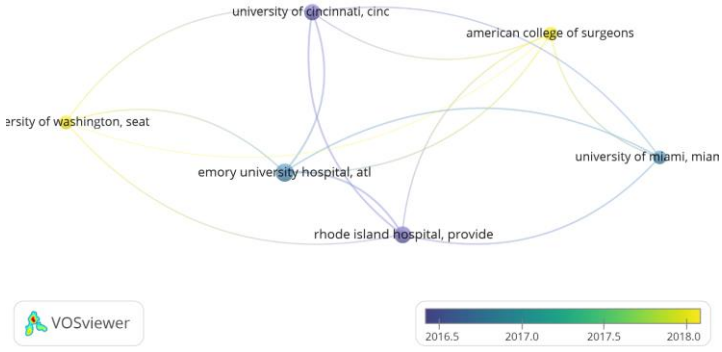

Figure 3. Network of Collaboration between Organizations.

This map shows a cluster of collaborating institutions over a relatively short period, from mid-2016 to mid-2018.

Central Collaborators: The American College of Surgeons appears to be a key, central hub in this network. Its node is bright yellow, indicating that its collaborations with other institutions, such as the University of Miami and the University of Cincinnati, are among

the most recent ones.

Established Connections: Rhode Island Hospital and Emory University Hospital also form a central part of this network, with strong connections to each other and to the University of Cincinnati. Their nodes are a mix of blue and green, suggesting that their partnerships are slightly older but still very active within this timeframe.

Distributed Network: The map doesn't show one single institution dominating the entire network. Instead, the collaboration is distributed across multiple key organizations that are all interconnected. For example, the University of Cincinnati links several different parts of the network together.

This VOSviewer map displays a keyword co-occurrence network in breast cancer research, showing the most frequent topics and how they have evolved from 2018 to 2022. The size of each term's circle reflects its frequency, while the color indicates the average publication year. As shown in Fig. 4

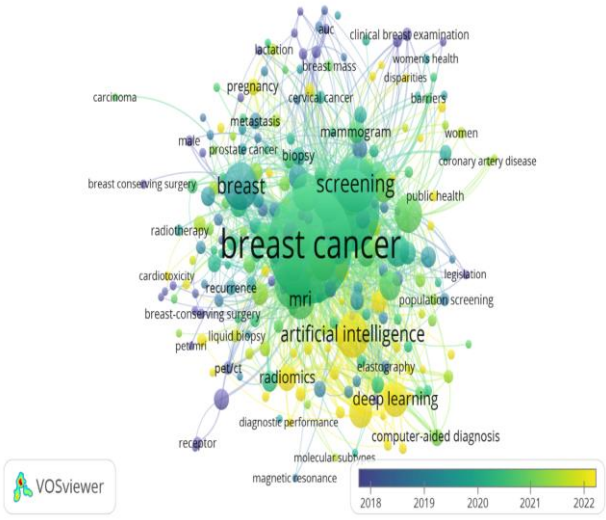

Figure 4. A keyword Co-Occurrence Network 2018-2022.

Core Research Areas: The largest and most central nodes are "breast cancer" and "screening," confirming these are the fundamental and most frequently discussed topics. They serve as the central hubs of the entire research field. Other core terms include "mammogram" and "biopsy."

Emerging Technology: A distinct, brightly colored cluster of keywords on the bottom right is entirely yellow, indicating the most recent research trends (2021-2022). This cluster is dominated by terms like "artificial intelligence," "deep learning," "radiomics," and "computer-aided diagnosis." This highlights a major shift toward technology-driven research in diagnosis and treatment.

Clinical and Patient-Oriented Topics: The map also shows a cluster of nodes related to patient health and demographics. Terms such as "women," "public health," and "disparities" are prominent, often with more recent, yellowish colors.

This indicates a growing focus on the societal aspects of breast cancer, including health equity and population screening.

In conclusion, the map shows that while the core research on breast cancer and screening remains central, the field is rapidly adopting new technologies. The most cutting-edge research is now centered on artificial intelligence and its applications in diagnosis and patient care.

This VOSviewer map shows a keyword co-occurrence network for research on breast cancer. The map reveals the key topics, their frequency, and their evolution over time. As shown in Fig. 5

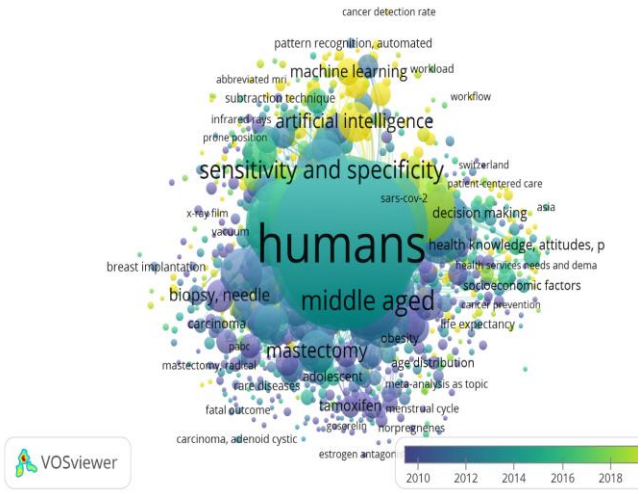

Figure 5. Figure 4. A Keyword Co-Occurrence Network 2010-2020.

The map illustrates a clear progression from core clinical topics to modern, technology-focused research. The field's most cutting-edge work now centers on the application of artificial intelligence for cancer detection and diagnosis.

DISCUSSION

This bibliometric study aimed to analyze trends, patterns, and influential factors in breast cancer imaging research between 2000 and 2025. The analysis of 4,107 review articles revealed a steady increase in publications, with a notable surge in studies on advanced imaging modalities such as digital breast tomosynthesis and contrast-enhanced mammography in recent years.(Abdulwahid Mohammad Noor, K., et al. 1995)

The growth in publications related to advanced imaging techniques reflects the rapid technological progress in breast diagnostics, as well as the increasing adoption of artificial intelligence in medical imaging analysis. This trend suggests a shift toward integrating innovative tools to improve diagnostic accuracy and personalized care.

These findings are constant with previous bibliometric research in scientific imaging, which additionally highlighted the growing position of AI and advanced modalities. However, in contrast to previous research that specialize in broader oncology topics, this take a look at provides a more unique mapping of breast imaging research over the last 25 years. (Syed, A. H., et al. 2022)

Understanding these bibliometric tendencies is treasured for researchers, policymakers, and clinicians, as it helps discover emerging subjects, capability gaps in the literature, and precedence areas for destiny research. Such insights can manual investment decisions and promote greater targeted investigations. (Wan, Y., Shen, Y., 2025).

A most important strength of this observe is its complete dataset spanning 25 years and using advanced bibliometric gear like VOSviewer for visual evaluation. Limitations encompass the reliance on a single database (PubMed) and limit to check articles, which can also have excluded different applicable studies.

Future studies need to encompass a broader range of publications from various databases to provide a greater comprehensive evaluate. Furthermore, longitudinal research assessing the clinical impact of superior imaging modalities and AI integration are critical to validate their effectiveness in real-world settings.

CONCLUSION

The comprehensive bibliometric analysis of 4,107 review articles on breast cancer imaging

published in PubMed between 2000 and 2025 highlights significant technological and thematic advancements over the past 25 years.

While mammography remains the core of breast cancer screening, the field has rapidly evolved with the emergence of complementary and advanced modalities. The study revealed a notable increase in publications concerning advanced techniques like digital breast tomosynthesis and contrast-enhanced mammography.

The most prominent and cutting-edge trend in recent years is the integration of artificial intelligence (AI). Terms such as "artificial intelligence," "deep learning," and "radiomics" form a highly active, recent cluster in the keyword co-occurrence network, underscoring a major shift toward technology-driven improvements in diagnostic performance and personalized care.

Analysis of the co-authorship network identifies Nehmat Houssami as a central and highly influential figure, leading the largest and most productive research cluster, which shows sustained, long-term activity.

In essence, the body of evidence indicates that the future direction of breast cancer imaging lies in optimizing early detection and clinical outcomes by combining conventional modalities with innovative techniques and AI-driven analysis. Understanding these trends is crucial for guiding future research funding and policy decisions.

ACKNOWLEDGEMENT

We would like to thank everyone who contributed to this work

ETHICS

Ethical approval was not required because this study was based exclusively on published literature.

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اتجاهات البحث العالمي في مجال التصوير الطبي لسرطان الثدي : تحليل ببيليومترى 2000 – 2025

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الملخص

لا يزال سرطان الثدي أكثر أنواع السرطان شيوعًا بين النساء على مستوى العالم، مما يجعل الكشف المبكر والتشخيص الدقيق أمرين بالغَي الأهمية لتحسين نتائج المرضى. وقد لعبت التطورات في تقنيات تصوير الثدي دورًا محوريًا في تحسين دقة التشخيص خلال العقود القليلة الماضية. PubMedخلال الفترة من عام 2000 إلى عام 2025 حول الكشف عن سرطان الثدي وتشخيصه باستخدام مختلف تقنيات التصوير الطبي. تهدف هذه الدراسة إلى تلخيص الأدبيات العلمية المنشورة في قاعدة بيانات المنهجية: أُجري بحث شامل في قاعدة بيانات PubMed باستخدام مصطلحات MeSH والكلمات المفتاحية المرتبطة بأورام الثدي وتقنيات تصوير الثدي، بما في ذلك تصوير الثدي الشعاعي(Mammography) ، والتصوير بالموجات فوق الصوتية (Ultrasound)، والتصوير بالرنين المغناطيسي(MRI) ، والتصوير المقطعي الرقمي للثدي (Digital Breast Tomosynthesis)، والتصوير الشعاعي المعزز بالتباين(Contrast-Enhanced Mammography) ، والتصوير الجزيئي للثدي(Molecular Breast Imaging) ، والتصوير الحراري .(Thermography) واقتصر البحث على المقالات المرجعية المنشورة بين عامي 2000 و2025، وأسفر عن 4,107 دراسة. لا يزال تصوير الثدي الشعاعي يمثل الركيزة الأساسية لبرامج الكشف المبكر عن سرطان الثدي، بينما يُستخدم كل من التصوير بالموجات فوق الصوتية والتصوير بالرنين المغناطيسي كوسائل مكملة، خاصة لدى النساء ذوات كثافة نسيج الثدي العالية والفئات المعرضة لخطر مرتفع. وخلال السنوات الأخيرة، حظيت تقنيات حديثة مثل التصوير المقطعي الرقمي للثدي، والتصوير الشعاعي المعزز بالتباين، والتصوير الجزيئي للثدي باهتمام متزايد نظرًا لقدرتها على تحسين الحساسية والنوعية التشخيصية. بالإضافة إلى ذلك، أبرزت الأدبيات العلمية دمج تقنيات الذكاء الاصطناعي في تصوير الثدي باعتباره نهجًا واعدًا لتعزيز الأداء التشخيصي وتقليل معدلات النتائج الإيجابية الكاذبة. تشير الأدلة المتوفرة إلى حدوث تطورات كبيرة في تقنيات تصوير الثدي خلال الخمسة والعشرين عامًا الماضية. ويكمن مستقبل الكشف عن سرطان الثدي في دمج وسائل التصوير التقليدية مع التقنيات المبتكرة والتقييم المعتمد على الذكاء الاصطناعي، بما يسهم في تحسين الكشف المبكر وتقديم رعاية صحية أكثر تخصيصًا للمرضى..

.**الكلمات المفتاحية**: التحليل الببليومتري، الثدي، السرطان، التصوير الطبي.